A MODEL TO PREDICT THE OCCURRENCE OF INFORMATION OVERLOAD OF PROJECT MANAGERS

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ABSTRACT: This paper investigates information overload of construction project managers. The aim is to identify its occurrence pattern and predict the occurrence probabilities in a given circumstance, as a project manager's information load is inconstant in nature, fluctuating over time, changing character and source. A conceptual definition of information overload is developed, using time as the criterion to describe information load. Information overload for a project manager is taken as occurring when the demands on information processing time exceed the supply of time. The variation of information load throughout the project is modelled in a matrix format using the interaction of a project manager with project members through the stages of a project. Data were collected using a questionnaire survey of 140 project managers in the UK to test the model. The results revealed that the extent, sources and probabilities of information overload of construction project managers vary throughout the stages of a project. The main sources of information overload are the project participants contributing the key expertise in each stage. This is the first of its kind in construction project management and provides an invaluable source of reference and guidance on the extent of information overload in a construction project.

KEYWORDS: Information overload, construction project management, modelling, information management, time.

INTRODUCTION

The construction industry is characterised by the large number of parties involved in a project. This is mainly due to the advancing level of technology fragmenting expertise. The number of project participants, and the need to manage them, cause increasing difficulties associated with information and the need for communication. It has been documented that construction projects generate massive flows of information (Fisher, 1991; Atkin, 1995). For example, the number of drawings issued in a project with a value of £25 million was found to be as high as 150,000. The huge quantity of information generated by construction projects has also been exacerbated by the rise of information technology (IT), which enables cheap and rapid propagation of information. If IT is not used with care, vast quantities of useless information may be generated (Chow, 1989). There are also psychological reasons for project managers processing a high proportion of this available information. Managers may see the possession of information as a measure of prestige and power within a project, with the consequence that they demand amounts in excess of their immediate needs. Excessive information gathering may also be understood through the principle of scientific economy (Ackoff, 1967): "the less a phenomenon is understood, the more variables are needed to explain it." Hence, if project managers do not understand the phenomenon they control, they 'play it safe' with respect to information and want 'everything', which increases the amount of irrelevant information. Also, as pointed out by Pietroforte (1997) that project team members have an interest in feeding information to project managers which promotes their own goals. If this information is not useful, processing it will waste management time.

Increasing quantities and varieties of information affect project organizations and their members (Keller and Staelin, 1987). Studies have shown that information overload may have various negative consequences of equal significance to those resulting from deficiencies in the available information. Managers working under conditions of information overload are unable to use effectively any additional information supplied (Hahn *et al*., 1992). Overload may cause mistakes through overlooking important pieces of information (Black, 1993). High levels of stress and undesirable working conditions are experienced by managers working under overloaded conditions (Meyer and Johnson, 1989). Information has an associated cost, and to waste it has financial consequences (Ouwersloot *et al*., 1991). Therefore efficiency in information processing and transfer could improve the economic performance of a project organization.

The lack of knowledge about circumstances where project managers are prone to information overload, and how the degree of that overload fluctuates from situation to situation, hinders attempts to manage information overload efficiently. One reason for this is that no method is available for defining and measuring project managers' information overload. Following the principle that 'if you cannot measure it, you cannot manage it', attempts to prevent the occurrence of information overload would be ineffective. Information overload is an important problem that needed to be specified more precisely. Therefore, there is an urgent need to develop a method to illustrate the extent of information overload in construction project management.

In order to measure information overload, a precise definition of the term needs to be made and a practical measurement unit identified. Drawing upon the information processing approach to organization design, Schick et al (1990) applied the concept of time to an analysis of information overload. Time was conceptualised as a measure of information processing capacity (IPC) and as a measure of the interaction and internal information processing demands on that capacity (IL). This made it possible to define information overload in terms of the relation between the demands on, and supply of, time and measure it conceptually for any entity, i.e. individual, group or organization, regardless of the causes or circumstances of its occurrence. The definition of information overload is also based on the notion that time for processing information is used on the interactions project managers have with other project team members and relevant outside authorities, and on internal information processing. The meaning of the term 'information processing time' is taken as time spent interacting with project team members and outside legal and local authorities, and time to perform internal information processing, such as thinking, reading, planning, problem finding, problem solving, implementation and review. Time is used to measure project managers' information load so that the information processing demands placed upon their time is seen as equivalent to their information load. Thus, information overload can be defined as occurring for a project manager when the information processing demands on time (IL) to perform information processing exceed the supply of time available (IPC) for such processing (IL>IPC).

