Information model for construction briefing

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ABSTRACT | This paper describes an information model for the establishment and processing of client requirements on construction projects (briefing). The model is described using the *EXPRESS-G* graphical notation, and it provides a formal representation of the nature, sources and interrelationships between information required for the implementation of a methodology for client requirements processing in a computer environment. The rationale and details of the methodology, which forms the basis for the information model, are reviewed, and the complete entity-level diagram of the *EXPRESS-G* model is presented and discussed. The implementation of the information model in a computer environment will enhance the definition, analysis and translation of client requirements into solution-neutral design specifications. This in turn increases the chances that the resulting facility that is designed and built from those requirements will be to the satisfaction of the client.

KEYWORDS | construction briefing, client requirements, information model, EXPRESS-G notation

1 Introduction

The need for improved business performance in the construction industry, which is plagued by problems associated with its fragmentation, has generated much interest in the modelling of various aspects of the construction process. Although various forms of modelling (e.g. architectural models of buildings, models of construction operations) have been used in the industry [1], current interest in construction modelling is related to the need for improved business processes and the need to implement computer integrated strategies [2-3]. The development of models is particularly seen as vital for the development of computer-based information technologies (IT) since modelling provides a logical step to automation [2, 4, 5]. Applications of IT in construction have generally focused on the automation of specific activities that involve computation (e.g. detailed design of structural members), and the integration of various aspects of the construction process [6]. However, it is now recognised that IT tools can also be used to improve the effectiveness of the briefing phase in construction, which deals with the fuzzy task of establishing the requirements of a client [7]. The development of IT tools for briefing, as in every software development process, requires a detailed information/data model of the process that can be implemented in a computer environment.

This paper describes an information model, presented using the EXPRESS-G graphical notation that derives from an innovative approach for establishing and processing client requirements (briefing) on construction projects. The meaning, scope and methodology for client requirements processing are described. This is followed by a discussion of the complete entity-level

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diagram of the information model, and how it could be implemented in a computer environment.

2 Establishing Client Requirements on Construction Projects

As the initiators and financiers of projects, clients are central to the construction process, and are considered to be the driving force in the construction industry (hereinafter referred to as 'the industry'). The ultimate goal of all parties in a project, therefore, is to fully satisfy the requirements of the client. This invariably depends on the project organisation, design quality, skills of the construction workforce, and the quality and suitability of construction materials [8]. However, the process of satisfying client requirements begins with a clear definition of what those requirements are. This requires a renewed focus on the requirements of the client, and the effective encapsulation of their 'voice' in the design and construction process. An innovative methodology for achieving this is presented in a client requirements processing model (CRPM). The CRPM is designed to fulfil defined objectives for establishing client requirements, and was developed following research on the existing process of briefing in construction, and a study requirements processing in similar disciplines such as manufacturing and requirements engineering. The information model discussed in this paper derives from the CRPM.

2.1 Objectives for Briefing in Construction

Previous studies on briefing [9-17] have shown that the goals for establishing clients' requirements on construction projects can be summarised as follows:

1. To address the complexities within the client body through the identification, resolution and incorporation of the different perspectives within the client body.
2. To clarify the objectives and expectations of the client to ensure that they are understood from the perspectives of the client.
3. To exclusively focus on client requirements so as to understand how other project requirements can either enhance or constrain their implementation.
4. To translate and present client requirements in a format that will allow collaborative working and the development, verification and management of appropriate design and construction solutions, which satisfy the objectives of the client.

To satisfy these goals, an appropriate framework for establishing client requirements is required. This framework should ensure that the *process* and the *outputs* of the system satisfy the goals for client requirements processing. This can be part of an integrated project environment, or it can serve as an input into the design and construction process [18-20]. As part of an integrated project environment, client requirements processing should reflect the manner of working within that environment. For example, it should facilitate the participation and integration of a multi-disciplinary team in defining the requirements the client, and the integration of client requirements processing with other activities in the construction process. It is also essential that such a framework is computer-based, in order to realise the full benefits of computer-integrated construction [21-23]. A computer-based client requirements processing framework is vital for integration with IT-based downstream activities in construction. Furthermore, conformance checking and traceability of requirements throughout the project life cycle can be automatically done if requirements processing is computer-based.

As an input to design, client requirements processing provides an interface between a client's demands and the measures (design and construction) used by the industry to meet those demands [24, 25]. Therefore, the *nature* and *content* of the information, which constitutes the 'voice of the client' (i.e. how it is expressed or stated), should facilitate the development of appropriate solutions (design and otherwise) to the client's problem, and enhance the work of an integrated project team. Client requirements should therefore be:

1. Clear and unambiguous, to minimise or eliminate any confusion arising from multiple interpretations of their meaning. Clarity can also facilitate the verification and management of client requirements throughout the life cycle of the project/facility.
2. Comprehensive. That is, they should incorporate, as much as possible, the collective wishes and expectations of the different components of the client. Issues relating to the life cycle of the facility (e.g. its acquisition, operation, use, management, disposal, etc.) should also be included.
3. Solution-neutral (or performance based), to allow innovation and creativity in devising solutions to the client's problem.
4. Stated in a format that can be understood by the different disciplines working on a project. This goes beyond understanding requirements from the perspective of the client. It involves the presentation (or translation) of client requirements to satisfy the information needs of the different disciplines represented in an integrated project team.
5. Processed and categorised to the same level of granularity for adequate and effective prioritisation by removing as much fuzziness as possible.

