INFORMATION TECHNOLOGY TOOL FOR THE ASSESSMENT OF KNOWLEDGE GAP IN REFURBISHMENT PROJECTS

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ABSTRACT
Refurbishment projects are generally considered to be of higher risk, more complex and in need of greater co-ordination than new build projects. Meeting client requirements and managing refurbishment projects can pose a difficult task for construction organisations. In project-based professional or technical service organisations, an organisation’s competences are reflected not only in the quality and number of its individual experts, but also in the integration of the organisation’s knowledge resources through its deployment of people in project teams. It is argued that a knowledgeable project team that is able to understand and interpret the client’s requirements and rely on their knowledge and experience to meet the client’s requirements is likely to increase the chance of delivering a project on time and within budget. From a knowledge-based strategic management perspective, the creation of an optimal mix of a project team (i.e. having expertise in its membership drawn from across organisations) that has requisite skills and competences matched unto the client’s project requirements, will lead to client satisfaction of the project. The aim of this paper is to explicate the operation of a developed information technology tool to assess the knowledge gap between the knowledge of the project team and the requisite knowledge for meeting client’s project requirements in refurbishment projects.

KEY WORDS
Client’s project Requirements, Information Technology Tool, Knowledge Gap, Knowledge Management, Refurbishment

INTRODUCTION
In the construction industry, the satisfaction of the client has long been acknowledged as a much needed issue to be addressed and the importance of achieving client’s satisfaction has been emphasised by many authors: Bennett et al., (1988), Latham (1994) and Egan, (1998). In order to achieve client satisfaction, client’s project requirements have to be met and this can be done by, firstly translating client needs into a design, which specifies technical characteristics, functional performance criteria and quality standards; and secondly, completing the project within a specified time and in the most cost effective manner (Bowen, et al, 1999).

The requirements of the client are difficult to interpret by the project team and to reduce client’s requirements to a textual form is clearly impractical. For refurbishment projects where the clients are very dependent on the knowledge and skills of the project team (Smith, et al., 1999), it is all the more important that the project team is able to understand and

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interpret client’s requirements and rely on their knowledge and experience to meet client’s requirements.

The importance of a knowledgeable project team has been indicated by Othman et al (2005). Hatten and Lalani (1997) have also suggested that by selecting an appropriate consultant team the chance of delivering a project on time and within budget might increase. Cooley (1994) concurred that good consultants would bring genuine and lasting value to the organisation they serve.

Ideally, a multidisciplinary design team is staffed in such a way that both the levels and the distribution of knowledge within the team match those required for the project (Fong, 2003). However, the knowledge or expertise of staff is seldom deployed according to the requirements of the project as a result of a shortfall in knowledge, such as the mismatch between staff expertise and project domain knowledge or because of ad hoc staffing approaches followed in most organisations due to a sudden increase in workload (Fong, 2003).

In addition, given the fact that refurbishment projects are characterised by high risk and uncertainty; working under such situations, and at the same time attempting to achieve the stipulated time for project completion would mean that very often decisions made need to be impromptu and sound. Frequently, project team members only access the knowledge available when the process of executing a task comes to a halt in the face of a problem. There is a general lack of understanding of how valuable the fusion of processes and knowledge can be. One of the major causes of process delays is the lack of the right information or knowledge at the right time, which causes the process execution to slow down or come to a halt. Until appropriate information or knowledge is acquired for the performance of tasks in the process, there will be a delay in the process and incurrence of costs. Thus, there is a need to integrate knowledge management into the refurbishment process.

Based on an on-going doctorate study which aims to provide an appropriate methodology to match the knowledge of the project team with the project requirements for refurbishment projects so as to fulfil the client’s needs and increase client’s project objectives, this paper examines and presents the development of an information technology (IT) tool for the assessment of knowledge gap between the project team’s knowledge and the requisite knowledge to meet client’s project requirements during the refurbishment process in the construction industry.

**RESEARCH METHODOLOGY**

The research paradigm used in this context was be phenomenological so as to understand meanings, or look at, describe and understand experience, ideas, beliefs and values in the construction industry. In order to gain insights to the research area, make inferences and draw conclusions from the research, methodological triangulation was adopted. To optimise the quality of data collection and due to the qualitative nature of the data in this research, non probability sampling was the primary sampling method.

