
PLANT LOCATION - A CASE STUDY:
THE VALUE OF NON-QUANTIFIED VARIABLES FOR SITE SELECTION

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Introduction

It has long been considered by management that the three most important considerations in plant location decisions are the delivered cost of materials and supplies, the cost of production and the cost of outbound finished goods transportation. The primary objective of management is to increase the wealth of the stockholders through improvement in the corporate bottom line. The principal method used by production management to accomplish this objective is to minimize the total delivered cost of the product to the final destination [1] — and to most management this total delivered cost is merely the sum of the factory door cost for producing the product and the transportation cost for delivering the product from the point of manufacture to the customer.

Quite often those responsible for plant location decisions use the classical linear programming “transportation problem” model to determine the most cost effective area of all those under consideration [2] — and then this “most cost effective area” is the one selected for further superficial study. But is cost the one overriding factor [3]? And how does management know that cost, by itself, will really provide the optimal area?

The authors of this paper have been intimately involved with several plant location studies performed by a Fortune 100 corporation. It is our opinion that microanalysis, using the transportation model method with or without the additional superficial site selection studies generally considered necessary for selecting the optimal facility location, ignores a multitude of important factors.

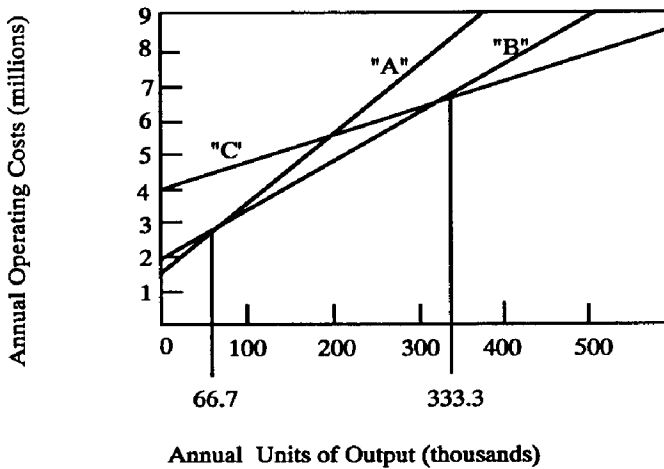
These additional meaningful, but generally non-quantifiable, factors must be fully investigated and evaluated, along with traditional site selection quantitative analyses, in order to determine as accurately as possible the probability of success or failure of a specific area toward reaching the corporate objective of being in a “quality” location. Costs can be and generally are accurately measured and optimized, but it is our opinion that many intangible and not easily quantifiable factors must also be quantified and considered by the organization in order to predict success. Twenty-two of these additional, generally non-quantifiable, variables are described in detail in this paper.

The purpose of this paper is to describe a “total” area location and site selection study performed by a major corporation. As part of the overall study, this corporation went far beyond the usual economic analysis in order to identify locations totally satisfactory for both the near and long term. The “total” study did accomplish the organization’s objective of avoiding a disastrous location — and this corporation’s management truly believes this objective is far more important than merely finding the location which is just the “most cost effective.”

Frequently other organizations identify what they deem to be suitable areas for new facilities through use of the traditional economic approach — they first determine break-even volume points for the various locations under consideration and then select the location which will generate the lowest total costs for the volumes selected. The break-even chart below is an example of this approach.

Figure 1

Break-Even Analysis of Facility-Location Decisions



Results of Break-Even Analysis

When output is less than 66.667 units/year. Location A is best.

When output is between 66.667 and 333.333 units/year. Location B is best.

When output is greater than 333.333 units/year. Location C is best.

This break-even chart merely adds the fixed costs to the variable costs in order to obtain total costs at various volumes for each of the locations under consideration. The break-even approach is a variation of the classical linear programming transportation model in that it analyzes costs from a different perspective — it also considers labor and fixed costs while the transportation model considers only transportation costs. The break-even model, in addition, provides sensitivity of a particular site to changes in production volumes.

The site selection technique which is reviewed in this paper is used by several major corporations. In order to properly employ this technique, the organization must first select the three or four (or more) most cost effective locations from all those under consideration through use of traditional site selection methodology — be it break-even, transportation model, or some other cost comparison method. It must then compare each of these pre-selected locations — one against the others — on a checklist of various non-

quantified intangible but identifiable variables such as labor and business climate, living conditions, ecology, educational opportunities, political and financial stability, police and fire protection, etc. Each factor is then rated on a scale of 1 to 10, with each variable bearing its exclusive subjective weighting in comparison to the other variables. Each evaluated location, then, is ranked against each other — and the location with the most favorable ranking is recommended.