These objectives for establishing client requirements influenced the study on the existing process of briefing, and the development of the CRPM.

2.2 Existing Process of Briefing in Construction

A review of existing literature on briefing, case studies, discussions with construction professionals and clients, and a structured postal questionnaire survey were used to assess how briefing is carried out in the UK construction industry [17]. These studies (the findings of which are summarised in Table 1) revealed that there are limitations in the process of briefing. These include: inadequate involvement of all the relevant parties to a project, insufficient time allocated for briefing, inadequate considerations of the perspectives of the client, inadequate communication between those involved in briefing, and inadequate management of changes to client requirements. These problems, which are supported by other studies on briefing [7, 9, 10], may be due to the attitude or inefficiencies of those involved, but they also suggest that the general framework for briefing is inadequate.

Current briefing practice deals with the collection of information for project implementation, and often, project requirements are taken to be the same as client requirements. However, an adequate understanding of client requirements can only be achieved if they are considered distinctly from other project requirements, so that the problem that design and construction are to solve, within the context of the site and immediate environment, can be clearly defined (ensuring that 'the tail doesn't wag the dog'). Another limitation is that, use of the solution (i.e. design) to clarify the problem, can also shift focus from client requirements to the preferences of designers. This is because proposed solutions are usually made before a thorough understanding of the client's requirements. There is therefore an inherent tendency for the client to be influenced by the preferences of the designer(s). This in itself may not be disadvantageous to the client, who relies on the expertise of the designer to provide a design solution to his or her problem. However, as MacLeod et al. [26] put it, "if one does not know clearly what one is trying to achieve … then the chances of achieving good outcomes must be diminished." Furthermore, this practice assumes that a design professional has to lead the briefing process. But designers are not necessarily good brief writers since briefing is mainly concerned with the processing of information [27]. It is therefore not surprising that many briefs are generated out of design rather than a clear understanding of the client's actual objectives [28].

The limitations in the process and framework for briefing have led to various initiatives to devise ways for its improvement. These include the development of computer and information tools to assist in the creation and management of briefing information, and the use of

Table 1. Summary of findings on the briefing process [17]

Briefing Process	Summary of Findings
Those involved in briefing	• a broad mix of professionals (both within and outside the client organisation) are involved in briefing; • they include: administrators (managers), architects, development managers, engineers (building services, civil, structural), planning supervisors, portfolio managers, project managers, quantity surveyors (QS), etc.; • design professionals (e.g. architects however, tend to dominate the briefing process.
Stages in briefing	• briefing is combined with design (i.e. conceptual and scheme design), and usually, there are no distinct stages in the process; • briefing information becomes more detailed as design progresses.
Collection and documentation of information	• focus is on the collection of information for project implementation; • a variety of methods are used to collect information: e.g. interviews, workshops, evaluation of existing facilities, visits to similar facilities, etc.; • information collected is sometimes documented in formal documents (e.g. letters, faxes, e-mail, minutes of meetings, sketches and drawings, etc.); • these documents are not normally stored as part of 'the brief', and usually, design team relies on recollections of verbal communications with the client.
Processing of information	• a process of 'trial and error', through the use of sketches and drawings, is mostly used to clarify the client's problem, or process briefing information; • there are situations, however, where clients who commission many projects, define their requirements before design.
Decision-making in briefing	• decision-making involves the resolution of competing interests between different groups within the client body, and between professionals with diverse perspectives; • decisions are usually the result of discussions and negotiations between those involved; • techniques such as value management are used to assist in decision-making.
Management of the briefing process	• management of changes to requirements is influenced by the way requirements are represented in subsequent stages of the briefing and design process; • changes to requirements are managed by recording them as corrections to sketches and drawings, the main medium for representing the brief; • changes may also be discussed in meetings and decisions recorded in the reports (minutes) of those meetings.
Limitations in current briefing practice	• inadequate involvement of all the relevant parties to a project; • insufficient time allocated for briefing; • inadequate considerations of the perspectives of the client; • inadequate communication between those involved in briefing; • inadequate management of changes to requirements.

techniques from manufacturing to analyse client requirements [29-33]. However, these efforts do not adequately provide for the effective processing of client requirements. For example, those that are based on the development of software to support briefing are basically computerised systems of existing practices without any re-engineering of the process. There is also no comprehensive framework to incorporate and prioritise the different perspectives represented by the client. It is therefore evident that the current process of briefing, and emerging initiatives for its improvement, do not satisfy the objectives for establishing client requirements outlined above. This calls for the development of an innovative approach to briefing, which will draw from techniques in similar industries such as manufacturing and requirements engineering.

2.3 Requirements Processing in Related Disciplines

Related research on the encapsulation of customer requirements in manufacturing, and requirements engineering, gave rise to the following insights into how client requirements can be effectively processed.