Survey research methodology was adopted in this research to investigate a particular phenomenon, i.e. the knowledge enabled process for meeting client’s project requirements for refurbishment projects in the construction industry.
The use of questionnaire survey and semi-structured interview as the method for data collection was adopted in this research study. According to Smith (1975), each method, tool or technique for data gathering has its strengths and weaknesses. Since different methods will have different effect, different methods – questionnaire survey which is a quantitative method of data collection and interview which is a qualitative method of data collection – were used in this research so as to cancel out the ‘method effect’ so that it will lead to greater confidence being placed in the conclusion.

**SAMPLING**

The study population in the data gathering stage consisted of: the client population: developers, hotel owners and private and public hospitals the project stakeholders: professionals who are involved in refurbishment projects. The key professionals included architects, quantity surveyors, structural engineers, building services engineers and contractors.

The sampling frame for the questionnaire and interview included client, users, architects, quantity surveyors, consulting engineers and project managers who have the experience or are currently working on hotel, retail, offices and hospitals refurbishment projects. The choice of this sampling frame was based on the generic organisational structure of the UK construction industry (Riley and Brown, 2001) which illustrates the range of contributors that are required for a construction project.

The sampling units (i.e. respondents) were developers, facilities managers of hotels, facilities managers of private and public hospitals. For project stakeholders, the respondents were drawn from registered architects from the RIBA list, quantity surveyors registered with the RICS, structural engineers and building services engineers from the Institute of Structural Engineers and Chartered Institution of Building Services Engineers respectively. The contractors were selected from a list of refurbishment contractors searched through online database.

Out of the 600 questionnaire surveys sent out between February and March 2006, 124 completed and usable questionnaires were returned, representing a response rate of 20%; which falls within the norm of 20% - 30% response rate for most postal questionnaire surveys conducted in the construction industry (Akintoye and Fitzgerald, 2000). Forty semi-structured interviews were also conducted between May and July 2006.

**MATCHING CLIENT’S PROJECT REQUIREMENTS WITH THE KNOWLEDGE OF THE PROJECT TEAM IN REFURBISHMENT PROJECTS**

A methodology for matching client’s project requirements with the knowledge of the project team was developed for this research from the literature review, questionnaire survey and semi-structured interview results. It focuses on the matching of client’s project requirements in refurbishment projects and its purpose is to enable organisations to meet client’s project requirements by allocating individuals with the requisite knowledge to form a project team. The significant areas considered in the methodology are as follows:

- Client’s project requirements for refurbishment projects
• Types of knowledge required to meet client’s project requirements in refurbishment projects
• Sources of knowledge from which project team can draw in order to meet client’s project requirements
• Techniques and technologies for knowledge capture

Figure 1 shows the developed methodology for matching client’s project requirements with the knowledge of the project team for refurbishment projects.

The developed methodology has the following important stages:

**Identification and Categorisation of Client’s Project Requirements**

Under this section, client’s project requirements are first elicited using common methods like questionnaire, interviews, brainstorming exercise or discussion sessions conducted among the project team, end users and client or client representative (s). From the list of project requirements elicited, the requirements are categorised under the types of knowledge that is required to meet these identified requirements. The six types of knowledge identified are:

• building (i.e. knowledge on the fabric of the building, the extent of deterioration, history of the building etc),
• client (i.e. knowledge on client’s needs and requirements),
• authorities (i.e. knowledge on authorities’ regulations),
• management (i.e. knowledge on the management of refurbishment project),
• personal (i.e. knowledge acquired from own experience), and
• industry (i.e. knowledge on the available technologies and materials in the industry)

In his plan for a route to a successful refurbishment project, Latham (2000) identified eight stages involving a mix of players, where critical risks arise and important decisions have to be taken. The eight stages are: (1) Initiating action, (2) understanding the building, (3) Understanding the user’s requirements, (4) enhancing the value of the property, (5) Design: working with the building, (6) Presenting the project, (7) Techniques: materials and craftsmanship, (8) Implementation: time and quality. Under these eight stages, understanding the building, knowing what is required from the client, knowing the authorities’ legislation and being able to carry out the work smoothly are some of the knowledge required for a successful refurbishment project. From the research interview conducted in this study, the types of knowledge required for the management of refurbishment projects identified by respondents indicate a similar inclination.