THE MODEL

The identification of information overload in construction project management is modelled using the conceptual information overload framework described in the previous section. The model provides the basis for measurement of the information overload of project managers. The application of the model should enable the mapping out of the current information overload occurrence patterns and probabilities of project managers. Given the factors affecting information overload, the model was developed considering three elements. First, that information overload is the difference between the available and required information processing time. Second, the information which requires processing will come from a variety of project members, and third, that the information exchange between project members will vary throughout the project. These three elements are discussed and their considerations for the model are justified in the following sections.

The measurement problem

A difficult and intriguing aspect of information overload is its measurement. In reviewing the literature, it appears that the measurement of information has always been very context-specific. Theil (1967) used a dimensionless unit to measure the informational content of messages, defined as the difference in entropy of the states of the world before and after the message was received. Cravis (1981) uses the number of telephone calls as a measure of the interactions between countries based on communication. In decision theory, the value of information is calculated on the basis of changes in expected use (Hirshleifer and Riley, 1979). However, Cravis (1981) and AT&T (1988) used the number of telephone calls as a measure of interaction between countries based on communication. Other measurement units for the volume or amount of information are; bits in an electronic mail setting, words for an article, pages of a book, time for a TV commercial, and so on (Ouwersloot *et al.*, 1991). The common element in the above examples is a type of unit that is appropriate for the purpose of measuring information load. The unit to be used to measure project management information must provide a meaningful explanation of where and how much information overload has occurred. Therefore, using the time element is ideal to serve this purpose, as time links information load with information processing capacity, but has its own operational difficulties. In summary, the nature of the problem with measuring information overload is to operationalise the conceptual definition of information overload.

Subjective vs. objective measurement

Reviewing the theories of subjective and objective measurement, it is clear that in any setting, objective measurement should be considered first as it is the ultimate way and has advantages over subjective measurement in terms of reliability and accuracy (Allen and Yen, 1979). However, if the concept which needs to be measured is inherently complicated and does not allow the application of objective measurement, as is the case in this study due to the complexity and wider time scope, it is very common to use subjective measurement mechanisms (Meddis, 1984). Examples of the use of subjective measurement are frequently seen in social sciences, in particular in attitude measurement (Edwards, 1957; Dawes, 1972).

Although not feasible, the information processing time needed by a project manager for a task could objectively be recorded in terms of hours, days or weeks. However this objective measurement cannot take into account the following circumstances: (1) if the project manager deliberately took more time than needed; (2) if the project manager unwillingly had to cut short the time needed because of a deadline; (3) if the processing time was used on parallel and mixed processing of different sets of information. Therefore, one of the effective approaches to determining the difference between information processing time needed by and available to a project manager for a task or circumstance is to seek the knowledge of the concerned individual. This approach overcomes the limitations of objective measurement as it is difficult to determine objectively how much time an individual may need to process a piece of information.

The main drawback of using subjective measurement is ensuring that all the respondents' replies represent the same reality as closely and accurately as possible. Fienberg (1980) suggests that this could be achieved by supplying descriptive and explanatory information to the respondents to obtain their subjective responses as uniform for the same reality. Therefore, it is concluded that using subjective measurement, with a supply of additional guidance, is best suited to the requirements of the model.

Project stages

Information overload will not necessarily be constant throughout a project. A project manager's information load, and therefore overload, may be measured at any instant, through a period of time, or between pre-determined milestones depending on the context or purpose of the particular study. Therefore it is not meaningful to classify an entire project as overloaded. In the context of this investigation, the best way to capture the changing nature of information overload is dividing the project into its plan of work, or stages.

