The role of information management in the development of a strategic model of buildability

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ABSTRACT

The key to the successful implementation of buildability lies with the effective management of information through all stages of the project life cycle and across functional divisions. The majority of building design errors occur not because of the lack of information, but the lack of management of information. Buildability requires information affecting the quality of project decision making to be timely, relevant and effectively communicated to the decision makers.

A strategic management model of buildability has been developed based on the working definition that buildability is *"the extent to which decisions, made during the whole building procurement process, ultimately facilitate the ease of construction and the quality of the completed project"*. This strategic model is underpinned by the conviction that information technology offers the means to overcome the space and time communication problems which have beset previous attempts to introduce effective buildability programmes. The capacity to process and manage large quantities of data is seen as an essential attribute of buildability

The approach adopted is that of a holistic view of factors which are likely to impact on not only the design and construction process, but of the total procurement process. This allows the boundaries of the buildability management model to be adjusted to be appropriate to specific project conditions.

This paper will describe an information management framework which will support the implementation of the buildability management model.
Keywords
Buildability; information management; decision support

Introduction

The widely accepted definition of "buildability" proposed by (CIRIA 1983) was "the extent to which the design of the building facilitates ease of construction, subject to the overall requirements for the completed building".

This view was taken because of the perception that buildability problems exist, "probably because of the comparative isolation of many designers from the practical construction process. The shortcomings as seen by the builders were not the personal shortcomings of particular people, but of the separation of the design and construction functions which has characterised the U.K. building industry over the last century or so." (CIRIA 1983)

This definition focused only on the relationship between the design and construction activities and implies that factors which have a significant impact on the ease of construction of a project are solely within the influence or control of the designer.

In fact, the buildability of a construction project can be affected by decisions made upstream of the design stage which impose constraints on the designer. Decisions which may not be made by the designer concerning intermediate functions between design and construction such as documentation, contractor selection, and choice of contract or procurement management forms may also have a significant impact on the construction process.

The performance of the completed project needs also to be taken into account in evaluating buildability. For instance, a particular assembly could be designed for easy initial construction but may result in costly and difficult access for maintenance purposes. A life cycle perspective is necessary to provide a true assessment of buildability.

The inadequateness of the definition of buildability proposed by CIRIA has been recognised (Griffith 1986) and reflected in the loss of some momentum in research in the U.K. However, the CIRIA's analysis of the situation does underscore an important issue - that compartmentalisation of functions in the project process contributes to buildability problems.

In addressing the narrowness of the CIRIA definition, a research team at the University of Newcastle reassessed the management of buildability using a systems approach and coined a working definition of buildability as "the extent to which decisions, made during the whole building procurement process, ultimately facilitate the ease of construction and the quality of the completed project". (Chen, McGeorge and Varnam 1991)

This definition embodies two important principles:
a) buildability performance is driven by the quality of relevant project decisions
b) buildability performance extends beyond just the ease of construction. The trade-offs manifested in terms of the quality of the completed project need also to be taken into account in evaluating buildability.

Buildability is thus regarded as a project attribute which is within the influence of those who shape the whole project process, that is the project decision makers. The compartmentalisation of functions in the project process causes barriers to information flow to project decision makers. This degrades the quality of decisions which may ultimately result in buildability problems.

The Systems Model

The approach takes a holistic view of factors which are likely to impact on not only the design and construction process, but of the total procurement process.

Every project environment consists of a unique combination of exogenous and endogenous factors. The project environment is also dynamic and changes with each project decision made. A systems view of the interaction between project buildability and the factors which impact on it is illustrated in Fig.1

"Buildability factors" are those which one or more of the "participants" through their actions can influence or respond to, and which would impact on the ease of construction and the quality of the completed project. These "buildability factors" may be exogenous factors generated by the external environment, endogenous factors which project participants can control or project goals defined by decisions.

As these factors may have a positive, negative or neutral effect on the buildability of a particular project a pro-active strategy towards managing buildability would identify and characterise factors relevant to a specific project and aim at mitigating or reversing the negative effects and enhancing the positive of these factors.

