

Cloud-Based Knowledge Brokering Platform for Managing Construction Claims — A Conceptual Framework

Hai Chen Tan, Chimay Anumba, and Lam Tatt Soon

Abstract—Claims management is a critical task within any contracting company, which entails the supports from custom-designed information systems and even external experts, when complex legal issues or disputes are involved. Conventional model for knowledge brokering is limited to only being able to identify external experts within the personal networks of the knowledge broker. To be more effective and efficient, a cloud-based knowledge brokering model that allows access through the Web is recommended. This paper presents a conceptual cloud-based knowledge brokering platform, which is integrated with a construction claims management system, to improve both the management of claims and to bridge the knowledge gap problem faced by contracting companies in dealing with complicated claims and disputes. It discusses also the benefits brought about and how the platform is envisaged to operate in detail.

Index Terms—Cloud-based technology, construction claims, contract administration, knowledge brokering.

I. INTRODUCTION

Claim is a request, demand, application for payment or presumed entitlement, to which the contractor, rightly or wrongly at this stage, considers himself entitled [1]. In typical construction projects, contractors (i.e. contracting companies) will prepare and submit claims to the contract administrators for the work done, extension of time (EOT), additional expenses incurred, and loss and/or expense, at predetermined intervals or as they arise, in accordance with the conditions stipulated in the contract. If the contractors have valid grounds for the claims, and that the claims are submitted by the deadlines, prepared in accordance with the requirements of the contract and substantiated with relevant evidence and records, the quantum claimed should be granted accordingly by the contract administrators. In reality, however, this process may neither be straightforward nor smooth, as disagreements and disputes can arise as to the validity and quantum of the claims for various reasons. As such, it is also possible for the claims to be rejected outright, or the quantum granted by the contract administrators to be lesser than that claimed by the contractors.

Reference [2] covers a study on the issues faced by the contractors with the management of claims, which have direct impacts on the success of the claims submitted. The top ten issues identified in [2], in reverse order of importance, are

as follows:

- 1) Lack of knowledge about the contractual provisions or requirements related to claims
- 2) Client intervenes the consultant's decision on the approval of claim.
- 3) Failure of the lead consultant to act impartially in dealing with claims.
- 4) Lack of company management's support affects the management of claims.
- 5) Insufficient information provided to substantiate the claim.
- 6) Inability of staff to recognize events or consultant's instructions that might lead to claims
- 7) Incomplete contemporary records/documentation related to claims.
- 8) Lead consultant fails to decide the outcome of the claim by the deadline as stipulated in the contract.
- 9) Lack of competent in-house contract administrator affects the management of claims.
- 10) Poor communication system within company affects the management of claims

Out of the top ten issues identified in [2], only three are caused by the employers or their staff, and the rest (i.e. seven) are in fact the contractors' in-house problems (see Table 1). If the contractors would like to increase their chances of winning in the claims submitted, it is imperative for the contractors to address their in-house problems related to the management of claims.

TABLE I: TOP TEN ISSUES FACED WITH THE MANAGEMENT OF CLAIMS (ADAPTED FROM [2])

Attributable to the Contractors	Attributable to the Employers & Staff
A1: Lack of knowledge about the contractual provisions or requirements related to claims	B1: Client intervenes the consultant's decision on the approval of claims
A2: Inability of the staff to recognise events that might lead to claims	B2: Failure of the lead consultant to act impartially in dealing with claims
A3: Lack of competent in-house contract administrator	B3: Lead consultant fails to decide on the outcome of the claim by the deadline
A4: Lack of company management's support affects the management of claims	
A5: Insufficient information provided to substantiate the claim	
A6: Incomplete contemporary records/documents related to claims	
A7: Poor communication system within company affects the management of claims	

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Four of the seven issues attributable to the contractors, namely issues A4 to A7, are related to the need to have better support for the management of records and preparation of claims, and the communication among the staff. These can be addressed through the utilization of suitable information and communication technologies (ICTs). Related to this, there are a number of research conducted to leverage on the benefits brought about by ICTs for the management of construction claims. Reference [3] proposes the utilization of electronic document management systems to improve the documentation of claims and management of relevant records. Reference [4] introduces a database to record the relevant information and support the analysis of claims for additional payment and time. Advanced artificial intelligence is also being utilized in claims management. For instance, multiagent system (MAS) can be used to automate construction claims negotiation [5], Particle Swarm Optimization-based (PSO-based) artificial neural network can be adopted for the prediction of the outcome of construction claims [6], and Claims Decision Model based on game theory may assist in analyzing people's behaviors during different claiming situations [7]. The Web-based construction claims management system developed in [8] provides a platform for the parties involved, e.g. contractor, contract administrator and quantity surveyor, to complete the processing of claims online. In addition, the system also supports the management of records and filing of claims, and has built-in intelligence to advise the parties involved on the next course of actions.

