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FEASIBILITY OF WEB-BASED MICROSERVICES ARCHITECTURE FOR CONTRACT DOCUMENT DRAFTING

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ABSTRACT

This study investigates the feasibility of utilising web-based microservices architecture (MSA) for contract document drafting in the construction industry. The research aims to identify essential selection parameters for contracts, address challenges in manual drafting, and determine necessary features for MSA integration. Through interviews with industry professionals and a comprehensive literature review, the study uncovered key parameters such as project size, type, procurement method, and design responsibility, with jurisdiction emerging as a significant factor. Challenges in manual drafting included human errors, stakeholder delays, and inefficiencies in existing tools, particularly regarding document tracking and security. Desired features for a microservices-based solution included version control, real-time collaboration, machine learning capabilities, and customisable data validation. Current technologies are often fragmented and lacking cohesive integration, which MSA could address by modularising features and improving overall efficiency. The findings suggest that MSA could enhance contract management by offering a more integrated, secure, and efficient solution. This study provides valuable insights for construction industry practitioners seeking to improve document handling and offers a foundation for further research into MSA applications and their impact on legal drafting processes.

Keywords: *Contract Drafting; Construction Industry; Document Management; Microservices Architecture; Technology Integration.*

1. INTRODUCTION

Contracts are crucial in the construction industry, acting as binding agreements that define roles, responsibilities, and expectations among stakeholders, thus ensuring the smooth progression of projects (Hughes & Murdoch, 2007). Over the years, contract drafting has evolved significantly, from manual processes involving extensive paper documentation to the adoption of digital formats. The advent of digital contracts, including Smart Contracts, has introduced automation and efficiency in contract management, potentially reducing fraud and enhancing transparency in construction projects (Ahmadisheykhsarmast et al., 2023).

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However, despite these advancements, conventional contract drafting practices still face significant challenges. The integration of various technologies often lacks cohesion, leading to communication breakdowns, information silos, and inconsistencies in contractual terms (Abdallah et al., 2023). This disjointed approach can result in disputes, delays, and increased costs, undermining project success (Vilkonis & Antuchevičienė, 2024).

Microservices architecture presents a promising solution to these issues. This architectural style, characterised by the deployment of independently functioning services, allows each microservice to handle a specific business function, enhancing modularity and scalability (Jamshidi et al., 2013). Unlike traditional monolithic applications, where a single issue can affect the entire system, microservices can be updated and scaled individually, facilitating more efficient management of complex tasks like contract drafting (Ren et al., 2018). The use of lightweight HTTP protocols for communication ensures high concurrency and reliability, essential for the dynamic and high-stakes environment of construction projects (Ren et al., 2018).

Studying the potential of microservices architecture in contract drafting is crucial for addressing the current inefficiencies and promoting more cohesive and reliable contract management practices. This study aims to explore the feasibility of utilising microservices architecture for contract document drafting within the construction industry. It seeks to identify essential selection parameters for contract types, address challenges and issues related to manual contract drafting and document preparation and determine the necessary features for integrating microservices. By examining these aspects, the study aims to provide insights into how microservices can streamline contract drafting processes, enhance real-time collaboration, and improve overall efficiency, thereby reducing the risk of disputes and contributing to the success of construction projects.

2. LITERATURE REVIEW

2.1 CONTRACTS IN CONSTRUCTION

Before the Industrial Revolution, construction projects were managed by a "master builder" responsible for both design and construction (Turner, 2009). Contracts in construction, emerging around this period, allowed for specialised roles, giving owners the freedom to employ multiple professionals rather than relying on a single individual (Eenmaa & Schmidt, 2019). Modern construction contracts have evolved into complex agreements involving financers, architects, suppliers, and insurance companies, with clearly defined tasks and responsibilities for each party (Nadar, 2023; Wautelet et al., 2012). Quantity Surveyors now play a crucial role in maintaining these contractual links, serving as Commercial Managers, Contract Administrators, and Contract Managers (Australian Institute of Quantity Surveyors [AIQS], 2024). Construction contracts are essential for addressing issues like professional pride, stage overlaps, extended project participation, and potential conflicts among stakeholders and teams (Hughes & Murdoch, 2007).

2.2 DIFFERENT CLASSIFICATIONS OF CONTRACTS

Construction contracts are categorised based on the parties involved and project circumstances (Hinze, 2010). Various sources offer different classifications. Traditional

Contracts, such as the General Contract Method and Design-Bid-Build, are widely recognised (Clough et al., 2015; Hinze, 2010). The Separate Contracts Method, where the owner acts as the general contractor, includes Direct Contracting (Bailey, 2016). The Design-Build Method integrates design and construction, often under one contract, providing a streamlined approach (Godwin, 2013). Construction Management approaches, such as Professional Construction Management and Construction Management at Risk, involve separate entities managing the construction process (Bailey, 2016; Hinze, 2010). Collaborative Contracting, similar to Joint Venturing, involves shared risks and rewards among parties (Hughes & Murdoch, 2007). Public/Private Partnerships (PPP) and Turnkey Contracts/EPC are specialised for large-scale projects (Kelley, 2012; Robinson, 2011). The MDB edition contracts, offered by FIDIC, are used for projects funded by international agencies like the World Bank and Islamic Development Bank (Robinson, 2011). These diverse classifications, also known as procurement routes, cater to various project needs, offering flexibility and specificity (Bailey, 2016; Chappell, 2021).