The importance and relevance of the various participants and buildability factors shifts through the different stages of a project life cycle. An effective approach to managing buildability should not be restricted to just the design-construction nexus because decisions which impact on buildability include those which are made upstream of the design stage of the project.

At the same time, the standards by which buildability should be assessed includes the performance of the completed project. This third dimension of the systems model recognises the crucial contribution of timeliness to the quality of project decisions. A project life cycle may be divided into the following stages to reflect the different emphasis on participants and buildability projects:

Fig. 1 Systems View of the Project Buildability Environment

Information Management Requirements

Decisions which will impact on buildability are made at different levels from the strategic to the operational and on different issues reflecting the factors which are significant for specific projects. The quality of these decisions is reflected by a number of characteristics including:
a) correctness - identifying and facilitating the desired outcomes
b) effectiveness - timely and complete

It has been well established that a major cause of building performance problems is the failure of decision makers to use existing knowledge (Munday, 1979; Bonshor and CSIRO, 1986).

Decision makers tend to use information which is readily available. Applying information on the basis of availability rather than relevance also presents obstacles to improving project decision making (Leslie, 1992).

The key to the successful implementation of the buildability management model lies with effective information management through all stages of the project life cycle and across functional divisions. The actions of project participants need to be informed and coordinated towards the achievement of buildability goals.

Participants who need to make the necessary project decisions need to be aware of the issues which require their attention, at the appropriate time and have the knowledge and skills available to enable the best decisions to be made. Information management for the buildability approach need to meet the requirements of:
a) timeliness
b) relevance
c) effective communication

An I.T. Model for Managing Buildability

In terms of the buildability management approach, the systems action plan is a powerful decision support tool around which an IT model can be built to facilitate its effective implementation. Fig. 2 illustrates such a model at a conceptual level.

Fig 2. The Buildability Information Management Framework Model.

The primary functions of the system would be:

a) issues identification - generating decision situations

b) information access - identification of information source, data filtering, data processing

c) decision support - establishing performance goals, application of decision rules, identification of solutions, evaluation of solutions by simulating performance and compliance testing.

d) communication and coordination- updating integrated project description, decision tracking and updating

Conceptually, the IT model consists of the following major components:

a) the Buildability Action Plan

b) the Integrated Project Description

c) Information Sources

d) Decision Situations

e) other Decision Support tools

f) the Communication and Coordination Module

The buildability action plan is the primary decision support tool which drives the Buildability Information Management Framework Model. It identifies issues which will have major impact on buildability and alerts relevant decision makers of the buildability factors which they need to deal with. The timing of these actions is governed by the development of the integrated project description through each stage of the project life cycle.

The project description is the representation of the project in terms of all the decisions which have been made. At the feasibility stage, the project description could be a statement of all perceived project objectives which can be developed into a design brief. At various later stages of the project life cycle, a project description may be manifested in forms such as sketch design drawings, working drawings, specifications, bills of quantities, shop drawings and as-built drawings. In practice, the compartmentalisation of the different functions in the project process tends to fragment the project descriptions put together by different participants. This contributes to communication and coordination problems. The use of computerised tools for integrated applications and networking allow the development of an integrated project description which all project participants are informed by and contribute to.

Responses to the decision situations generated by the buildability action plan will determine the buildability performance of the project. The quality of decision making is enhanced by decision support in two forms:
a) access to relevant information, and
b) expertise to formulate, evaluate and select optimal solutions

Leslie (1992) identified three primary sources of information which support project decisions. These are:
a) Reference materials
b) Personal knowledge and experience
c) Existing description of the project

The major problems associated with managing these sources of information include :
- the volume of information involved
- communication and access due to physical and time separation

- fragmentation of information

Ineffectiveness in using existing reference materials could arise from:
- inaction either because the decision makers are unaware of such information sources, or they are unaware of gaps in their own knowledge (no motivation);
- inability to locate information (poor indexing);
- lack of availability because of resource constraints; or
- the materials not being in a form which can be understood or applied within project resource constraints.