On the other hand, issues A1 to A3 (i.e. on the lack of in-house competent contract administrator and the lack of contractual knowledge among staff), reveal the existence of knowledge gap within the organizations. Knowledge gap may occur when the knowledge required to accomplish a task, e.g. knowledge on claims management, is not available within an organization. The challenges faced and expenses incurred for bridging the knowledge gap are dependent on the types of knowledge concerned. For the knowledge needed for the daily operation and management of claims, the knowledge gap can be easily bridged through recruiting experienced competent staff and provision of trainings on contract administration for staff, which are not costly. For the advanced knowledge to deal with complex contractual issues on claims, on the other hand, requires the inputs from the experts in order to bridge the knowledge gap. This entails either for the experts to be recruited to work on full-time basis, or arrangements to be made for the experts to provide inputs when and as needed. Experts, however, are expensive. Smaller companies with less resources might find the cost incurred for recruiting experts as full-time employees difficult to be justified, due to the corresponding smaller volume of workloads available for the experts, despite still needing one. The more feasible yet cheaper alternative is therefore to engage the experts as external claims consultant on temporary basis, to assist in certain claims or disputes when and as needed. The challenges, however, are on how to connect with the experts whose fees the contractors would be comfortable with, and that the experts possess the capability or knowledge required [9].

ICT-based knowledge brokering platforms may assist in this regard by matching the knowledge needs of companies

with the expertise of external experts, whose capability have been assessed, verified and even rated. In addition, such platforms can be designed to allow quotations to be obtained from different external experts for assisting in dealing with a particular claim or dispute, to suit the budget of the individual contractor. The knowledge brokering platforms can be integrated with the ICT-based information system for managing the preparation and processing of claims, which can potentially deliver better results through the synergy of the systems. The system is envisaged to operate in the cloud-based environment, allowing external experts to access the detailed information pertaining to the claims and hence providing their service without having to be physically at their client's office. This might help in bringing the fees chargeable by the external experts down.

This paper first presents the issues faced by contractors in managing claims, and the existing research conducted on the development of IT-based information systems to facilitate better management of construction claims. It then covers the importance of accessing the knowledge of experienced staff or the external experts on claims, the role played by information systems in this regard, cloud-based technology, and knowledge-brokering. It continues to introduce a conceptual framework of a cloud-based knowledge brokering platform for managing construction claims and the relevant workflows, which address the requirements of contractors for the purpose. The paper forms part of the initial findings of an on-going research. Further findings will be presented elsewhere.

II. CLOUD-BASED TECHNOLOGY

Cloud-based technology, or the technology based on cloud computing, is an evolving paradigm in ICT that has gained much popularity recently. Unlike other technical terms, cloud computing is not a new technology, but rather a new operations model that brings together a set of existing technologies to serve the end-users in a different way [10]. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [11]. Fig. 1 depicts the high-level architecture for market oriented Cloud service, which comprises:

- 1) *Physical Machines*. These include the physical servers, routers, switches, power and cooling systems [10];
- 2) *Virtual Machines (VMs)* that can run applications based on different operating system environments on a physical machine. VMs can be started and stopped on-demand, which provide the critical flexibility in partitioning the computing resources [12];
- 3) *Service Level Agreement (SLA) Resource Allocator*. This acts as the interface between the Cloud service provider and external users/brokers. It assigns service requests to VMS and determines resource entitlements for allocated VMs [12]; and
- 4) *Users/Brokers*, who submit service requests to the Cloud to be processed [12]. A cloud user may request cloud services from a cloud broker, as the integration of cloud

services can be too complex for an ordinary user to manage. A cloud broker is an entity that manages the use, performance and delivery of cloud services and negotiates relationships between cloud providers and cloud consumers [13].