Using this approach, Hewlett-Packard recently selected Boise, Idaho as a new plant location based upon such subjective factors as:

- An attractive place to live.
- A graduate engineering school nearby.
- Two hours by air to San Francisco.
- An adequate supply of available labor.
- Good freight service.
- An enlightened community leadership.
- A community that wants Hewlett-Packard.

Using this same “logistics chain” approach, Kraft-General Foods selected both Mason City, Iowa in 1986 as a site for production of its new family of shelf stable ready-to-eat prepared food products and Jonesboro, Arkansas in 1988 as a new site for production of breakfast cereals; Fuji-Isuzu chose Lafayette, Indiana in 1986 for Isuzu automobile production; Chrysler-Mitsubishi located its new automobile plant in Bloomington, Illinois in 1986; and Lockheed decided to build a new automated AS/RS warehouse adjacent to its existing California facility rather than locate the warehouse at an alternate site. These are six specific examples of successful companies that have employed the method we will describe in detail for successful plant location selections.

With the new united European Economic Community concept, many American corporations are now actively considering the establishment of European facilities so that they might be in a position to take advantage of the benefits of this united European community. When evaluating foreign locations however, many of these organizations have found that additional factors also require careful study. For example, language and cultural differences immediately become apparent, and these differences can present operating and control difficulties overseas. All existing policies, procedures, and instructions which will be used in these foreign facilities must be translated into the language of the land, and local customs must be recognized and observed.

“Cheap foreign labor” is generally no longer a major factor to American industry since many foreign industrialized countries now enjoy wage and benefit rates equal to, and in some cases greater than, those in the United States. In those foreign societies where these rates are substantially below those in America, such as in many of the third world countries, the productivity of the worker is also substantially lower.

Governmental stability is also of great concern when it comes to guaranteeing the safety of overseas industrial investment. We have all recently been made aware of the importance of the relationship between overseas industrial investment and government stability by the August 1990 invasion of Kuwait by Iraq, the June 1989 events in China and the

August 1991 events in Russia. This is especially true, as reported in Time, Business Week and Newsweek, for those organizations such as Texaco which lost millions of dollars worth of petroleum in Kuwait, and by Occidental Petroleum, Chrysler, and Windmere which had invested in excess of \$2 billion in mainland China prior to the violence and massacre in Beijing's Tiananmen Square and subsequent political clampdown throughout China.

Plant Location: A Case Study

This paper discusses the procedure used by a consumer products manufacturer that is a member of the Fortune 100 to select a site for a new manufacturing facility. To conceal the name of this client company, we will refer to it in this paper as "A" Corporation - a fictitious name. Our purpose in preparing this paper is to present and discuss those non-quantifiable and intangible factors which this corporation considered important enough to use as a basis for the selection of a specific location for a new multimillion dollar facility.

"A" Corporation operated multiple manufacturing facilities in the northeastern section of the United States, all producing the same family of products. All of these facilities, although recently modernized, were relatively old and inefficient, but each was still producing an acceptable quality product with relatively few consumer complaints.

Management recognized that this geographical concentration of old and inefficient facilities with multiple overheads was not cost effective. After a thorough study and evaluation, they concluded that a single new state-of-the-art facility should be established with the capability of producing twice the volume of the combined existing facilities. Based upon distribution logistics, it was concluded in the evaluation that this new facility should be located within 350 miles of the principal market, New York City.

A major plant location consulting organization was retained to identify, using traditional area location and site selection methodology, the most cost effective area for the company's new plant. Various parameters and delimitations were provided to aid the consultants in the selection of a suitable location. Among these, in addition to the marketing oriented objective that the facility should be within 350 miles of New York City, was the sourcing oriented objective that the facility should be near an ocean port since much of the raw material used would come from overseas.

These consultants evaluated many areas in the ten eastern states which satisfied the parameters and delimitations of the study. The consultants' study indicated that the new state-of-the-art consolidated facility should be located somewhere within the geographic triangle formed by Wilmington, Philadelphia and Baltimore. This area location study identified a general area for the new facility based upon the parameters supplied by "A" Corporation and specific cost information which the consultants obtained, such as inbound transportation costs for materials, costs of production, outbound transportation costs for finished product, state and local taxes, utility costs, and other costs which are generally associated with identifying the most cost effective site for a plant relocation.

