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THE CAUSES OF DELAY IN THE CONSTRUCTION INDUSTRY

By

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The construction industry serves many valuable functions in our society. One of the most important is providing all of the physical structures required by the population of our highly diversified country. In a complex nation such as the United States, construction requirements vary considerably. Some of the basic needs in which construction plays a significant role are housing, industry, education, recreation, government, commerce, utilities, transportation, and defense.

In fact the construction industry is involved in every activity carried on by the country's population. To further indicate the significance of the construction industry, it has been estimated that over 100 billion dollars will be spent in construction during the year of 1970. This figure represents approximately ten percent of the gross national product of the United States.

The three most important phases of the construction process are project conception, project design, and project construction. Project conception is the recognition of a need which can be satisfied by a physical structure. The project design process translates the primary concept into a spatial form which will satisfy the owner's requirements in an optimum, economic manner. The construction operations are the final stage of the three part process and create a physical form which permits the designed function to be carried out.

Although the expected 1970 construction volume of approximately 100 billion dollars is high, the backlog of construction is still higher. The backlog of construction plans totaled 182 billion dollars at the end of 1969.¹ This backlog figure represents a sum which is about double the anticipated 1970 construction volume. To explain further, the construction industry is satisfying only one third of the nation's needs for new construction.

The problem of delays in all phases of construction is a stumbling block in the path of the industry. Part of the lag in construction progress is due to delays in the construction industry itself. Delays and their causes are often talked about, yet it seems that little has been done to alleviate this problem. It was hoped that a nationwide survey into the causes of delays to the construction phase might shed some light on the subject. Such a survey of general contractors was initiated and completed by the author during the summer of 1969. It was also expected that analysis of delay factors in the construction industry would alleviate their far reaching effects such as the current failure to meet the stated national goal of constructing 2.6 million units of housing each year for the next decade.

Delay factors found to be most important as a result of this survey and suggested ways to reduce delays are discussed in this paper.

A year long study conducted at the University of Michigan provided valuable information regarding the causes of delay in the construction industry. The analysis was carried out by the author on the basis of data obtained from responses to questionnaires sent to 400 contractors throughout the United States and Puerto Rico. (64% of the contractors who were sent questionnaires responded to the survey. This included contractors from all of the states and the Territory of Puerto Rico.) The contractors responding to the questionnaires were involved in various types of construction including buildings, highways, utilities, airports, dams, space industry and bridge construction.

The study investigated the relative effects of delays in construction projects as caused by seventeen factors. These factors were:

WEATHER	PERMITS
LABOR SUPPLY	SHOP DRAWINGS
MATERIAL SHORTAGES	SAMPLE APPROVALS
EQUIPMENT FAILURE	BUILDING CODES
FINANCES	SUB-CONTRACTORS
MANUFACTURED ITEMS	CONTRACT NEGOTIATION
CONSTRUCTION MISTAKES	JURISDICTIONAL DISPUTES
DESIGN CHANGES	INSPECTIONS
	FOUNDATION CONDITIONS

The questionnaire sent to each contractor provided two possible responses, "very important" and "important", for the contractor to show that a particular factor was an important contribution towards delaying construction projects. The summation of responses for the indicated choices of "very important" and "important" can be considered an index to measure the severity of delay for each factor, showing the extent to which a factor delays construction progress. Table 1 shows the severity of delay index for each factor, based on the results of the questionnaire survey. Factors are listed in rank order, from those causing the greatest amount of delay to those least influential in delaying construction projects.

All of the data was analyzed by means of the IBM System 360/67 Computer located at the University of Michigan's computer center in Ann Arbor.

The results indicated that eight different factors were considered to be of significant importance in causing construction delays by more than fifty per cent of the contractors responding. These factors are weather (90%); labor supply (80%); sub-contractors (77%); design changes (70%); shop drawings (59%);

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foundation conditions (57%); material shortage (54%); and manufactured items (51%).

Two other factors approached majority agreement in terms of being significant delay factors. These were sample approvals (56%) and jurisdictional disputes (44%).

The survey demonstrated that time is lost in construction projects as a result of on-site delays, off-site delays and environmental delays.