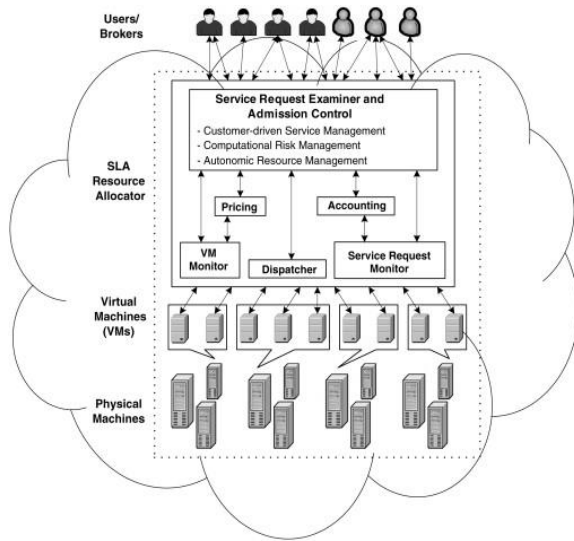


Fig. 1. High-level market-oriented cloud architecture [13].

Cloud computing has some features that are attractive to the users:

- 1) On-demand self-service. A consumer or user can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider [11].
- 2) Easy network access. As services hosted in the cloud are generally Web-based, they can be easily accessible through any devices with internet connections, such as smart phones, laptops and tablets [10].
- 3) Lower adoption cost. Users do not have to invest in the infrastructure, hardware maintenance and staff trainings necessary for hosting their systems or applications.

These features are also relevant and important to the knowledge brokering platform for managing construction claims, which will be discussed in subsequent sections.

III. KNOWLEDGE BROKERING — ACCESSING THE KNOWLEDGE OF EXTERNAL EXPERTS

Knowledge is the main source of competition in the age of knowledge economy. Knowledge is generally categorized as either tacit or explicit in nature [14], which may come in the forms of lessons learned (i.e. mistakes made), best practice (i.e. better ways of performing a task), know-how to do a job, and know-who (e.g. knowing who might have solution to a problem faced). Tacit knowledge refers to those that are both difficult to be explicated and shared with others, whereas explicit knowledge is easier to be articulated and stored in various media for sharing purpose. Advanced level knowledge, which in the context of this study refer to that require extensive technical know-how and experience to acquire, are normally more tacit and scarce in nature. These are the knowledge possessed by experienced competent staff and experts. The management of claims require the input of

staff or experts with advanced level knowledge when the issues concerned are in the grey area, i.e. the relevant contractual conditions are ambiguous, or there have been disputes between the parties. This also entails the parties involved to be extra vigilant and well prepared to increase the chances of winning the disputes or to be successful in the claims.

Knowledge gaps exist when the advanced knowledge needed for accomplishing a task (e.g. dealing with a claim related dispute) is missing or not readily available within an organization. This normally happens when the staff with the knowledge has left the organization, or the knowledge required never exist within the organization. In order to bridge the knowledge gap, organizations have to either create the knowledge required internally or source for it externally. Knowledge creation is normally a long learning process that involves an individual or a group of people, where tacit and explicit knowledge from different sources are internalized, shared and combined to create new knowledge. Creating new knowledge can be time consuming and yet there is still no guarantee that it will be successful. As for advanced level knowledge, the possibility for it to be created internally is very slim since the input from relevant experts will be needed. Therefore, the easiest and fastest way of bridging that knowledge gap is to recruit the people or experts with the knowledge, or outsource the tasks to the external experts. Both of the approach, however, can be very challenging as experts are scarce [15] and it is notoriously difficult to assess the capability of experts [9]. A reliable and more convenient solution for the purpose, such as knowledge brokering, is required.

Knowledge brokering is a relatively new discipline but has been gaining attention. Knowledge brokers are often referred to as people or organizations that move knowledge around [16], and create connections between individuals/organizational units that possess the knowledge to those who need it [17]. In other words, knowledge brokers' role is about knowing who possesses the knowledge and who needs the required knowledge, and how to pass the information between them. The onus of ensuring that someone has the required knowledge or is an expert in the field is passed to the knowledge brokers. As such, construction companies can source for external experts with the knowledge required to deal with the complicated issues related to claims through the knowledge brokers.