Hughes (1989), in his work of organizational analysis of construction projects, identified and compared seven different plans of work. Then he designed his own classification as inception, feasibility, scheme design, detail design, contract, construction and commisioning. The eight plans of work clearly have much in common and Hughes's classification roughly complements the classification made in the Code of Practice for Project Management, published by CIOB in 1992. In principle, these stages of work are accepted, but further combination of these stages was necessary in order to simplify the model building process and the ultimate data collection. This is achieved by combining inception and feasibility; scheme and detailed design; and construction and commissioning stages as a single stage. The resulting adaptation provided four distinct stages: feasibility / briefing, design, procurement and construction / completion. These four stages were considered because the tasks of the project manager, and therefore the information processed within them, are distinctive in character and quantity. Four stages were thought to be ideal, as this provided the right blend of data quality and manageability. If it had been chosen to divide the project into more detailed stages, to gather data for the model would have been far more difficult and time consuming. Therefore, four stages are chosen as optimum for simplicity to complete, but still sufficient to study the changing pattern of information load.

Project members

The manner in which construction projects are built and managed requires interdependency of project members. From the management perspective, the dependency is mainly on the information required or supplied by other members to carry out their individual responsibilities. The central question regarding the occurrence of information overload lies mainly in the demand/supply equilibrium of information processing time between project members at different project stages. As suppliers to or demanders of information to project managers, the other project members' involvement in terms of information exchange is seen as critical for this investigation. Therefore, investigating project members' involvement with project managers through different project stages will help in understanding information loads in different stages of the project.

The project team members who interact with a project manager are classified into six groups. These are: client, architect, consultant(s), main contractor(s), subcontractors and outside local and legal authorities. This classification of members is drawn from the Code of Practice for Project Managers (CIOB, 1992). These six groups cover all the key expertise that a project manager interacts with. As with the choice of stages, this was chosen as the optimum number which provides sufficient richness and manageable data. Therefore, the interaction of a project manager with his own organization is not included in the classification in order to keep the model simple and straightforward.

Information load matrix (ILM)

Discussion of the three elements of the model in the previous sections have shown that the information load of project managers is not constant throughout the project and information loads may be provided by any project participant. Therefore, to provide meaningful representation of information overload, two dimensions are necessary; the project team member requiring interaction and the time at which the interaction is occurring. To model such an interaction and collect data in a useful format, a matrix format is conventionally used. The matrix designed to identify information overload is called 'Information Load Matrix', abbreviated as ILM. The ILM, designed specifically for construction project managers, represents project stages in columns and project team members in rows. Thus each cell in the matrix represents a circumstance of communication between the project manager and each project member at each stage. Therefore, each circumstance can be located within the matrix using its address, i.e. Cij, where i represents the project stage, and j represents the project members. An example of the ILM as presented to the project managers is shown in Table 1. The ILM, having four stages and six members, consists of 24 stage-member cells. This cell number indicates the sensitivity of the ILM. The sensitivity of the matrix can be changed by increasing or decreasing the number of project team members and/or stages.

Table 1 The layout of the information load matrix

	Feasibility/ Briefing	Design	Procurement	Construction/ Completion
Client	C_{11}	C_{21}	C_{31}	C_{41}
Architect	C_{12}	C_{22}	C_{32}	C_{42}
Consultant(s)	C_{13}	C_{23}	C_{33}	C_{43}
Contractor(s)	C_{14}	C_{24}	C_{34}	C_{44}
Subcontractors	C_{15}	C_{25}	C_{35}	C_{45}
Others	C_{16}	C_{26}	C_{36}	C_{46}

Information overload situations

The complexity of objectively evaluating information overload resulted in the adoption of a subjective evaluation methodology. It is also suggested by Carter (1981) that the time pressures associated with information overload can be most accurately identified by the managers concerned. However, due to the intensity and pressure of day-to-day activities, they may often not be aware of an overloaded situation, or its extent; or without structured external help, not know how to express it in a meaningful way. Therefore, to assist project managers to assess their information overload, a guiding scale was provided to allow them to choose one of the five possible information overload 'situations'. These situations are drawn from the definition of information overload and are intended to represent real life situations of information overload in a simplified way. Each of these situations was given a value of 1 to 5, this being the information load point for the assessed circumstances by the project manager. These situations describe the information overload in terms of information processing time available and required, and are described in Table 2.