**Establishment of Knowledge Gap and Identification of Knowledge Sources**

Having identified and categorised the client’s project requirements under the different types of knowledge, the next step is to assess the knowledge gap between the existing knowledge of the project team members and the required knowledge. As refurbishment projects involve a lot of stakeholders, it is almost impossible to pin point a project team member that will meet a specific client’s project requirements. Instead, the knowledge from various members of the project team may be required to meet just one of the client’s project requirements. As
indicated from the result of the research study, tacit knowledge is used more extensively than explicit knowledge by professionals in their attempt to meet client’s project requirements. As tacit knowledge is cognitive and personal, it is difficult to identify the person who possesses the required knowledge. In addition, knowledge used by a team or organisation involves not one but several people coming to understand, accept and internalise new ideas (Eraut, 1985). Furthermore, an individual’s knowledge is very much influenced by his experience accumulated through the years. For this reason, and in order to establish the knowledge gap, project team members are instead asked to answer a given set of questions formulated from the elicited project requirements (see Table 1 for an exemplar of the knowledge gap assessment questions). The formulation of the questions can be conducted by, firstly, scrutinising each client’s project requirement and asking oneself what knowledge is required in order to meet the client’s project requirements. Next, questions are formulated to ask if one has that required knowledge. From this exercise of answering the assessment questions, the knowledge gap between the required knowledge and the existing knowledge that the project team has can be identified. By answering the assessment questions, the knowledge source from which the required knowledge can be found is reflected upon and identified by the project team. Knowledge sources from which project team members can acquire knowledge to fill the knowledge gap are suggested in the developed methodology.

**Knowledge Capture**
At the knowledge capture stage, project team members need to ask themselves if they know the types of knowledge capture tools that are used or available. If they do not know, they would need to find out from colleagues, publications or electronic sources. If they know what the knowledge capture tools are, they will then need to ask if the knowledge from the identified sources is available for capture, if it is available, they would then proceed with the capturing of knowledge from the identified knowledge sources, or else they will proceed to the next available knowledge source to capture the requisite knowledge.

From the research survey results, the knowledge capture techniques and technologies used by the respondents tend to be more for personal use. The choice of knowledge capture techniques and technologies used tends to be personal or constrained by construction organisations’ usual practice. The research results indicate that the more often used knowledge capture techniques and technologies are project documentation, pre/post project reviews, company’s database and internet / intranet. In the developed methodology, various knowledge capture techniques and technologies are suggested. However, there will not be any indication of the knowledge capture technique or technology to be used for each specific client’s project requirements, since the choice of knowledge capture techniques and technologies and the extent of their use is dependent on the organisation’s usual practice and available resources.

**MATCHING CLIENT’S PROJECT REQUIREMENTS WITH PROJECT TEAM’S KNOWLEDGE**
Upon capturing the required knowledge, the knowledge gap between the requisite knowledge and the existing knowledge of the project team is filled. The client’s project requirements are matched with the knowledge of the project team.
Figure 1: A Process for Matching Client’s Project Requirements with Project Team’s Knowledge for Refurbishment Projects (adapted from Kucza, 2001)

### Identification and Categorisation of Client’s Project Requirements

1. Elicitation of client’s project requirements using techniques like interviews, questionnaire, brainstorming exercise and discussion sessions

2. Categorise client’s project requirements under the required knowledge types, for example:
   - client (knowledge of what client’s project requirements are)
   - building (knowledge of fabric of the building, the extent of deterioration, history of the building etc)
   - authorities (knowledge of authorities requirements and regulations)
   - management (knowledge on the management of refurbishment project)
   - personal (knowledge acquired from own experience)
   - industry (knowledge on the available technologies and materials in the industry)

### Establishment of Knowledge Gap and Identification of Knowledge Sources

3. Determine the knowledge required to meet client’s project requirements. Assess the knowledge gap between the existing knowledge of the project team and the required knowledge by:
   - Securitising each client’s project requirements
   - Identify what knowledge is required in order to meet the client’s project requirements
   - Formulate questions to ask if one has that required knowledge and conduct a questionnaire exercise.

4. Identify the knowledge source

   **Knowledge sources** can be from: client, colleagues, project documents, publications, internet/intranet, past experience of colleagues or self

### Knowledge Capture

5. **Does one know what the available knowledge capture tools are?**
   - Yes: Capture knowledge from the identified knowledge sources using the selected techniques / technologies given the organisation’s resources and usual practices
   - No: Find out what are the available techniques and technologies for knowledge capture from colleagues, publications, and electronic sources

   **Knowledge capture techniques and technologies:**
   - Interaction with colleagues
   - Documentation
   - Lessons learned
   - Personal record
   - Database
   - Internet/intranet
   - Emails
   - Photographic record
   - Reviews

6. **Is the knowledge available for capture?**
   - Yes
   - No: Go to the next available knowledge source

7. **Fill knowledge gap between the required knowledge and the existing knowledge that the project team has with the captured knowledge**

8. **Client’s project requirements are matched with the knowledge of the project team**
### Table 1: Recommended Questions for the Assessment of Knowledge Gap