- Structured, matrix-based techniques such as quality function deployment (QFD) can assist product development teams to focus on customer (client) requirements, provide for their effective translation into design attributes, and enhance the traceability of those requirements throughout the product development process [34-36]. QFD is a matrix-based methodology used in the manufacturing industry to translate customers' required quality characteristics into appropriate product and service features.
- The structuring and decomposition of requirements into a hierarchy from primary (most general) to increasing levels of detail (secondary and tertiary requirements) can facilitate greater understanding and traceability of requirements [34, 37-39];
- The categorisation of requirements into functions (what the system should do), attributes (system features), constraints (system limitations), and preferences (i.e. customer preferences) can enhance the understanding of requirements and remove ambiguities in their definition [40];

Thus, the resulting model for client requirements processing reflects the above principles, but with particular emphasis on the QFD methodology, which is already being adapted in the construction industry [29, 32]. However, other techniques and standards such as value management, which are used in the construction industry, were also incorporated [41-43] in the model, which is briefly described below.

3 Methodology for Processing Client Requirements

The development of the client requirements processing model (CRPM) involved an iterative process, with reviews and feedback by various academics and researchers, and detailed analysis and discussion with construction industry practitioners. The approach adopted in the processing of client requirements, focuses on the description of the proposed facility (which satisfies the business need of the client) in terms of its functions, attributes, effects on people, and the process of acquiring, operating, and disposing it. Through a process of structuring, a hierarchy of primary, secondary and tertiary requirements are established, and these form the basis for translating the client requirements into solution-neutral design specifications which can be acted upon by designers. Figure 1 shows the activities in the CRPM, and Table 2 provides details on each of the three main activities: "define client requirements", "analyse client requirements", and "translate client requirements".

At the "define client requirements" stage, the project context and interest groups represented by the client are identified, and client requirements are elicited. The "analyse client requirements" activity deals with the structuring (into primary, secondary and tertiary requirements) and prioritisation of (tertiary) client requirements based on the relative importance interest groups place on those requirements. The "translate client requirements" activity deals with the translation of client requirements into design attributes (e.g. 'gross floor area', 'air flow velocity', etc.). It involves the generation of design attributes, determination of target values (for design attributes), translation of client requirements into design attributes, and the prioritisation of design attributes.

The translation process involves associating tertiary client requirements with generated design attributes using the QFD 'house of quality' matrix. For example, a client requirement for 'pleasant internal environment' can be associated with any, or a combination, of the following design attributes: 'air flow velocity', 'mean radiant temperature' and 'sound pressure levels'. The target values (e.g. gross floor area of 2500m^2) are intended to define a solution space for the design attributes, are their determination depend on the *controls* for that activity. For example, the target (minimum or maximum) value for 'air flow velocity' that will contribute to a 'pleasant indoor environment' for the client will depend on factors, which include: the number and categories of users

Table 2. The main stages and activities for client requirements processing

Main Stage	Activities	Required Resources/ Tools
Define Client Requirements	• establish and document basic facts about the project and the client; • identify and describe the people or groups ('interest groups') which influence, and/or are affected by the acquisition, operation/use and existence of the proposed facility; • elicit from client, the functions and attributes of the proposed facility, information on its acquisition, operation, future demolition, activities to be performed in the facility, and the characteristics of proposed users ('voice of the client').	• A multi-disciplinary requirements processing team; • Elicitation techniques (e.g. questionnaires, interview techniques)
Analyse Client Requirements	• Structure and prioritise client requirements; • Restate (or decompose) client requirements into primary, secondary and tertiary requirements to facilitate a clearer understanding of those requirements; • Determine the relative importance of 'interest groups'; • Prioritise tertiary requirements with respect to the relative importance of each interest group and their weighting of each tertiary requirement	• Requirements processing team; • Value tree analysis to decompose requirements; • Decision making techniques (e.g. criteria weighting & weighted score model, etc.) [42]
Translate Client Requirements into solution-neutral design specifications	• Generate design attributes; • Determine target values for these design attributes using information on the characteristics of the project, proposed use and users of the facility, acquisition and operation of the facility, international standards (including codes of practice), and target values for similar facilities); • Translate tertiary client requirements by matching them with identified design attributes to determine which design attributes best satisfy a particular requirement; • Prioritise design attributes which have been matched with client requirements • Prioritised design attributes and their target values constitute the solution-neutral specifications.	• Requirements processing team; • The QFD 'house of quality' matrix [29]

and use categories and patterns. The strength of the relationship between a requirement and a design attribute can be represented by 9, 3, 1, 0 for strong, medium, weak, and no relationship respectively. This is used, together with the relative weights of tertiary client requirements, to determine the absolute and relative weights of each design attribute. The output of the translate requirements activity is solution-neutral specifications. These comprise of the following: design attributes (translations of tertiary client requirements), relative weights of design attributes (indicating the level of importance) and the target values for design attributes (solution space). The descriptions of the CRPM provided in Figure 1 and Table 2 serve as the basis for the information model, which is the focus of this paper.