Table 2 Description of possible information overload situations

Situation	Rating	Description
Situation 1	None	No communication or information processing time spent.
Situation 2	Very little	Very little interaction or communication occurred. It did not affect project managers' information processing.
Situation 3	Some	Project managers had reasonable information processing or interactions. They could deal with information processing most of the time without affecting their performance or working schedule. However, there were times when they had to process more information than was possible in the time available. This ranking shows that they were sometimes overloaded with information.
Situation 4	High	Often, the amount of time needed to process information and interactions was much higher than the time available. This ranking indicates that most of the time they were overloaded with information.
Situation 5	Very high	Very often, the amount of time available to process information was less than the required time. This ranking shows that information overload was very high, and present almost all the time.

After checking with the pilot study that, due to the matrix format, the data for the model can be collected without difficulty or loss of richness in a self-administrative questionnaire, it was decided that the questionnaire survey was the better and more economic option, considering time and financial constraints, to collect the required vast amount and wide range of data set to validate the model. The numeric nature of the model also lent itself to the application of the questionnaire, therefore the data for the ILM was gathered using a questionnaire survey.

Information load points (ILPs)

The nature of the data gathered to identify the level of information overload of construction project managers is ordinal. Therefore, it requires the application of ordinal categorical data analysis techniques, which will be discussed later in this section. However, in order to make profound use of these raw data of ordinal nature, Agresti (1996) explains that the data can be converted into an interval or continuous mode by applying certain techniques. One of these techniques is to allocate weights to each information load situation. Through the application of a weighing mechanism, it is possible to create a meaningful and practical interval scale on which information overload can be measured. This technique is commonly used in sociometric research, which describes the social relationship amongst individuals (Bailey, 1987).

A weight scale of zero to four for each cell is allocated to the information load situations of one to five respectively. It is then possible to calculate a total information load point for each situation in the ILM. This is achieved by multiplying the number of project managers who identified each situation by the weight of that situation. The score of zero indicates no information processing and nullifies this situation in subsequent calculations. The scores of each situation are summed to calculate the grand total of that circumstance(Cij). This total is then divided by the total number of project managers to calculate the 'Information Load Point' (ILP) of that circumstance. These calculated points are a representation of the information overload situations.

Information load zones

The introduction of a visual aid is seen as instrumental in the interpretation of the ILP scores in the ILM tables, therefore a graphical representation of the ILP scores is prepared. After considering several graphical representation alternatives, i.e. area, line, pie, column, scatter and radar; the x-y scatter chart was chosen as most suitable and meaningful for the ILP data set. This graphical representation provides an opportunity to divide the ILP scale mechanism into information load zones (Haksever and Fisher, 1996). The zone mechanism gives more flexibility and power in the process of interpreting the results and, in particular, in determining the information overloaded circumstances. Therefore, a zoning mechanism which complements the original situational classification is devised.

Probability calculations

One of the analyses applied to the data produced by the ILM model provides predictions on the chances of the occurrence of information overload. The method of analysis is called 'logistic regression for ordinal data', which treats ILP scores as an ordered categorical response. This is the only suitable method for calculating the probabilities of the occurrence of information overload (Conover, 1980). The output of the analysis gives the probability for each of the five situations in each of the twenty-four circumstances and is presented in a contingency table. The information overload probability matrix answers questions such as; what are the chances of a project manager being in an overloaded situation with the client at the procurement stage? The application of this analysis makes the model a predictive one. A total of 507 questionnaires were sent out, and 144 were returned in a useable format, which provided a 28.4% return rate.