<table>
<thead>
<tr>
<th>Category of client requirements</th>
<th>Client’s Project Requirements for refurbishment projects</th>
<th>Recommended Questions for The Assessment Of Knowledge Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Completing refurbishment project on time</td>
<td>• What is the time given to complete the project?</td>
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<td></td>
<td>• How much time is required for each activity?</td>
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<td></td>
<td>• Do you have the knowledge to reduce unanticipated extra time?</td>
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<td></td>
<td></td>
<td>• Do you have the knowledge on which activities can be speed up?</td>
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<tr>
<td>Client</td>
<td>Cost certainty of refurbishment project</td>
<td>• Do you have the knowledge to calculate the cost involved for the change / variation to the work?</td>
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<tr>
<td></td>
<td></td>
<td>• Are you able to source for cheaper options that are available?</td>
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<td></td>
<td></td>
<td>• Do you have the knowledge to work out how much the client has to pay at each period of time?</td>
</tr>
<tr>
<td>Client</td>
<td>Ensuring the quality of refurbished building is up to client’s standard</td>
<td>• Do you know the quality standards required by the client?</td>
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<tr>
<td></td>
<td></td>
<td>• Do you know the things to be done in order to achieve the quality standard?</td>
</tr>
<tr>
<td>Client</td>
<td>Keeping prices competitive</td>
<td>• Do you have knowledge of the market price for the work?</td>
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<tr>
<td></td>
<td></td>
<td>• Are you able to provide client with value for money?</td>
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<tr>
<td>Client</td>
<td>Responsible and knowledgeable project team</td>
<td>• Do you keep client informed on all changes and progress so that client can make informed decision if necessary?</td>
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<td></td>
<td></td>
<td>• Are you able to solve up rising problems with minimum time?</td>
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<tr>
<td>Client</td>
<td>Enabling the asset and value of the refurbished facility to be increased</td>
<td>• Do you know what is required in the market and by the client?</td>
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<tr>
<td></td>
<td></td>
<td>• Are you able to design facilities that meet these requirements?</td>
</tr>
<tr>
<td>Building</td>
<td>Ensuring that the refurbished facility is aesthetically pleasing to look at in line with client’s requirements</td>
<td>• Do you know what standards can be achieved with the given budget?</td>
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<tr>
<td></td>
<td></td>
<td>• Do you have the knowledge to design buildings / facilities that reflects the client’s activities and image?</td>
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<tr>
<td>Building</td>
<td>Ensure facility is free from defects on completion</td>
<td>• Do you understand the operation of the equipment / facility and what is expected of its performance?</td>
</tr>
<tr>
<td>Building</td>
<td>Ensure that the refurbished facility is fit for the purpose</td>
<td>• Do you know what client’s reasons for refurbishment are?</td>
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<td></td>
<td></td>
<td>• Are you able to devise solution that is able to solve the problems of the client and meet their expectations?</td>
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<tr>
<td>Building</td>
<td>Ensure that the refurbished facility is supported by worthwhile guarantees</td>
<td>• Do you have the knowledge on disputes and arbitration resolutions in the contract?</td>
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<tr>
<td></td>
<td>Keeping the operation cost of refurbished facility low</td>
<td>• Are you able to provide client with value for money?</td>
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<tr>
<td></td>
<td></td>
<td>• Do you have the knowledge to work out how much the client has to pay at each period of time?</td>
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<tr>
<td></td>
<td></td>
<td>• Are you able to anticipate constraints and problems?</td>
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<tr>
<td></td>
<td></td>
<td>• Are you able to provide solutions to the up rising problems?</td>
</tr>
<tr>
<td>Building</td>
<td>Ensuring that the refurbished facility blends and harmonises with existing materials and services</td>
<td>• Do you know the history of the building and how long ago does the material used to build the building dates back to?</td>
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<tr>
<td></td>
<td></td>
<td>• Do you know if the types of materials used still available?</td>
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<tr>
<td></td>
<td></td>
<td>• Are you able to source out skilled workmen who are doing or producing that kind of work / material?</td>
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<tr>
<td>Building</td>
<td>Ensuring that any structural problems are fully addressed</td>
<td>• Are you able to identify the structural problems that the facility has?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do you have the knowledge on the method/s or solution to solve the identified problems?</td>
</tr>
<tr>
<td>Authorities</td>
<td>Ensure that health and safety is adhere on site</td>
<td>• Are you able to identify the health and safety risks?</td>
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<tr>
<td></td>
<td></td>
<td>• Do you have the knowledge to devise solutions to minimise the risks?</td>
</tr>
<tr>
<td>Authorities</td>
<td>Ensuring that the refurbished building complies with authorities’ regulations / requirements</td>
<td>• Do you have the knowledge on authorities’ regulations / requirements?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do you have the knowledge to devise solutions that meet client’s requirements and the authorities’ regulations / requirements?</td>
</tr>
<tr>
<td>Management</td>
<td>Ensure that disputes and arbitration solutions are in place</td>
<td>• Do you know what is required in the market and by the client?</td>
</tr>
<tr>
<td></td>
<td>Aim for design flexibility to accommodate changes due to structural / regulations constraints</td>
<td>• Are you able to identify the constraints on site?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do you have the knowledge to work around the problems?</td>
</tr>
<tr>
<td>Management</td>
<td>Keeping disruption to services and occupants of the refurbished building to a minimum</td>
<td>• Are you able to identify what activities are required for the performance of the technology / equipment?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do you know the cost of fitting such technology / equipment and if client’s budget allows that?</td>
</tr>
<tr>
<td>Industry</td>
<td>Providing the refurbished facility with services that satisfy contemporary requirements and enable the use of modern technology</td>
<td>• Are you able to identify what modern technology is available?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Are you able to identify what facilities are required for the performance of the technology / equipment?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do you know what other alternatives are available with the given client’s budget?</td>
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</tbody>
</table>
AN IT TOOL FOR ASSESSMENT OF KNOWLEDGE GAP BETWEEN PROJECT TEAM’S KNOWLEDGE AND THE REQUISITE KNOWLEDGE IN THE REFURBISHMENT PROCESS