2.3 SELECTION PARAMETERS OF MAIN CONTRACT TYPES

The selection of contract types in construction projects depends on various parameters. Traditional Contracts often involve the architect taking design responsibility, with the contractor selected through competitive bidding. These contracts are suitable for projects with a well-defined scope, budget, and timeline, typically in commercial construction (Chappell, 2021; Clough et al., 2015; Surahyo, 2018).

The Design-Build Method consolidates design and construction responsibilities under a single entity, which can streamline processes, reduce conflicts, and shorten project timelines (Surahyo, 2018). This method is particularly effective for projects needing expedited delivery.

Construction Management Contracts involve a construction manager overseeing all project aspects, including design, providing a centralised approach and often used for complex projects requiring detailed coordination (Hinze, 2010).

Public/Private Partnerships (PPP) are ideal for long-term infrastructure projects, where the private sector assumes significant design, construction, and financial responsibilities, offering economic benefits to the public sector (Surahyo, 2018).

Joint Venturing is selected when multiple firms collaborate, often necessitated by legal requirements or the need to combine different expertise and resources (Surahyo, 2018).

Turnkey Contracts/EPC assign all project responsibilities, from design to completion, to the contractor, making them suitable for large-scale industrial projects such as petrochemical plants (Bailey, 2011; Hinze, 2010).

2.4 STANDARD TYPES OF CONTRACTS USED IN CONSTRUCTION

Contract documents in construction typically include several essential components, often referred to as "boilerplate" provisions, which are consistent across various forms such as FIDIC (Godwin, 2013). These documents, including tender documents, conditions of contract, specifications, schedules, construction drawings, and bills of quantities, provide a comprehensive legal framework between the contractor and the employer (Clough et al., 2015; Surahyo, 2018). Additionally, forms like the project manual, performance bonds, and insurance certificates are critical to the contract's structure (Hinze, 2010).

In construction, standard contracts are essential for defining the roles and responsibilities of parties involved, and several recognised forms are widely used globally. The FIDIC suite, for instance, includes the Red Book for employer-designed projects and the Yellow Book for contractor-designed works, offering a comprehensive legal framework adaptable to various jurisdictions (Fédération Internationale des Ingénieurs – Conseils [FIDIC], 2022). The JCT contracts are prevalent in the UK, providing options from minor works to complex projects, ensuring clarity in roles, timelines, and payment structures (Eggleston, 2001). The NEC contracts are known for their flexibility and clarity, facilitating smooth project management through standard forms like the Engineering and Construction Contract (ECC). Similarly, IChemE contracts cater specifically to the process industries, and DBIA contracts are tailored for design-build projects, integrating design and construction responsibilities. These standard forms help streamline the contractual process, reduce ambiguity, and promote fair and efficient project execution (Hillig et al., 2010).

2.5 PROBLEMS ASSOCIATED WITH DRAFTING CONTRACTS

Drafting construction contracts presents numerous challenges that can lead to disputes and litigation, despite adhering to best practices. A primary issue is the use of complex and ambiguous language. Adams (2018) points out that long sentences, syntactic ambiguity, and jargon can result in misinterpretation, often leading to disputes. To combat these issues, best practices recommend using simple language, avoiding jargon, and maintaining clarity through concise sentences (Paris, 2015).

Another significant problem is the failure to review and update contract documents adequately. Fox (2008) notes the importance of collecting and integrating information from related documents to ensure comprehensiveness. Yet, failure to do so can lead to incomplete or outdated contract terms, contributing to conflicts. Furthermore, as advised by Stark (2014), reliance on templates and precedents can sometimes perpetuate outdated practices or overlook unique project requirements.

Despite following best practices, contracts are inherently imperfect. Soo and Cheng (2022) argue that even the most carefully drafted contracts are prone to disputes, as highlighted in the Arnold vs. Britton case, conflicts can arise even from well-drafted agreements. This underscores the reality that while best practices can minimise issues, they cannot completely eliminate the potential for disputes.

2.6 USE OF TECHNOLOGY IN CONSTRUCTION CONTRACT DRAFTING

The evolution of technology in construction contract drafting has introduced various tools to enhance accuracy and efficiency. Initially, basic software like MS Word facilitated the creation of documents, while grammar checkers and find-and-replace tools improved drafting quality (Espenschied, 2020). Modern advancements include Natural Language Processing (NLP) for drafting and interpreting contract clauses and smart contracts for automating and securing transactions (Aggarwal et al., 2021; Ibba, 2022). These innovations address specific challenges such as complex clause management and transaction automation (Safa et al., 2017; Pierro et al., 2020).