The study did not, however, identify any specific sites within the "triangle," nor did it evaluate non-quantified variable factors which the company felt were necessary to insure a successful transition. "A" Corporation then did two very important things — first, it

enlarged the consultants' assignment to include these non-quantified intangible variable factors. Secondly, it assigned knowledgeable corporate production supervisory employees full-time to the consultants to provide user input and to work with the consultants in the identification and evaluation of specific alternate sites for the new facility.

The consultants and production supervisors together developed and used the following checklist of 22 objective and subjective characteristics for detailed investigation of each potential site within the specified triangle. This list and analysis is presented as suggestive, rather than definitive. The specific factors relevant to any particular site location should be carefully considered to insure completeness. It should also be noted that the weighting of the factors are not equal, and any such weighting should be reserved until all information is gathered on each site. It is possible that one site could have a unique advantage that would dominate the decision, but which would have never been considered until this uniqueness is revealed from the investigation.

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|---|--|
| 1. Labor history | 13. Local and state business climate |
| 2. Labor availability | 14. Community employer |
| 3. Influence of labor on
local industry | 15. Police, security and fire protection |
| 4. Maturity of citizens | 16. Physical climate |
| 5. Residential housing and general
community aspects | 17. Roads and highways |
| 6. Management potential | 19. Trash, garbage and sewage disposal |
| 7. Educational facilities | 19. Utilities -
electricity,
natural gas,
fuel oil, and
coal |
| 8. Health care | |
| 9. Culture and recreation | 20. Water supply |
| 10. Industrial planning and zoning | 21. Transportation |
| 11. Community financial picture | 22. Material availability |
| 12. Tax structure | |

The task force developed specific relevant questions for each of the categories on the check list. These questions were designed to complement "A" Corporation's mission and to satisfy the requirements of the new facility. Examples of the type of questions asked and evaluated for each of the categories follows:

1. Labor History
 - a. Does a significant portion of the labor force have deep community roots as expressed by family orientation, long term residency, home ownership, and community involvement?
 - b. What is the degree of area unionization?
 - c. Are one or two unions dominant in the area?
 - d. What has been the area history of work stoppages and the willingness of local labor to accept both work methods improvements and automation?

The responses to this category of questions would provide an indication as to the rela-

tive stability of the area's potential work force. "A" Corporation was proud to have had a long-term history of labor peace and good labor-management relations at all of its locations, and it was considered important by Management that this history be maintained at the new location.

2. Labor Availability

- a. What is the labor population within a 30 mile radius? What percent are employed in manufacturing?
- b. What is the area labor distribution between skilled, semi-skilled, and unskilled labor?
- c. What is the willingness within the area for shift work?
- d. What is the average area family income? Does a need exist for supplemental income?

The responses received to this grouping of questions would provide Management with information about the availability of sufficiently skilled workers within the area willing to work each of the three shifts for wages considered "normal" for the industry.

3. Influence of Labor on Local Industry

- a. What are the area median wage rates and benefits, by skills.
- b. What is the area degree of unionization? How mature are the area union leaders?
- c. What has been the labor strife record in the area?
- d. How much will we have to compete with the area's larger industrial manufacturers for competent labor?
- e. Have the labor or industry leaders in the area developed any special area contract provisions, such as for seniority, bidding, layoffs, grievances, etc.? What are these provisions?

As previously stated, this company has had a long-term history of "good" relations with its workers at all locations. The responses to this series of questions would either resolve or heighten any fears that Management might have about the probable relations between labor and management at this new location.

4. Maturity of Citizens

- a. Have civic leaders, local officials, and religious leaders demonstrated a positive and progressive attitude toward industry? Do they enthusiastically encourage new industry?
- b. Are the area residents generally labor-oriented, business-oriented, or well balanced?
- c. What is the community attitude toward industrial development?
- d. Do the area residents actively vote in municipal, state and national elections? Are the residents active in community activities?
- e. Is the area standard of living at or above average?

As a "good" neighbor, "A" Corporation has always encouraged its local management to become actively involved in local civic and community activities. The answers to this

series of questions will indicate to corporate management the degree to which local company management might be accepted by the community and by local leaders. This series of questions will also forecast the probable degree of future "A" Corporation involvement in the community and in community activities, as well as whether the community will accept "A" Corporation as a "good" neighbor.