To enhance the developed methodology detailed above, an information technology (IT) tool was developed in this research to measure the knowledge gap between the required knowledge and the existing knowledge which the project team has. The said tool was developed on Microsoft Excel; one of the more common software used by most construction companies.

Users of the IT tool would firstly be introduced to the aim of the tool. Next, they would be required to answer five sets of questions pertaining to their knowledge on the types of knowledge identified (i.e. client, building, authorities, management and industry).

These knowledge types are categorised as:

1. knowledge of what the client’s project requirements are
2. knowledge of the fabric of the building, the extent of deterioration, history of the building etc
3. knowledge of authorities requirements and regulations
4. knowledge of the management of refurbishment projects
5. knowledge of the available technologies and materials in the industry.

Users are given instructions on what they should do when using the tool and also what they could expect after answering the set of questions under each category.

An indication of the questions that users are required to answer in one of the categories is shown in Figure 2. On the top of the page, users are shown which category of the knowledge type they are answering. Before the list of questions, users are given the client’s project requirements under that knowledge type. To answer the questions, users are given two options, ‘Yes’ or ‘No’ and they are to select from the drop down box.

Upon completing each set of questions, users would be given their scores indicating the difference between their current level of knowledge and the target level of knowledge.

After that, users would be provided with suggestions on the key personnel who are identified to meet the client’s project requirements, the knowledge asset which the person should possess, the knowledge sources from which they can draw and the techniques and technologies that they can use to capture the requisite knowledge. After answering all five sets of questions, users would be presented with a summary of their scores and the mentioned suggestions to once again reinforce their understanding.
CONCLUSIONS

The satisfaction of the client has long been acknowledged as a much needed issue to be addressed and the success of a project is often determined by the satisfaction of the client. In order to meet the objective of client satisfaction, a knowledgeable project team that is able to understand and interpret client’s requirements and rely on their knowledge and experience to meet client’s requirements is likely to increase the chance of delivering a project on time and within budget. In construction projects, each project team member brings with them a great deal of experience. Knowledge is also elicited from various project team members during the construction process. There are many people involved during the refurbishment process and each person is a potential source of knowledge. For refurbishment projects, where physical limitations of the building will always pose a problem when implementing client’s project requirements, project team members who have the knowledge and experience will be able to foresee problems and avoid possible variations and unnecessary work.

This paper presented a methodology to match the project team’s knowledge with client’s project requirements during the refurbishment process in the construction industry. It described a knowledge enabled process for meeting client’s project requirements in refurbishment projects with the knowledge of the project team. This methodology sees the
fusion of the refurbishment process and knowledge management and it is envisaged that it can provide a much higher return to construction organisations in terms of client’s satisfaction and effective work process. Lastly, the IT tool that was developed with this research should enable the assessment of knowledge gap between project team’s knowledge and the requisite knowledge for the meeting of client’s project requirements.

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