While personal knowledge and experience plays an essential role in project decision making, heavy reliance on it may have shortcomings such as knowledge obsolescence, communication difficulties and uncertain availability.

Information sources can be characterised as "hard" or "soft", reflecting different management requirements. "Hard" information sources contain relatively stable and simple data. Examples of these include manufacturers' product specifications and performance databases, building regulation databases, building cost data bases, and other types of industry or in-house databases. These information sources tend to be organised systematically allowing easy selection and access using simple data filters.

"Soft" information sources on the other hand are more complex and dynamic. While "hard" information sources may be considered to be passive in terms of their interaction with users, "soft" information sources can be regarded as "intelligent" or interactive. Accessing relevant information from these sources usually requires interactive interrogation and iterative procedures.

Information technology offers the means to overcome space and time communication barriers and the capacity to process and manage large quantities of data which tend to overload non-electronic information systems.
Computerised decision support tools facilitate the establishment of performance goals, application of decision rules, identification of solutions, and the evaluation of solutions by performance simulation and compliance testing.

The shortcomings of relying on individuals' personal knowledge and experience can be overcome by using knowledge based or expert systems.

As each decision situation is acted upon, the resulting decision needs to be communicated to participants to facilitate coordination. This could be achieved by a decision logging system The decision log will also allow backtracking in case it is necessary to reconsider a particular decision which proves to be problematic for other participants.

Another essential aspect of communication and coordination is the updating of the integrated project description. This keeps all participants up to date on the status of the project and also triggers the progress of the buildability action plan to the following decision situation.

The Practical Implications

This paper has frequently referred to the problems which have arisen from the current compartmentalisation of the building process and has advocated a holistic approach to buildability employing information management as a means of overcoming this barrier. It is worth stressing however that information technology is seen as a means and not an end in this context. We would contend that the reason why developments in buildability have been very slow to date is due to the difficulties of communication between the various participants. The approach suggested in this paper should improve the channels of communication by making explicit many connections which have hither to been implicit. This approach will only be effective if the full range of information technology methods are deployed.

The difficulties involved in developing a holistic approach to buildability cannot be underestimated. For example even the simple task of identifying the stakeholders in the buildability process and then achieving an information flow between these stakeholders has yet to be successfully achieved. Indeed without recent developments in information technology the conceptual model being proposed in this study would have little prospect of implementation.

Conclusion

The buildability performance of a project is influenced by the quality of project decision making. This is in turn dependent on the information management support which is available.

The strategic model for managing buildability provides a framework from which an action plan can be formulated for a specific project. The action plan identifies relevant issues which need to be acted upon to improve buildability and provides a key decision support tool around which an electronic information management system can be built.

The pro-active approach advocated by the buildability action plan, supported by powerful information management techniques and technology offers the potential of a quantum improvement in building productivity.