4 Information Model For Briefing

Information modelling is an outgrowth of, and is similar to, data modelling. The difference between them lies in the fact that, while data modelling is explicitly aimed at computer automation, information modelling has the goal of describing information so that the representative data *could* be computer-processed [44]. The need for a computer representation of the client requirements processing model (CRPM) is of particular significance, as the use of computer technology is necessary to fully exploit the benefits of computer integrated construction (CIC) [21]. The information model for the CRPM therefore provides the basis for developing a computer application for client requirements processing.

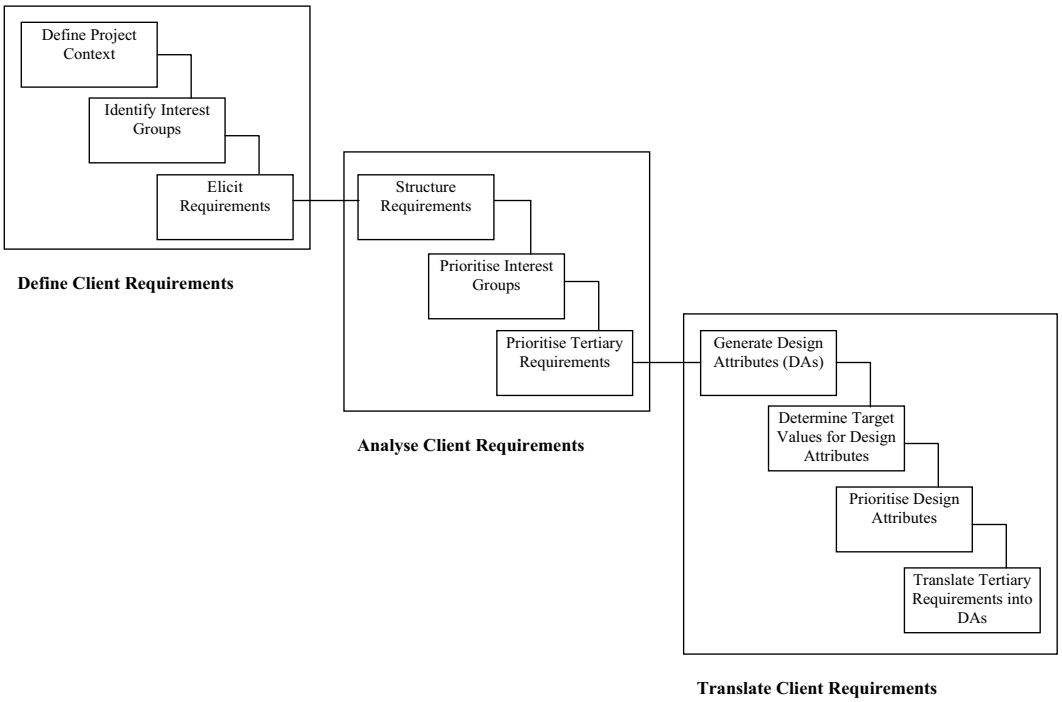

Figure 1. Flow diagram of all the activities in the CRPM

4.1 Representation of the information model

The EXPRESS-G graphical notation is used to represent the information model for client requirements processing. EXPRESS-G facilitates the representation of the information structure of a model in a format that is easy to follow and understand. It also generally accepted, and has been successfully used to model various aspects of the construction process [33, 45, 46]. Furthermore, information models described using EXPRESS-G are independent of any implementation context, and would therefore allow flexibility in computer implementation of the model. However, because it is an object-flavoured tool, it supports the development of object-oriented database systems, which are increasingly being used in database development for requirements management (as in reference [47]. The basic notation of EXPRESS-G is presented before a discussion of the information model for the CRPM.

4.2 EXPRESS-G notation

EXPRESS-G is represented by three types of graphic symbols, which together form a diagram (Figure 2). These are: definition symbols, relationship symbols and composition symbols [44, 48]. Definition symbols (varying forms of rectangular boxes) are used to denote simple, constructed, defined, and entity data types, and schema declarations. Relationship symbols (lines) describe relationships, which exist among the definitions. Relationships are bi-directional, but one of the two directions is emphasised, using an open circle in the emphasised direction. For example, in an entity-attribute relationship, the emphasised direction is towards the attribute. For inheritance relationships, the emphasised direction is toward the subtype [48]. Composition symbols enable a diagram to be displayed on more than one page. When there is a relationship between definitions on separate pages, the relationship