Conventional knowledge brokering model that is dependent on the personal network and database of the knowledge broker, however, has some limitations. These include:

- 1) There might not be any candidate with the expertise required in the database of the knowledge broker.
- 2) The candidates available in the database of the knowledge broker may not be the best for the task. Simply put, there are better qualified candidates out there who have not been identified by the knowledge brokers. This is depicted in Fig. 2, where knowledge requestor refers to a person who is looking for a certain type of knowledge. In this case, the knowledge of the unknown experts is not accessible albeit important.
- 3) Only very limited number of candidates for the clients to choose from (e.g. one or two), which may consequently

lead to higher fees for their service due to lack of choices.

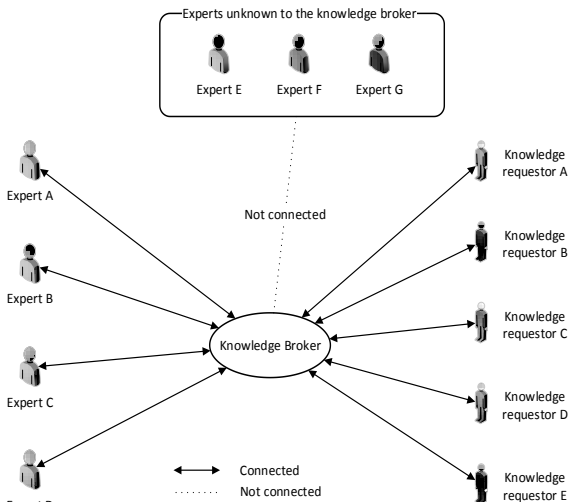


Fig. 2. Connections between the knowledge broker, knowledge requestors and experts.

There is an inherent limitation on how many people/experts that a knowledge broker may know and can source from his networks. For knowledge brokering to be effective, however, the more the experts registered in the database are the better it is. This in return will increase the probability of getting an expert, or even the best possible expert, to help fill the knowledge gap. If there is more than one suitable experts for a task, the chances of getting a better deal are higher. Therefore, there is a need for knowledge brokering to expand beyond the personal networks of the

knowledge brokers in order to include as many experts as possible into the database. It is envisaged that a computer application for knowledge brokering hosted in the cloud may provide solution to this problem. A cloud-based knowledge brokering platform can open to all the external experts to submit their details via internet and subsequently register as an expert (subject to the verification of credentials). This logically will have the potentials to include more experts in the system than what an individual knowledge broker is capable of. The details of the conceptual framework are presented in the next section.

IV. CONCEPTUAL FRAMEWORK OF A CLOUD-BASED KNOWLEDGE BROKERING PLATFORM FOR MANAGING CLAIMS

The conceptual framework of a cloud-based knowledge brokering platform aims to enable contractors to source for external experts with verified credentials, to assist in the management of claims and disputes in view of the various issues faced by contractors in this regard. The cloud-based conceptual framework comprises a knowledge brokering layer and a construction claims management layer. These two layers are fully integrated into the framework, which may lead to better synergy and provide easy access of useful information pertaining to the claims for the experts engaged to carry out their tasks. The conceptual framework is depicted in Fig. 3, and the details are discussed in the subsequent sections.