5. Residential Housing and General Community Aspects

- a. Is there adequate rental and ownership housing available that will appeal to both new employees and corporate personnel being transferred into the area? Is it reasonably priced?
- b. Does the community have adequate residential zoning?
- c. Are the residential areas attractive? Is the appearance of the center of town attractive? Does this indicate community pride?
- d. Are there good motels and restaurants in the area?
- e. Are there adequate banking, commercial, shopping and other community services and facilities available for area residents?
- f. Does the community have an excessive amount of slum or sub-marginal areas?

This group of questions will allow Management to evaluate the community as a respectable and responsible living community for all its employees - new hires currently in the area, new employees moving into the area, and seasoned corporate employees being transferred into the area. It has been an unwritten "A" Corporation policy to encourage and provide "incentives" to management employees to live in the community where they work and to take an active part in community activities. The answers to this series of questions should provide the company with a sixth sense as to the degree of resistance it might expect when asking both new and existing employees to accept a position at the new facility and to move into the new community.

6. Management Potential

- a. What is the possibility of attracting supervisors and managers from the local area?
- b. What is the possibility of attracting scientists and technicians from the local area?
- c. Can prospective local hourly workers be expected to grow into added supervisory responsibilities?
- d. Are any vocational, technical, trade and/or scientific schools located nearby? Are they accredited? By which associations?

The answers to this series of questions would provide Management with information concerning the degree of difficulty the company might expect if and when it attempts to recruit management, technical and/or scientific personnel from the community rather than import these necessary employees from outside the community. In previous area relocation situations, "A" Corporation found that it is considerably less expensive to recruit locally than to import personnel into an area with the attendant relocation costs.

7. Educational Facilities

- a. Are there a sufficient number of "good" public elementary and high schools in the community to accommodate the families of new and transferred employees?
- b. Is the public school system keeping pace with expected community growth?
- c. Are the local vocational, trade, technical, and scientific schools oriented toward our requirements? If not, will they be willing to modify their orientation? Will they be willing to implement specific training courses to meet our requirements?
- d. Are higher educational facilities sufficiently near to help attract management and other key personnel?
- e. Are there quality local adult and continuing education programs in the community?

The responses to this group of questions will provide an indication of the community's attitude toward education and whether the community might help train potential employees and participate in the continuing education of existing employees.

8. Health Care

- a. Are there adequate medical, dental and health services such as emergency services, doctors, general practitioners, specialists, hospitals, dentists, nursing services, etc.?
- b. Is there an adequate public health program?
- c. Has the community enacted and is it enforcing adequate sanitary and environmental health legislation?

The answers to this group of questions will tell the company what the community's attitude is toward the health of its citizens, and will indicate the degree of difficulty that the company might expect when requesting employees to relocate there.

9. Culture and Recreation

- a. Are there well maintained public parks and playgrounds, well equipped and adequately staffed public libraries, and a sufficient number of cultural centers such as museums and theaters to attract and retain management and other key employees?
- b. Do the local colleges and universities have cultural outreach programs for the community?
- c. Does the area have a variety of local outdoor attractions such as boating, swimming, golf, tennis, fishing, hunting, ice skating, skiing, etc.?
- d. Are there resort and other recreational areas located within a one hour drive?
- e. Are there sufficient houses of worship of varying creeds and denominations?

Cultural and recreational activities located within a reasonable commuting distance have been found by "A" Corporation to be very important to corporate employees transferring to rural locations from urban areas. The responses to this group of questions will help the company determine the degree of difficulty it might expect when recruiting manage-

ment, technical and scientific personnel from outside the area, and when transferring employees into the community.

10. Industrial Planning and Zoning

- a. Does the community have an active and forward looking planning and zoning commission?
- b. Are the industrial areas as well protected by planning and zoning as are the residential and commercial areas?
- c. Have building codes been revised and updated for modern methods, materials, and technologies?
- d. Will municipal authorities provide written assurances protecting against future unfavorable planning and zoning changes?
- e. If the specific site selected is outside the community zoning district, will the community annex the site to provide the necessary zoning for the plant's needs?