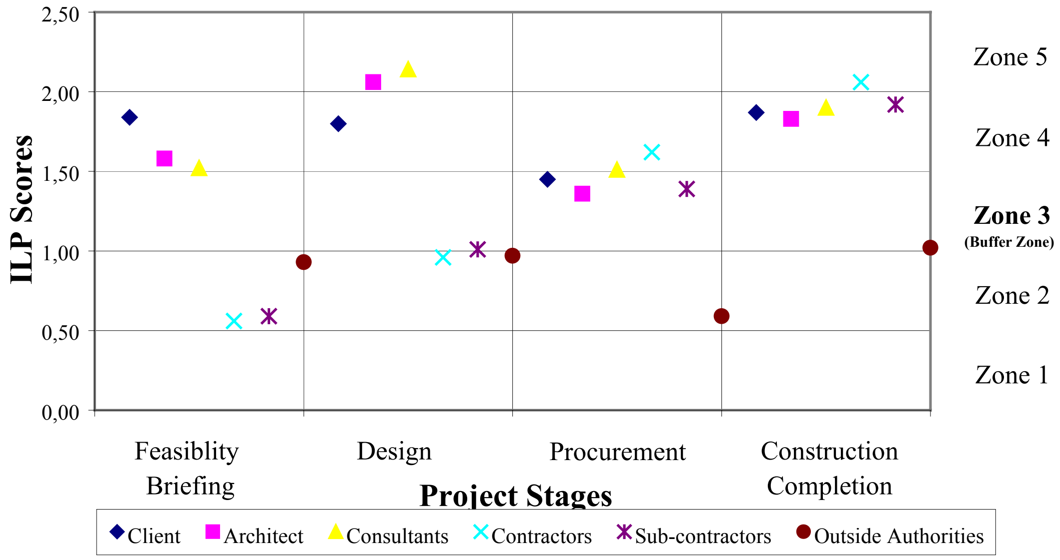
THE FINDINGS

This section presents the outcome of the model from the stage perspective and discusses the ILP scores relating to the key project members. The calculated ILP scores are presented in a graphical format in Figure 1.

Feasibility / briefing

The ILP scores at the feasibility/briefing stage are in two distinct clusters. The first group falls into Zone 4 and contains client (1.84), architect (1.58) and consultant (1.52). The second group is in Zone 2 and includes the other remaining members- outside authorities (0.93), subcontractors (0.59) and contractor (0.56). The ILM suggests that, at this stage, project managers mostly interact with the client. This is probably due to the critical role of the client on feasibility studies and the development of the brief. Assisting the client with these roles, architects' and consultants' involvement take the next two high overloaded positions on the chart. The involvement of the contractors and subcontractors are very low, to a degree which is almost negligible.

Fig. 1 Graphical representation of overall ILPs in ILM



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Design

The pattern of ILP score distributions at the design stage is similar to the one produced in the feasibility/briefing stage. There are still two distinct clusters of scores of the same project members, but with different scores and orders. The top group includes consultant (2.14), architect (2.06) and client (1.80). The first two, consultant and architect, fall into the very overloaded Zone 5, while client is in overloaded Zone 4. The ILP scores of the group in the bottom half of the ILM, which includes subcontractors, contractor and outside authorities, are extremely tightly grouped, at 1.01, 0.96 and 0.97 respectively, and each falls into the top end of Zone 2, indicating no information overload. For ILP scores in the design stage, a tendency to increase from the feasibility/briefing stage is observed, the only exception being the score for the client. In particular, the increases of architect and consultant are noticeable. This overall increase is understandable given the very complex nature of the design stage and its tendency to generate high volumes of information. The order of the most overloaded top three members has reversed to consultant-architect-client. This result is not surprising, as architect and consultant are the key players at this stage.

Procurement

The procurement stage shows a very different distribution when compared with the previous two stages. The ILP scores relating to all members, with the exception of outside authorities, fall into a very narrow band varying from 1.36 to 1.62. This group of scores is scattered around the border between Zones 3 and 4. The outside authorities, with a 0.59 ILP score, stayed very low in Zone 2. The members of the top group at the previous two stages (architect, consultant and client) still retained their togetherness, although their scores dropped significantly from Zone 4-5 at the design stage down to Zone 3. On the contrary, the increasing pattern of contractor and subcontractors continued at this stage, joining the top group, leaving outside authorities as the single low involvement. The contractor's ILP score (1.62) is the highest at this stage.

Construction / completion

In the construction/completion stage, the ILP score distributions are very similar to the previous procurement stage in that they all fall into one group. However, the scores are much higher than those at the procurement stage. All the members, with the exception of outside authorities, either fall into overloaded Zone 4 or 5. The ILP scores which are very close to each other are: contractor (2.06), subcontractors (1.92), consultants (1.90), client (1.87) and architect (1.83). The outside authorities are in Zone 2, with (1.02) score. These high scores make the construction/completion stage on average by far the most overloaded amongst the four stages. The increasing involvement pattern of contractors and subcontractors continued at this stage, reaching their peaks and occupying the top two places. Most of the members hold their highest ILP scores at this stage, the exceptions being architect and consultant, whose peaks were at the design stage.