An on-site delay is one which retards the construction due to conditions at the particular job site. This might include such factors as lost time due to construction equipment

TABLE 1
Rank Order of Delay Factors
Based on Questionnaire Responses

Rank Order	Delay Factor	Severity Delay Index
1	Weather	90%
2	Labor supply	80%
3	Sub-contractors	77%
4	Design changes	70%
5	Shop drawings	59%
6	Foundation conditions	57%
7	Material shortage	54%
8	Manufactured items	51%
9	Sample approvals	46%
10	Jurisdictional disputes	44%
11	Equipment failure	32%
12	Contracts	31%
13	Construction mistakes	27%
14	Inspections	23%
15	Finances	20%
16	Permits	19%
17	Building codes	10%

breakdown, construction mistakes, and unexpected site foundation conditions. An off-site delay is one which is the result of actions that take place at geographic locations that are distant from the construction site. Some examples of off-site delays are late delivery of construction materials and factory manufactured items; changes in design by the owner, architect or engineer; late approvals of shop drawings and construction materials; and delays in obtaining contracts prior to construction such as those required for sub-contractors and material suppliers. Environmental delays are those factors which impede construction progress but are not subject to control by the owner, contractor, or designer. Weather conditions are one such environmental delay because of the wide variation of weather during construction operations.

Regrouping the significant delay factors as determined by the contractors' responses into the above three categories, we have the following:

OFF-SITE DELAYS

SUB-CONTRACTORS	(77%)
DESIGN CHANGES	(70%)
SHOP DRAWINGS	(59%)
MATERIAL SHORTAGE	(54%)
MANUFACTURED ITEMS	(51%)
SAMPLE APPROVALS	(46%)

ON-SITE DELAYS

FOUNDATION CONDITIONS	(57%)
JURISDICTIONAL DISPUTES	(44%)

ENVIRONMENTAL DELAYS

WEATHER	(90%)
LABOR SUPPLY	(80%)

The largest quantity of delays occur in the category of OFF-SITE DELAYS (60% of the top ten delay factors are due to off-site conditions).

The survey data has indicated that much improvement can be made by concentration upon and correction of off-site conditions. The selection of sub-contractors, for example, is a decision made by construction management at the highest levels of a company and can be considered an off-site factor. The selection of sub-contractors should be made with careful consideration by construction management. Such determinations as experience, available manpower, financial capability, and volume of current work should be made before deciding upon the sub-contractors for each phase of the project.

The selection of material suppliers and manufacturers should be made with careful forethought because of the high ranking of these factors as causes of delay in construction projects. (Material shortages appeared in 54% of the contractors' replies as an important delay factor. Manufactured items appeared in 51% of the replies.)

The other important off-site delay factors such as design changes, shop drawings, and sample approvals can be minimized by greater coordination efforts between the contractor and the owner or his agent. Rapid communication of proposed design changes will accelerate construction projects by lessening the effect of design changes on construction sequence and scheduling. Expediting of shop drawings and sample approvals by the owner as well as the contractor will guarantee availability of these items prior to the time when they are required at the job site.

The high index of foundation conditions as a delay factor (57% of the replies and 6th in ranking order) indicates that improvements are necessary in the methods used to obtain foundation information. More reliable information such as that obtained by increased subsurface exploration and analysis can aid the designer as well as the construction contractor. More reliable foundation design will lessen the effects of foundation conditions as a delay factor.

The factor of jurisdictional disputes can be improved by providing accurate, up-to-date information to construction management on the latest labor practices regarding work assignments. This will help to decrease the number of disputes over work assignments. In addition, procedures should be implemented so that decisions on jurisdictional disputes can be enforced.

Further research is needed to lessen the effects of weather as an environmental delay factor. An increase in the supply of labor will lessen the effects of this significant delay factor. The seriousness of labor shortages indicated by 80% of the contractors responding to the survey should be used to support programs for providing construction trade training in high schools, vocational schools, and community colleges and for training of minority groups for construction employment.²

Analysis of the data received in the research survey has indicated that construction delays are due to off-site factors, on-site factors, and environmental factors. The data received in the study has demonstrated that construction delays can be minimized by improved planning and increased construction management controls and by a concerted effort to increase the labor supply.

NOTES

¹For a discussion on backlog in the construction industry see Engineering News-Record (January 23, 1969), p. 64 to 70.

²The future manpower needs of the construction industry are discussed in U. S. News & World Report article, "How Building Costs Can Be Cut," (January 20, 1969), p. 68.