Management recognizes that it is extremely important to protect corporate assets. The answers received to this series of questions will provide "A" Corporation with information concerning the community's attitude toward zoning, and the degree of planning and zoning protection the company might expect in the future from the community leaders.

11. Community Financial Picture

- a. Does the local tax structure allow the community to adequately service its existing indebtedness?
- b. Is the community tax structure well balanced between residential, industrial and commercial sources? Are the tax assessments in line with services received?
- c. Will the municipal authorities provide written assurances concerning future
- d. Do unusually low taxes indicate inferior schools, streets, health, safety and other services?

The answers to this series of questions will indicate the community's degree of financial stability and the protection that "A" Corporation might expect from unexpected community taxation.

12. Tax Structure

- a. What and how much are the state and local taxes - property, inventory, income, sales, franchise, other?
- b. Which taxes increase or decrease the number of new and transfer employees?
- c. Which taxes increase or decrease the number of new or expanded industry?
- d. Are there any state or local "special" or unusual taxes? Which taxes are these?
- e. Will the state or local government offer any incentives for location into their area? What are these incentives?

This group of questions will provide the company with an indication of the community's attitude toward industry and the existing tax relationship between personal and corporate taxation.

13. Local and State Business Climate

- a. Do the local community and the state both have a "good" record toward industry? Are they "fair" and "cooperative" to industry?
- b. Are local and state laws concerning industry fairly written and fairly administered? Are these laws conducive to good management-labor-government relations?
- c. Has the local community and the state each enacted legislation that will restrict unreasonable union acts? Do the local and state courts have a "good" record against illegal strikes and picketing?
- d. Will new industry strain municipal facilities? Which facilities?
- e. Does the community have any business-sponsored civic organizations?

The answers to this series of questions will provide the company with an indication as to whether the community is or is not industry-oriented. Although "A" Corporation is recognized as a "good" employer, it would be hesitant to enter an area which has an anti-management history.

14. Community Employer Evaluation

- a. Are there any branch plants representing national corporations in the area? Which ones?
- b. Do most area employers demonstrate enlightened management policies?
- c. Does any singular area industry have a poor labor strife record?
- d. Will local industry participate in surveys regarding wages, union contracts, personnel policies, etc.?

"A" Corporation has always cooperated with, participated in, and been a leader of area-industry associations. The responses to this group of questions will indicate the degree of cooperation and association the company might expect from other industries in the area.

15. Police, Security and Fire Protection

- a. Is the local fire department a paid department?
- b. Do the local and state police and fire departments each have high standards for personnel, equipment, training, and morale?
- c. Is a public police patrol provided for industrial properties? Are private security agencies available?
- d. Is there a cooperative disaster aid plan with other communities in the area?
- e. Is community and area crime under control?
- f. Does the area have a large number of bars and taverns?
- g. Is local industry satisfied with the police and fire departments?

Security for both corporate assets and for corporate employees is paramount for the organization and absolutely necessary for "A" Corporation's continued presence in an area. Responses to this group of questions will tell the company just how "secure" the area is for both the corporation and its employees.

16. Physical Climate

- a. Is the area climate satisfactory for both living and manufacturing?
- b. What has been the monthly average and ranges of temperature, humidity, rainfall, and snowfall?
- c. What has been the incidence of industrial disruption due to snow, heat, flood, wind, cold, prolonged dry spell, or prolonged wet spell?
- d. What is the average velocity and direction of prevailing winds?
- e. How deep is the area frost line?

The ability to satisfy customer demand by maintaining scheduled production as planned without unanticipated interruptions is believed by Management to be one of the key factors in the continuing success of the company. To insure uninterrupted production, "A" Corporation needs to know that the climatic conditions of the area are such that continuing production is assured.

17. Roads and Highways

- a. Are public roads and highways well maintained?
- b. Are public highways quickly cleared of snow and ice?
- c. Are local highways adequately interconnected with federal interstate highways?

Well maintained highways are essential for continued production support. Employees require well maintained roads for access to and egress from the facility. Incoming materials and outgoing finished product also require well maintained highways to assure adequate materials for production purposes and adequate finished goods for timely delivery to customers. Without the ability for employees to have continuous access and egress to and from the facility in all types of weather, production will falter; without the ability to receive raw materials for production and to ship finished product in all types of weather, customer requirements will not be satisfied. In a competitive consumer product environment, if one manufacturer cannot guarantee a continuous supply of product to the customer, the customer will go to a competitor for the product. "A" Corporation wants to assure itself that it will be able to guarantee the continuous supply of product to its customers.