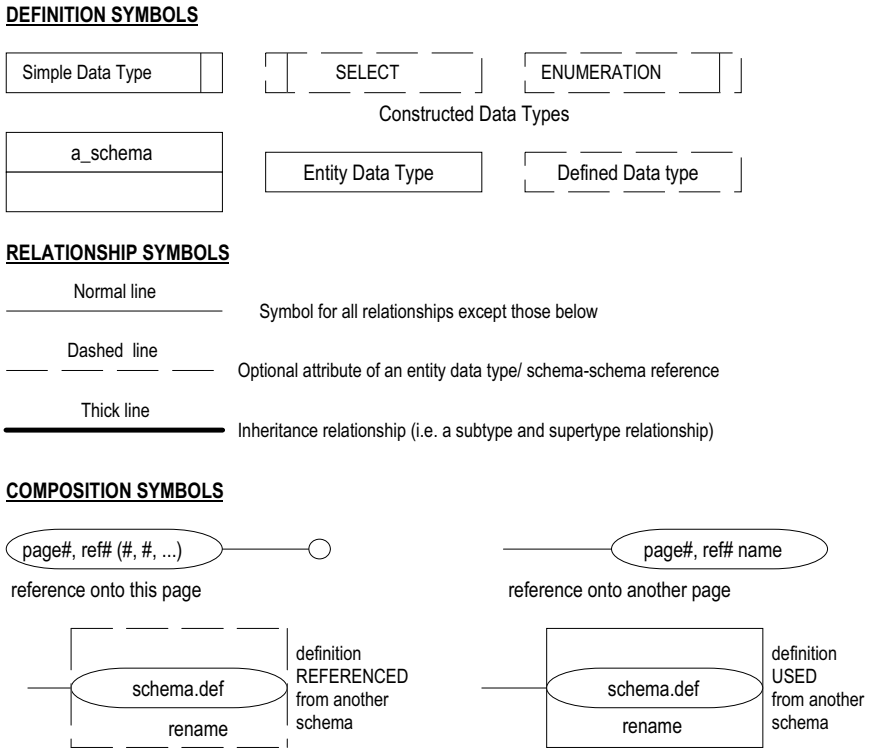

Figure 2. Symbols used in EXPRESS-G (compiled from [48])

line on the two pages is terminated by an oval (rounded) box that contains a page number and a reference number. The page number is the number of the page where a referenced definition occurs. The reference number is used to distinguish between multiple references on a page. The composition symbol on the page where the reference originated contains the name of the referenced definition [48].

There are basically two forms of EXPRESS-G models: entity-level, and schema level models. An entity-level model is one that represents the definitions and relationships that comprise a single schema. It consists of simple, defined, and entity type data, relationship symbols, together with role and cardinality information as appropriate. A schema level model consists of the representations of multiple schemas and their interfaces [44, 48]. A complete diagram (entity or schema level) in EXPRESS-G incorporates all the definitions, relationships and constraints in the model, in one or several pages. The title for each page follows the format: "complete entity level diagram of …", and it is numbered in the form: "page X of N, where N is the total number of pages forming the diagram, and X is the particular page number [48]. The CRPM informational model is an entity level model.

4.3 Informational Representation of the CRPM

The information model for the CRPM defines the information required for defining, analysing and translating client requirements into solution-neutral design specifications. Table 3 provides a hierarchy of the types of information used in processing client require-

Table 3. List of information requirements for the CRPM

Information Group	Basic Information Group Contains
Client Requirements ('voice of the client')	Primary Requirements
	Secondary Requirements
	Tertiary Requirements (including relative weights)
	Client/Project Characteristics
	Client Business Need
	Facility Process
Client Business Need	Facility Use Information
	User Information
	Facility Functions
	Facility Attributes
Client/Project Characteristics	Client Details
	Interest Groups Information
	Project Details/Characteristics
Facility Process	Acquisition Information
	Operation Information
	Disposal Information
Solution-Neutral Specifications	Design Attributes
	Relative Weights of Design Attributes
	Target Values
Other Sources of Information	International Standards
	Design Attributes for Similar Facilities (benchmark information)
	Target Values for Similar Facilities (benchmark information)

ments, and the groups to which they have been assigned for the purpose of the information model. This list can be further classified into 'entities' and 'attributes' as shown in Table 4. The structure of these information types and the relationships are illustrated in Figures 3(a-d). Figure 3a presents an overview of the information model; the entities represented in this figure, and the relationships between them are as follows:

Client requirements, expressed as primary, secondary and tertiary requirements (with absolute and relative weights), describe the facility that satisfies the business need of the client. The requirements of the client consists of information relating to: the characteristics of the client and the project ("client/project characteristics"), his or her business need ("client business need"), and the acquisition, operation and disposal of the facility ("facility 'process'"). Client requirements are influenced by "other sources of information" in the sense that a change in some standards (e.g. space standards, or energy emission targets) might influence the decision by a client to commission the refurbishment of an existing building rather than embark on a new building project.

Client/project characteristics include the nature of the client organisation and the project being considered. The client organisation determines the business need for a project. On the other hand, the business need (e.g. improved communication between two locations), influences the type of project (e.g. refurbishment) as well as the interest groups associated with the process and outcome of that project - the facility. The nature of

Table 4. Attributes for defined entities in the CRPM [17]