The project members providing the most information load during each stage are those members who play the leading roles during the relevant stages. Therefore, those with the highest ILPs are: client at feasibility, consultant and architect at design, contractor at procurement, and contractor and subcontractors at the construction stage. This goes some way to confirming the validity of the model. The ranking of stages in terms of their overall information load levels are construction, design, feasibility and procurement.

Information Overload Occurrence Probabilities

Information overload in any given circumstance is identified in terms of the occurrence probabilities of the predefined information overload situations. The results complement the ILP scores as can be seen from the comparisons of the ILP scores, the occurrence probabilities and the zoning mechanism in Table 3. The most overloaded three situations which fall into the very overloaded Zone 5 are; consultants in design, contractors in construction and architect in the design stage. All three of these situations are represented with an ILP score of more than two and the equivalent in probability calculations is that there is more than a 50% chance of a project manager being in an overloaded situation.

The situations which have an ILP score of 1.50 to 2.00 and the information overload occurrence probabilities of 30% to 50% fall into the overloaded Zone 4. The situations in this zone mainly consist of the top key players at each stage. For example: subcontractors and client in construction; client, architect and consultant in feasibility; contractors and consultants in procurement; and client in design stages. Zone 3, which is a buffer zone, includes situations where there is a 15% to 30% chance of information overload. The situations involving procurement fall into this zone. The situations where the interactions of project managers with the project members are not intense at a stage, fall into the information overload free Zone 2. This zone includes mainly circumstances of the less involved members of a stage, therefore it is dominated by situations with outside authorities. The probability of information overload occurrence in this zone is between 5% to 15%. Below 5% is classified as Zone 1, but none of the overall information overload situations fell into this zone.

Table 3 The comparison of ILPs and the overload occurrence probabilities

Cell	Circumstance	ILP	(%)	Zones	Range
C_{23}	Consultants in Design	2.14	53		
C_{44}	Contractors in Construction	2.06	52	Zone 5	over 50%
C_{22}	Architect in Design	2.06	52		
C_{45}	Subcontractors in Construction	1.92	44		
C_{43}	Consultants in Construction	1.90	43		
C_{41}	Client in Construction	1.87	43		
C_{11}	Client in Feasibility	1.84	42		
C_{42}	Architect in Construction	1.83	41		
C_{21}	Client in Design	1.80	39	Zone 4	30% to 50%
C_{34}	Contractors in Procurement	1.62	34		
C_{12}	Architect in Feasibility	1.58	32		
C_{13}	Consultants in Feasibility	1.52	30		
C_{33}	Consultants in Procurement	1.51	29		
C_{31}	Client in Procurement	1.45	28		
C_{35}	Subcontractors in Procurement	1.39	28		
C_{32}	Architect in Procurement	1.36	24	Zone 3	15% to 30%
C_{46}	Outside Authorities in Construction	1.02	15		
C_{25}	Subcontractors in Design	1.01	14		
C_{26}	Outside Authorities in Design	0.97	14		
C_{16}	Outside Authorities in Feasibility	0.96	13		
C_{24}	Contractors in Design	0.93	13		
C_{15}	Subcontractors in Feasibility	0.59	06	Zone 2	5% to 15%
C_{36}	Outside Authorities in Procurement	0.59	06		
C_{14}	Contractors in Feasibility	0.56	05		

% represents the probability of a project manager being in an overloaded situation.

However, there are several differences between ILP scores and the information overload probabilities in terms of their representative values. While ILP scores represent the information overload level of project managers in a given circumstance with a single index type of measurement value on a scale of one to four, the outcome of the ordinal logistic regression modelling gives the probability of each of the five situations for a given circumstance. Therefore, although the outcomes of these two techniques represent the same reality, their use can serve different purposes. For example, while ILP scores are better suited to test hypothesis of how the information overload pattern changes with certain factors, the probabilities give a more clear and practical explanation of information overload. One of the strengths of the model is that these two measurement techniques complement each other.