18. Trash, Garbage and Sewage Disposal

- a. Does the community have a pollution control board? Are pollution regulations rigorously enforced?
- b. Are incinerators permitted?
- c. Are private contractors available for trash and garbage removal?
- d. Is the municipal sewage system sufficiently sized to accommodate the plant's anticipated waste?
- e. Does the community require industry to pretreat sewage?

Environmental concerns today are paramount in selecting a facility location. Recognizing that solid waste landfills are becoming over utilized and are being closed by the various environmental protection agencies, that air and water pollution are becoming

concerns of the local environmentalists, and that every industrial facility creates both garbage and exhaust, "A" Corporation knows through its own experience that ineffective municipal control of the environment can, does, and will result in severe and unacceptable state and federal restrictions. The answer to this series of questions will provide Management with a good knowledge of present and a reasonable knowledge of future environmental requirements within the community in advance of selecting it as a location for the new facility.

19. Utilities - Electricity, Natural Gas, Fuel Oil, and Coal

- a. Is there sufficient economic electric power available for our present and future needs?
- b. Is co-generation permitted and acceptable?
- c. What is the history of area electric power outages?
- d. Are low sulphur oil, natural gas and low sulphur coal competitive fuels in the area?
- e. Can oil and coal delivery be depended upon in all weather?
- f. Is there any problem with disposal of coal ash?

The cost for utilities is a major cost factor for this company. The responses to this series of questions will provide "A" Corporation with the information it needs to know about the present status of utility supplies. Management believes it must know if it can rely on the continuous availability of sufficient cost competitive utilities to maintain production, and if not, whether it will be permitted by legislation to generate its own power?

20. Water Supply

- a. Is the quantity of water publicly available adequate for the plant's current and future needs? Is it pure enough for the proposed manufacturing process?
- b. Are private water wells permitted?
- c. What is the chemical analysis of the public water supply and of the well water? Is this satisfactory for the plant's needs?
- d. What is the history of uninterrupted public water service and well water supply?

"A" Corporation is a large consumer of water for processing purposes. The answers to this series of questions will tell Management if it can be reasonably certain that sufficient water of acceptable quality will be continuously available to insure adequate product quality and uninterrupted production operations.

21. Transportation

- a. Is there adequate rail, truck, ship, and air freight service available locally?
- b. Will the railroad provide switching services as needed?
- c. Do major truckers have terminals in the area?
- d. Are any state or local laws restrictive to trucking? Which ones?
- e. Are freight forwarders available locally?

f. Is adequate air passenger service available within a one hour drive?

As mentioned previously, good transportation facilities are essential for continued plant operations — for continued receipt of those raw materials and supplies needed for production and for continuous shipments to customers with the product they require when they require it. This is especially important in the just-in-time environment “A” Corporation is planning to implement at the new facility.

22. Material Availability

- a. What are the logistics of raw and packing material supply?
- b. Will raw and packing material costs be competitive with other sites?
- c. Can we be assured of multiple sources of supply?
- d. Will there be strong area competition for our needed supplies?
- e. What is the anticipated quality of locally supplied materials?

It goes without saying that the economical availability of raw and packaging materials are vital to the continued success of the operation

The enlarged area location task force, consisting of the consultants and the assigned corporate supervisory employees, evaluated a total of six specific locations in detail, each against the others, based upon the preceding 22-category checklist. Each of the twenty-two factors was independently weighted by the task force in consultation with Corporate management based upon presumed importance of the individual factor. As was indicated previously, the weighting of the factors were not equal, and the assignment of relative weighting did not occur until all information was gathered on all sites. The weighting were developed using this procedure because it was felt by both management and the consultants that one site could conceivably have a unique advantage over the others that might dominate the decision making process but which would have never been considered until the uniqueness was revealed from the investigation.

One of the six locations ranked very high and appeared to be superior to the others for the needs of the corporation. Further detailed investigation indicated that this one location was indeed superior to the others, and the “A” Corporation finalized on this one area as the most suitable for the new facility based upon a combination of both tangible cost factors and the important intangible non-quantifiable cost variables as described in this paper.

The facility was constructed as planned and the prognosis by Corporation top management is that a very successful, accurate, and valid area location and site selection study was conducted. The consultants agree and believe that time will prove them to be correct.

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