Entity Group	Entity	Attributes
Client/Project Characteristics	Client Details:	Client Name, Client Address, Client Business Type, Client Contact Person, Contact Person Address, Number of Employees, Average Annual Turnover, Occupancy Policy, Space Standard.
	Interest Groups:	Group Name, Type of Group, Relationship with Client, Group's Influence in Acquisition, Operation and Use of Facility, Effect of Facility Acquisition, Operation and Use, on Group.
	Project Details:	Project Name, Project Type, Project Location, Facility Type, Facility Objectives.
Client Business Need	Facility Use Information	Activity Type, Time of Day Performed, Time of Year Performed, Peak use Times, Required Equipment and Furniture
	User Information	User Name, User Type, User Size, Relationship with Client, Activity User Performs
	Facility Functions	Function Verb, Function Noun, Function Qualifier, Function Rationale (i.e. why a specific function is required)
	Facility Attributes	Attribute Name, Attribute Meaning, Attribute Rationale, Function Associated with Attribute
Facility 'Process'	Acquisition Information	Available Budget, Rationale for Budget Allocation, Level of Client Involvement (Risk), Rationale for Level of Client Involvement, Approved Client Representatives, Expected Date of Completion, Rationale for Completion Date.
	Operation Information	Costs in Use, Meaning and Rationale for Costs in Use, Operation/Management Strategy, Rationale for Operation/Management Strategy, Level of Operation/Management Technology, Rationale for Operation/Management Technology
	Disposal Information	Expected Life-Span, Rationale for Expected Life-Span, Etc.
Other Sources of Information	International Standards	Standards for the Expression of User Requirements, Standards for Air Capacity for Occupants in Specified Building Types, Etc.
	Benchmark/ Other Information	Operation/Maintenance Information for Existing or Similar Facilities, etc.

the client organisation, and the kind of project will also determine how the facility is procured, operated and disposed of. For example, a client organisation with a substantial property portfolio can have property staff who are responsible for the acquisition of new property, unlike a one-off client who might require considerable assistance from outside consultants. The "facility 'process'" on the other hand, will have an influence on the organisation of the project.

The attributes of the "client/project characteristics" entity (Figure 3b) are:

- client details (name, address, business type, contact person name, contact person address, number of employees, average annual turnover, and client policy on occupancy and space standards);
- interest groups (group name, type of group, relationship with client, group's influence in acquisition, influence in operation/use of facility, the effect of acquisition on the group, and the effect on the group, of the operation/existence of the facility);
- project details (project name, project location, project type, facility type, and facility objective(s)).

Client business need. The business need of the client, which has a relationship with *client/project characteristics*, is satisfied by the facility. The attributes of this entity (Figure 3c) include the following:

- facility use information (activity type, time of day performed, time of year performed, peak use times, and details of required equipment and furniture);

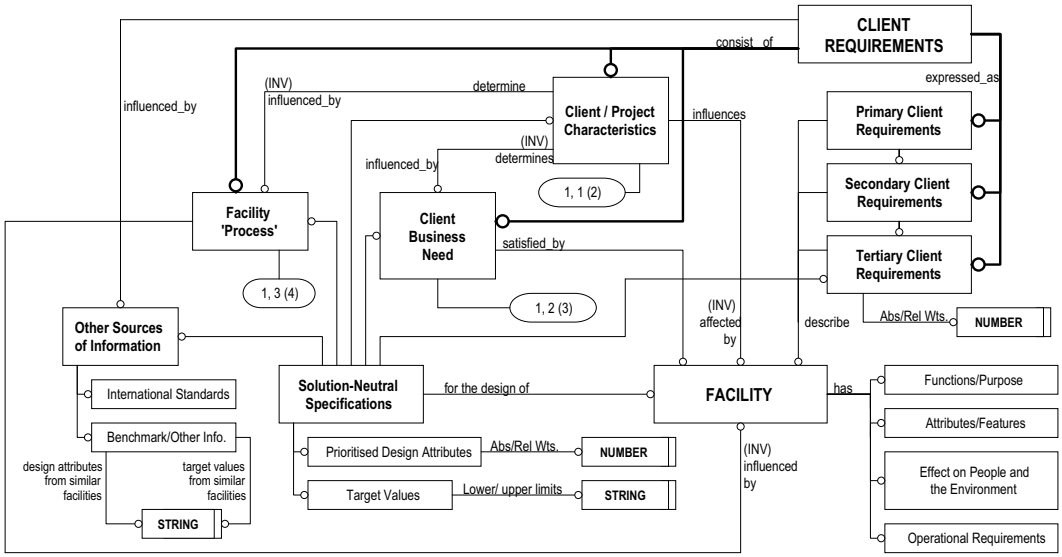

Figure 3a. Complete entity-level diagram of the CRPM information model (Page 1 of 4)

- user information (name, type, size, relationship with client, and activity performed);
- facility functions (function verb, noun, qualifier, and function rationale);
- facility attributes (attribute name, meaning, rationale, and associated function).

The user performs an activity (or activities), and facility attributes provide clarification for the functions of the facility.

Facility Process. The third component of the *client requirements* entity is *facility process* (i.e. information relating to the acquisition, operation and disposal of the facility) (Figure 3). The details of the *Facility process* entity, which is influenced by the kind of facility the client requires, are illustrated in Figure 3d. These include:

- acquisition information (available budget, rationale for budget allocation, level of client involvement, rationale for client involvement, approved client representatives, expected date of completion, and rationale for completion date);
- operation information (costs in use, meaning and rationale for costs in use, operation/management strategy, rationale for operation/management strategy, level of operation/management technology, and rationale for operation/management technology);
- disposal information (expected life-span, and rationale for expected life-span).

Other sources of information. The attributes for *other sources of information*, which influence *client requirements*, (Figure 3a) are: international standards (including codes of practice) and benchmark/other information (based on existing or similar facilities, or other sources of information).