Since they both are derived from the same data set, the outcome of these two measurement techniques must have a meaningful relationship. This relationship is shown in Figure 2 by making a correlation between ILP scores and information overload occurrence probabilities. The correlation between the two sets of measurement values are non-linear, and is expressed in a curvilinear monotic type of relationship. The probability of information overload is taken as the combined values of Situations four and five. The occurrence probabilities of information overload are relatively low as the probability of Situation three has not been included in the total. The reason for the exclusion is that Situation three represents a transitory situation where project managers are sometimes overloaded and sometimes not. This approach also complements the method used to determine the information overload starting point, where the zoning shifted to the lower end of the ILP scale to provide a realistic view. The graph can be used to predict the information overload occurrence probabilities from the ILP scores, or vice versa. It also assigns more explicit meaning to the representative values of ILP scores.

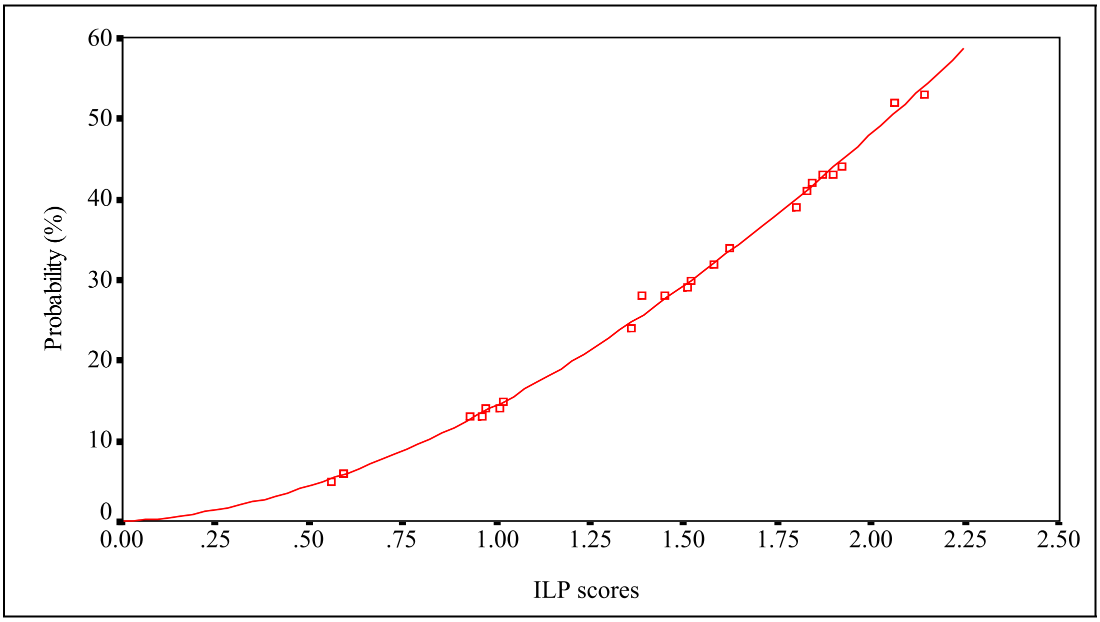

Figure 2 The correlation between ILPs and information overload probability

CONCLUSIONS

The results indicate that by using the method it is possible to have a numeric representation of the extent of information overload during the course of a construction project. The use of time to develop the information load points and the placing of these in the information load matrix provides an effective way of modelling the information overload of project managers as a result of interaction with key project members throughout the project. It meets the need for a technique to operationalise the use of time to conceptualise information overload. The model utilises a pioneering concept in project management and provides a high level of flexibility for its application to the unique features of building projects.

Project managers' information overload varies throughout the stages of the project, and the sources of the overload also change with these stages. The construction stage has the highest probability of information overload, followed by the design stage. The main sources of information overload are the project participants contributing the key expertise in each stage. In the design stage, the key contributors are architects and consultants, and in the construction stage, contractors and sub-contractors. Architects' and consultants' contributions to information overload show a similar pattern through the project duration, as do those of contractors and sub-contractors.

The model developed here is the first of its kind in construction project management. Therefore, further testing of the model is needed to see if it produces similar output in similar environments. Being an initiatory work in the field of information overload identification, there is plenty of scope for refining, or even replacing certain aspects of the model. In this way, the model is offered as a starting point for future developments, not as an end in itself.