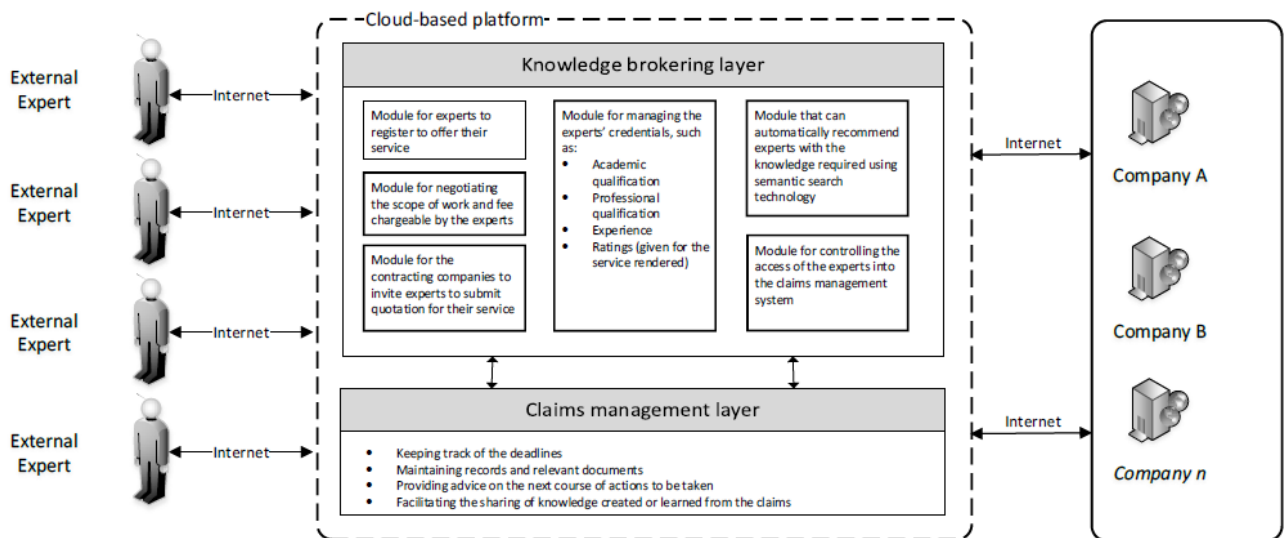


Fig. 3. Conceptual framework of the cloud-based knowledge brokering and claims management system.

A. Knowledge Brokering Layer

The knowledge brokering layer would automate the recommendation of suitable experts to the clients (i.e. the contractors in this case) based on their credentials, and provide a convenient platform for the clients to engage the service of the preferred expert. The cloud-based platform is open to everyone to register through the Web, through which the experts can submit their details, such as proof of identity,

academic qualifications, professional qualifications, experience and expertise, for the system administrator (or other designated persons) to vet through. Once the credentials have been verified, the experts will be registered in the system and may start taking up jobs or offering their service. Proof of identity is critical, as the job nature of the experts will require them to have access to private and confidential information related to claims through the system. The nature of cloud-based platforms that operate 24/7 on the Web, and

without being restricted by the geographical boundaries, will help in getting more experts to register to offer their service.

The mechanism within the system to automatically recommend suitable experts for a claim can be supported by the semantic search technology. In this regard, [18] has demonstrated the way experts could be identified within a Web-based portal using the technology. A semantic network is a structure for representing knowledge as a pattern of interconnected nodes and arcs [19]. Semantic search uses the links or relationships between concepts and instances in the semantic network, instead of the conventional keywords matching approach, to improve the accuracy and relevance of the results returned [18]. On the other hand, experts can also bid for tasks advertised by the contractors in the system (e.g. to help a contractor in the preparation and submission of a claim).

Regardless whether the experts are recommended by the system or are the ones making the offer to assist, a mechanism can be developed to allow the experts and clients to negotiate on the scope of service to be rendered and the payment terms. Once both parties have agreed to the scope of service and the terms of payment, the expert will automatically be given the access into the detailed and confidential information relevant to the claim or series of claims within the system. The clients/contractors will be given an opportunity to rate and comment on the service rendered by the expert engaged through the system, which can be referred to by other contractors for the same purpose. The knowledge brokering layer will also be closely integrated with the construction claims management layer.

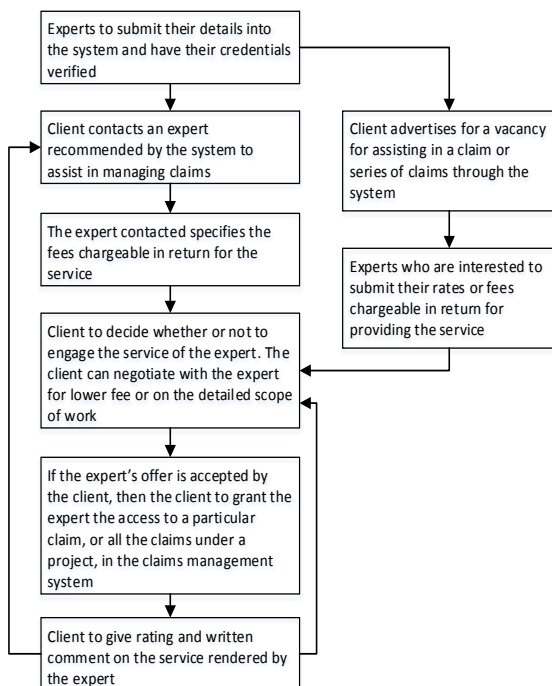


Fig. 4. The workflow of the knowledge brokering layer.