Solution-neutral specifications. The entity, *solution-neutral specifications,* shown in Figure 3a is derived from 'other sources of information', 'facility 'process'', 'client/project characteristics', 'client business need', and 'tertiary client requirements'. Solution-neutral specifications, required for the design of the facility that satisfies the business need of the client, consist of prioritised design attributes (absolute and relative weights) and target values (lower and upper limits).

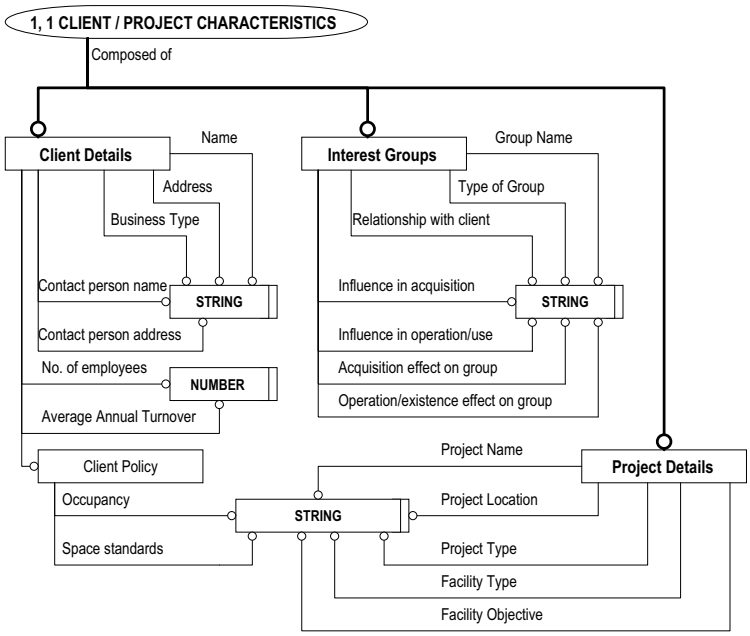

Figure 3b. Complete entity-level diagram of the CRPM information model (Page 2 of 4)

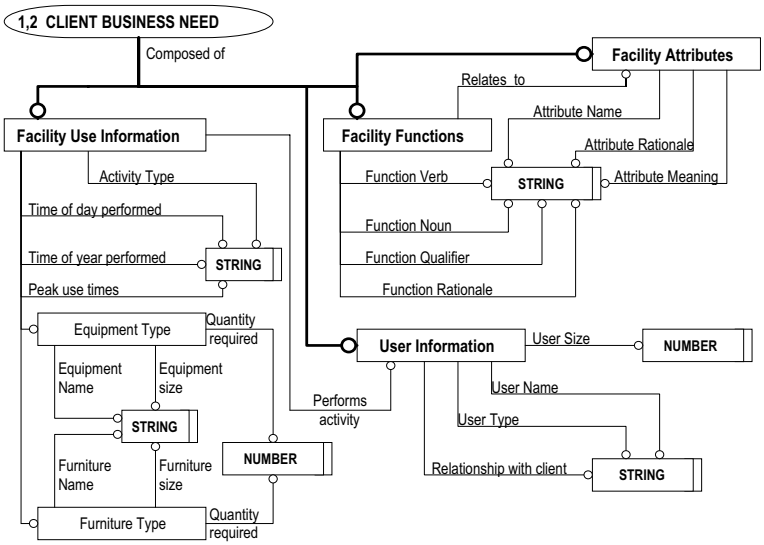

Figure 3c. Complete entity-level diagram of the CRPM information model (Page 3 of 4)

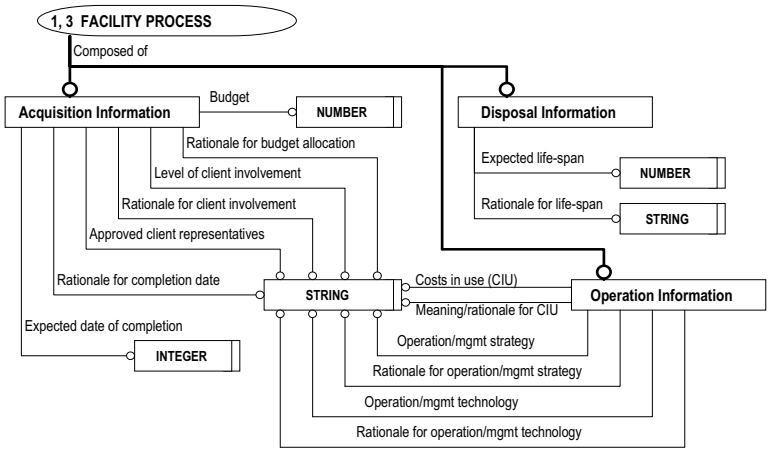

Figure 3d. Complete entity-level diagram of the CRPM information model (Page 4 of 4)