The topic of information overload has been overlooked by both the construction management research community and practitioners in the industry. This research aimed to understand the current state amongst the practising construction project managers and make it explicit. Therefore, it does not offer tangible solutions to prevent the problem, it functions rather as a pioneering work to bring the phenomena of information overload to the attention of the construction project management community. In that sense, it is a means to an end. There are countless numbers of areas for further research to complement the ultimate end- that is to understand information overload and prevent the occurrence and negative consequences of it in construction project management. Only then will it be possible to go forwards towards achieving a better management of project information and projects as a whole.

REFERENCES

Ackoff, R.L. (1967) Management misinformation systems, *Management Science*, 14(4), 147-156.

Agresti, A. (1996) *An Introduction to Categorical Data Analysis*, John Wiley and Sons, New York.

AT&T (1988) *The world's telephones 1985-1986*.

Atkin, B.L. (1990). *Information Management of Construction Projects*, T.W. Crow Associates, Sydney, Australia.

Bailey, K.D. (1987) *Methods of Social Research*, Free Press, New York.

Bennett, J. and Fine, B. (1982) Measurement of complexity in construction, *Final Report of SERC Research Grant*, Department of Construction Management and Engineering, The University of Reading, Occasional Paper No:8.

Black, R (1993) *Getting Things Done*, Duncan Petersen Publishing, London.

Carter, M.P. (1981) An economic appraisal of management information, PhD Thesis, University of Keele, USA.

Chow, K.F. (1989) The impact of information technology on the construction industry, In *Proceedings of the First IES Information Technology Conference*, May, Singapore, 25-27.

CIOB (1992) *Code of Practice for Project Management for Construction and Development*, The Chartered Institute of Building, Ascot, UK.

Conover, W.J. (1980) *Practical Nonparametric Statistics*, John Wiley and Sons.

Cravis, H. (1981) *Communications Network Analysis,* Lexington, MA, USA.

Dawes, R.M. (1972) *Fundamentals of Attitude Measurement*, John Wiley, New York.

Edwards, A. (1957) *Techniques for Attitude Scale Construction*, Prentice-Hall, Englewood Cliffs, NJ.

Fienberg, S.E. (1980) *The Analysis of Cross-classified Categorical Data*, MIT Press, Cambridge.

Hahn, M., Lawson, R. and Lee, Y.G. (1992) The effects of time pressure and information load on decision quality. *Psychology and Marketing,* 9(5), 365-378.

Haksever, A.M. and Fisher, N. (1996) A method of measuring information overload in construction project management, *CIB International Conference on Construction Modernization and Education*, Beijing, China, 21-24 October.

Haksever, A.M., Kim, H.S. and Pickering, G. (1996) Benefits of long-term relationships: UK contractors' experience, *The Proceedings of the 8th CIB W65 International Symposium on the Organisation and Management of Construction*, Vol.1, E & FN Spon, 239-246.

Hirshleifer, J. and Riley, J.G. (1979) The analytics of uncertainty and information: a expository survey, *Journal of Economic Literature*, 17, 1375-1421.

Hughes, W.P. (1989) Organisational analysis of building projects, Unpublished PhD Thesis, Liverpool Polytechnic.

Keller, K.A. and Staelin (1987) Effects of quality and quantity of information on decision effectiveness, *Journal of Consumer Research*, 14, 200-213.

Meddis, R. (1984) *Statistics Using Ranks: A Unified Approach*, Basil Blackwell, Oxford.

Meyer, R.J. and Johnson, E.J. (1989) Information overload and the nonrobustness of linear models: a comment on Keller and Staelin. *Journal of Consumer Research*, 15, 498-503.

Mintzberg, H. (1975) *Impedimence to the Use of Management Information*, National Association of Accountants, New York.

Ouwersloot, H., Nijkamp, P. and Rietveld, P. (1991) Economic aspects of information and communication: some considerations. *Information and Software Technology,* 33(3), 171-180.

Pietroforte, R. (1997) Communication and governance in the building process, *Construction Management and Economics*, 15(1), 71-82.

Schick, A.L., Lawrence, A.G. and Haka, S. (1990) Information overload: a temporal approach, *Accounting, Organizations and Society*, 15(3), 199-220.

Theil, H. (1967) *Economics and InformationTheory*, North-Holland.