End Note

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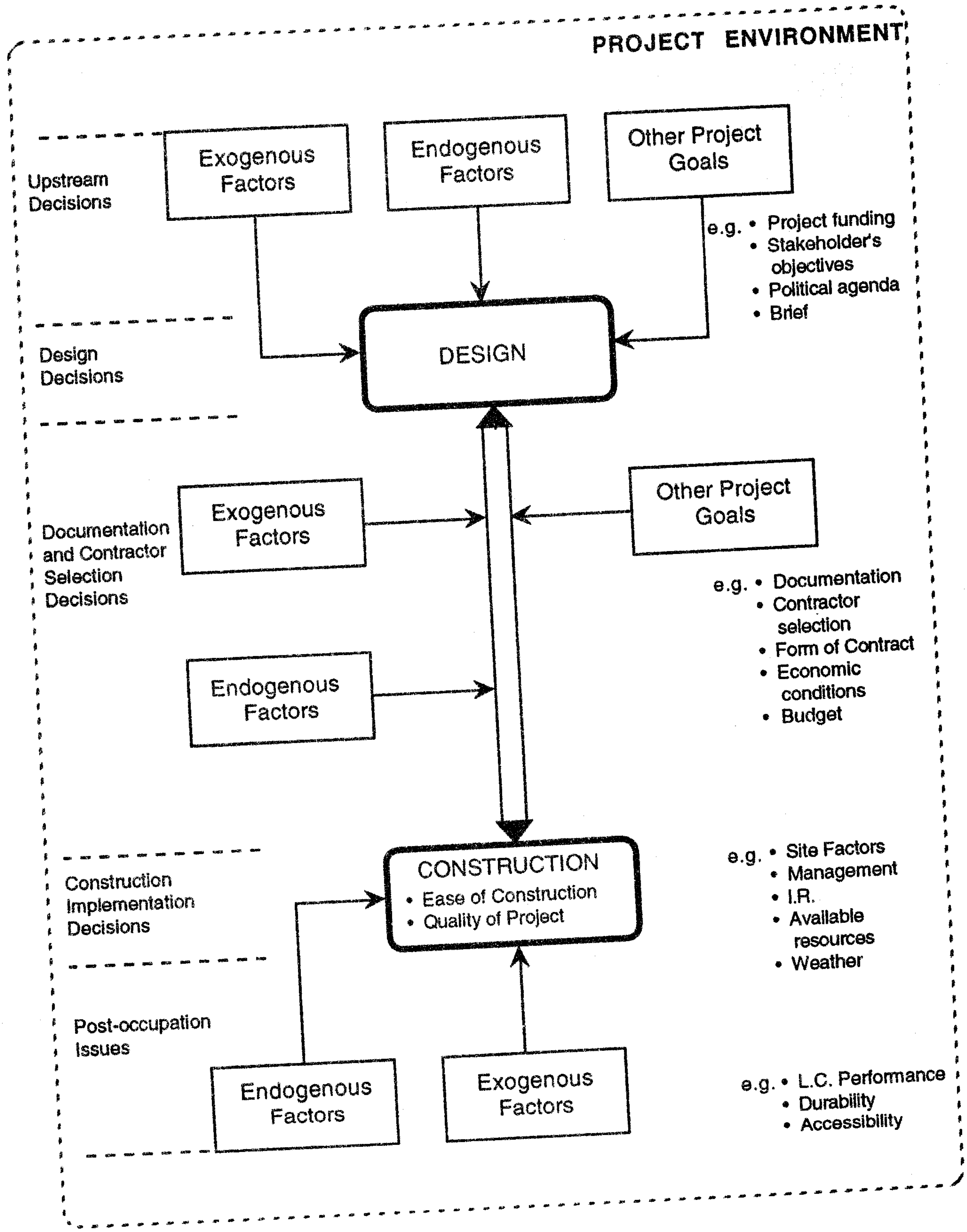
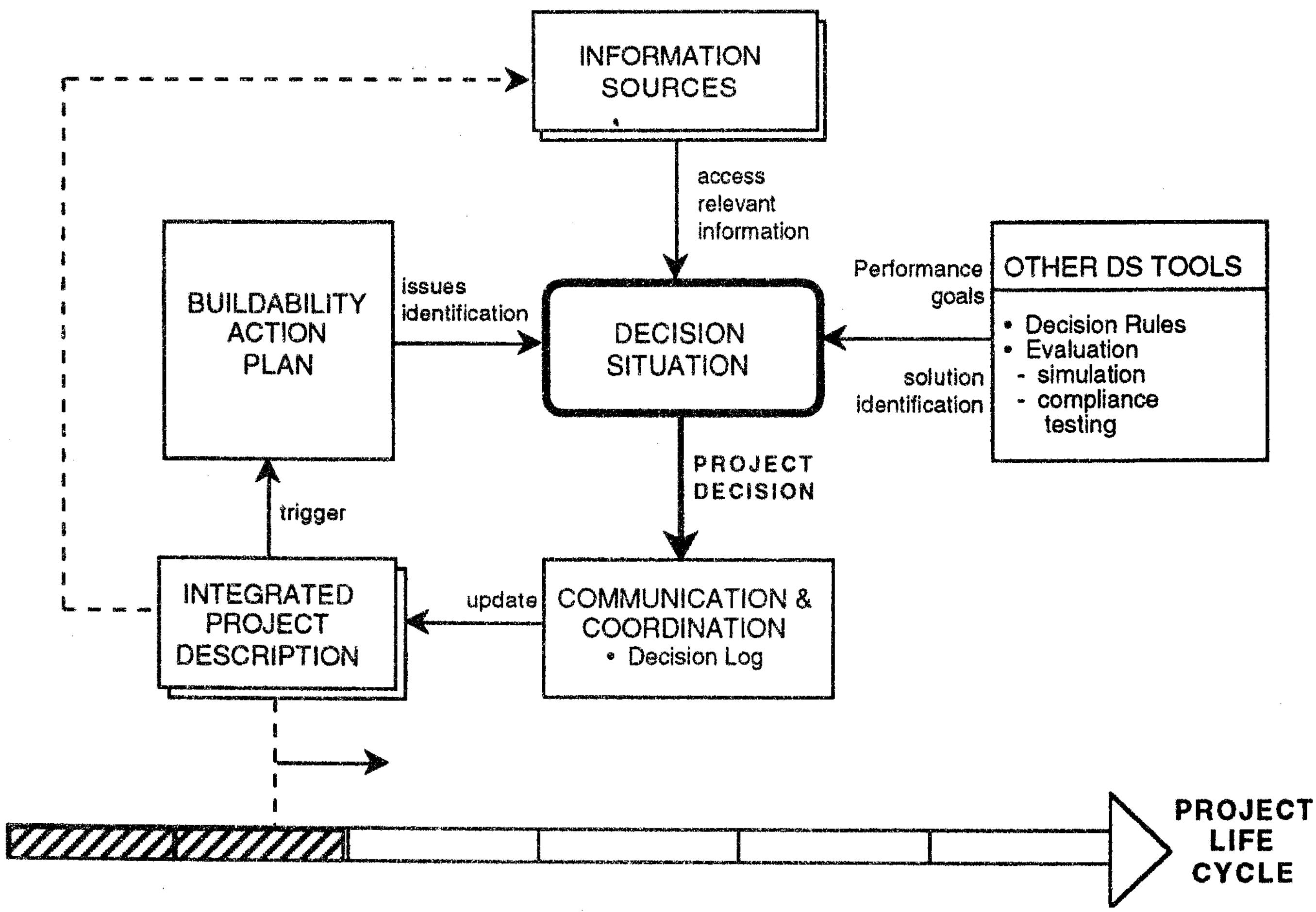


PROJECT ENVIRONMENT
Upstream Decisions
Exogenous Factors
Endogenous Factors
Other Project Goals
e.g. • Project funding
• Stakeholder's objectives
• Political agenda
• Brief
Design Decisions
DESIGN
Documentation and Contractor Selection Decisions
Exogenous Factors
Other Project Goals
e.g. • Documentation
• Contractor selection
• Form of Contract
• Economic conditions
• Budget
Endogenous Factors
Construction Implementation Decisions
CONSTRUCTION
• Ease of Construction
• Quality of Project
e.g. • Site Factors
• Management
• I.R.
• Available resources
• Weather
Post-occupation Issues
Endogenous Factors
Exogenous Factors
e.g. • L.C. Performance
• Durability
• Accessibility


INFORMATION SOURCES
access relevant information
BUILDABILITY ACTION PLAN
issues identification
DECISION SITUATION
Performance goals
OTHER DS TOOLS
• Decision Rules
• Evaluation
- simulation
- compliance testing
solution identification
PROJECT DECISION
trigger
INTEGRATED PROJECT DESCRIPTION
update
COMMUNICATION & COORDINATION
• Decision Log
PROJECT LIFE CYCLE