5 Computer Implementation of the Information Model

The information model for the CRPM provides a suitable reference point for designing a data structure for implementing the model in a computer environment. It also provides a structure for the adequate capture of client requirements. For example, if implementation is within a database package such as Microsoft Access, the defined entities (Table 4) will correspond to tables; attributes will correspond to different fields within tables. An example for the entity "client details" is illustrated in Figure 4, which shows that the different 'fields' (Field Name) correspond to the attributes defined in Table 4. The details about data types in Figure 3b are reflected in the 'data type' for each field name in Figure 4 (it should be noted that the 'currency' data type is a form of 'number'; likewise the 'text' and 'memo' data types are forms of 'string' data type). Similarly, the relationship between entities (Figures 3a-d) can be translated into relationship between tables within an Access environment (Figure 5). A detailed description of a prototype software (ClientPro) that was developed from these information models is provided in [49]. The use of this prototype offers the benefit associated with the use of computer-based applications (i.e. data storage and retrieval, online guidance, etc.). However, since the information model, and hence the prototype software underpins an innovative methodology for establishing client requirements, it provides a baseline for the adequate capture and documentation of client requirements.

6 Conclusions

This paper has described an information model for briefing, which is based on an innovative methodology for establishing and processing client requirements on construction projects. The approach adopted for the processing of client requirements focuses on the description of a facility that satisfies the business need of the client. This description is not based on the physical components of the facility (e.g. shape, materials, etc.) but on its functions, attributes, acquisition, operation, disposal, and effects on people and the environment. It also does not include other project requirements (such as site information), but focuses exclusively on the business needs of the client. This ensures that: adequate focus on client requirements is maintained and allows for the precise definition and representation of those requirements in a solution-neu-

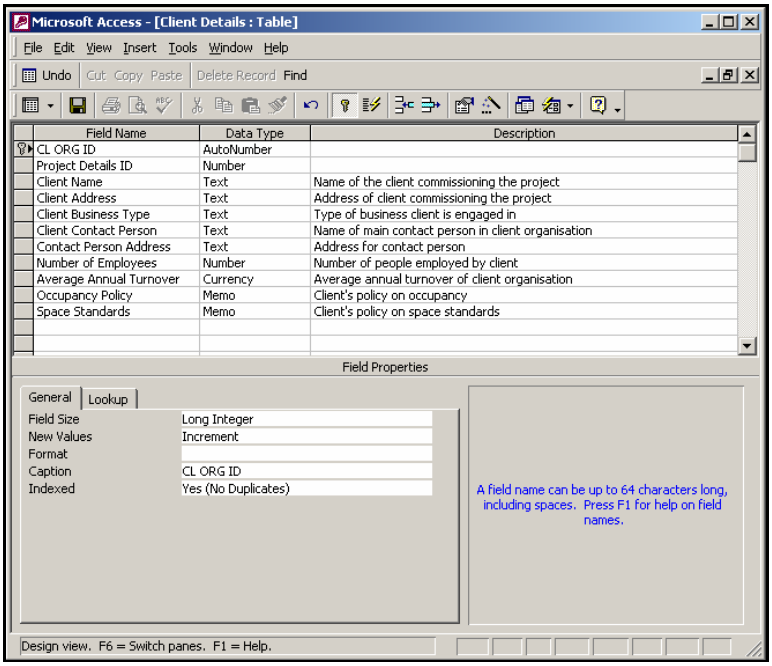

Figure 4. Design view of 'client details' table

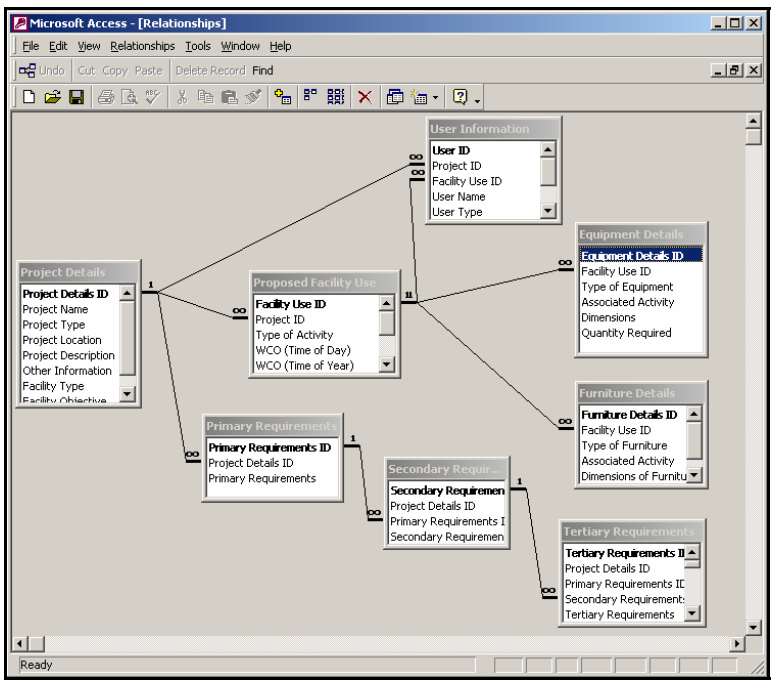

Figure 5. Relationships between some tables derived from the CRPM information model

tral format that enhances design innovation, and facilitates a multi-disciplinary team to work collaboratively. The client requirements processing model has been implemented in a computer environment, which enhances its effectiveness in the processing of client requirements, and facilitates its integration with other computer-based construction activities.

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