B. Construction Claims Management Layer

This layer is, on its own, a cloud-based information system for managing construction claims for the contractors. Some of the desired features of such systems are as follows [8]:

- 1) Ability to keep track of the deadlines, such as for submitting notice of the intention to claim and the final claims;
- 2) Ability to maintain, as complete as possible, the records and relevant documents pertaining to a claim or dispute; and
- 3) Ability to provide advice or suggestions, based on built-in intelligence, on the next course of actions to be taken in accordance with the conditions of the contract.

Such information systems help ensure good documentation on the part of the contractors, which is critical in increasing the chances of obtaining what the contractors believe they are entitled to and winning any disputes. However, the inputs from the experts might still be necessary when dealing with disputes or ambiguous contractual conditions pertaining to a claim. In such cases, the claims management layer which is closely integrated with the knowledge brokering layer, will allow the contractor to search for suitable experts from its database or to advertise a vacancy inviting interested experts to submit quotation for their service, as discussed in the previous section. The fully integrated knowledge brokering and claims management layers will provide a one-stop-center, whereby experts can be sought to assist in claims management and the relevant information pertaining to the claim(s) are accessible conveniently to the experts engaged through the same system.

As all the relevant information pertaining to claims is captured in the system, it also addresses a common problem faced by contractors in maintaining an archive for the claims. This detailed information captured in the system can also be wrapped up and presented in the form of a case study, covering the root causes of the disputes/issues, lessons learned and best practice developed. This can in turn be used for internal training purposes for the benefit of the staff who are not involved in the same project, or relatively inexperienced in contract administration.

V. CONCLUSION

Claims management requires the supports from custom-designed information systems and the experts when complex legal issues and disputes are involved. However, it is not surprising that knowledge gaps might exist within organizations, where the knowledge required for dealing with the more complex claim related issues or disputes are not available. Companies often resort to recruiting experts with the knowledge, or simply outsource the tasks to external experts, as means to address the problems caused by the knowledge gaps. Conventional knowledge brokering model is found less efficient and less effective in helping companies to identify experts for the purpose. This is because it depends solely on the personal networks of the knowledge broker, which has its own limitations as to how many experts the knowledge broker could possibly know and, whether the knowledge broker knows any experts with the specific knowledge and skills required. Cloud-based knowledge brokering platform may address the problem as it is accessible through the Web and open for registration to any experts to offer their service. This can help to populate a database with a long list of verified experts with different

expertise, and hence more likely to be able to provide at least an expert to any claim related issues that the contractors may face.

The conceptual cloud-based knowledge brokering platform for claims management proposed comprises also a fully integrated claims management layer. This allows better synergies between the two functions, and easy access to the relevant details pertaining to the claims that the experts are engaged to assist. Furthermore, the rating and feedback mechanisms on the performance of the experts engaged will be made accessible to other contracting companies, helping them to make informed and better decisions for the purpose. The built-in intelligence and advanced semantic search function may also help recommend suitable experts based on the nature of the issues faced by the contractors. Due to the potential large number of experts registered in the platform's database, the inherent competitions exist may also drive the fees chargeable by the experts down to a lower level.

The framework has shown how cloud computing and IT-based information systems may introduce changes to the ways companies are managing their claims, and other project management functions, in the future. The conceptual framework currently caters only for the needs of the contractors but not the other typical players (e.g. employers and consulting engineers) of construction projects. It is nonetheless possible for the framework to be further developed to allow the other players to benefit from its cloud-based knowledge brokering and claims management functions. The platform also may lead to the win-win situation, whereby the contractors would be able to find experts suitable for a task, and the experts can deal with the contractors directly without being subject to the potential personal bias of the knowledge brokers.

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