Despite these advancements, technologies often tackle discrete tasks without cohesive integration. For example, while NLP aids in drafting, software like AutoCAD and MS Project supports drawing preparation and scheduling, respectively (Parfitt et al., 1993;

Tereso et al., 2014). Additionally, e-tendering systems and Decision Support Systems (DSS) are used for submitting tenders and negotiating contract terms (Eadie et al., 2012; Mohemad et al., 2010). However, the lack of a unified system means these tools operate independently, potentially limiting their effectiveness in streamlining the entire contract lifecycle (Vukomanović et al., 2012).

2.7 USE OF MICROSERVICE ARCHITECTURE IN CONSTRUCTION CONTRACTS

Microservice architecture (MSA) has evolved from service-oriented architectures and web services, offering a modular approach to application development (Barros & Dumas, 2006; Richardson & Ruby, 2007). Unlike traditional monolithic applications, which deploy all components together, MSA breaks applications into smaller, independently deployable services, each handling a specific function (Ren et al., 2018). This approach supports diverse technology stacks and independent updates, utilising lightweight HTTP protocols for communication (Jamshidi et al., 2013).

Popular microservices include Single Page Applications (SPAs) for seamless user experiences, Multi Page Applications (MPAs) for traditional browsing, and Progressive Web Apps (PWAs) that combine modern features with offline capabilities (Al-Fedaghi, 2011). Each offers unique advantages in performance and user interaction.

In construction contracts, MSA can significantly enhance software solutions by improving integration and efficiency. To fully leverage MSA, it is crucial to identify and connect specific features that address various aspects of contract management. For instance, integrating legal drafting tools with contract management systems, risk assessment platforms, and document storage solutions can streamline the contract lifecycle and ensure cohesive output (Jamshidi et al., 2013).

Additionally, connecting features such as real-time updates, centralised data storage, and modular risk assessment tools can enhance overall contract management processes (Gorín et al., 2011). Despite these advantages, current solutions lack comprehensive MSA applications for legal drafting, indicating a need for further development to fully exploit microservices' benefits (Gorín et al., 2011).

3. RESEARCH METHOD

A well-structured research design is essential as it serves as the blueprint for the research project, integrating all its components. Research designs are generally categorised into experimental, quasi-experimental, descriptive, and correlational types, although classification methods can vary (Dulock, 1993).

The choice of research approach significantly influences the study's design, findings, and interpretations (Prescott & Conger, 1995). Approaches can be broadly classified into quantitative, qualitative, or a mixed approach that combines elements of both (Choudrie & Dwivedi, 2005). Quantitative research focuses on numerical data and statistical relationships, suitable for controlled environments but limited in capturing subjective experiences and complexities (Quick & Hall, 2015; Savela, 2018). In contrast, qualitative research delves into social phenomena and subjective experiences, making it more suitable for exploring nuanced issues like contract drafting challenges and technology integration (Teherani et al., 2015; Cleary et al., 2014). This approach allows for in-depth theory development and discovery, which is crucial for understanding specific requirements in the context of microservices architecture (Berg & Struwig, 2017).

Expert interviews are employed to identify contract selection parameters and challenges that microservices architecture should address. Eighteen experts were purposively sampled based on their extensive experience in contract management and technology integration, ensuring practical and relevant insights. Their diverse backgrounds, detailed in Table 1, provide a comprehensive understanding of current practices and challenges essential for developing effective microservices solutions.

Table 1: Interviewee profile

Respondent	Designation	Experience	Countries	Exposure
R1	Academic	9	Sri Lanka, Australia	Sri Lankan and Australian construction industries
R2	Academic	24	Sri Lanka	BIM technology
R3	Commercial manager	29	Dubai, Sri Lanka	Contract drafting, ADR, Road construction
R4	Commercial manager	16	Sri Lanka	Commercial and contracts manager
R5	Consultant	30	Sri Lanka, Qatar	contract administration, ADR
R6	Academic	15	UK, Sri Lanka	Contract law
R7	Consultant/Academic	15	Australia, Sri Lanka	Procurement and contract law
R8	Consultant/Chief Qs	12	New Zealand, pacific islands, Sri Lanka	Business law, Procurement
R9	Consultant Qs	6	Dubai, Sri Lanka	Infrastructure projects
R10	Contractor	5	Sri Lanka	ERP system, Cubicost
R11	Consultant	6	Sri Lanka	ADR and BOI projects.
R12	Contractor/ Academic	25	Dubai, Sri Lanka	academics.
R13	Consultant	14	UAE, Sri Lanka, Australia	Specialties in Pre-contract, post-contract Quantity Surveying and Contract Management
R14	Contractor	20	UAE	Precontract and post-contract administrations from the contractor
R15	Consultant	18	Dubai	Contract administration
R16	Consultant	10	Sri Lanka	Commercial projects.
R17	Procurement executive/planning engineer	7	Sri Lanka	Project Management
R18	Consultant Quantity Surveyor	10	Sri Lanka, Dubai, Australia	BOI projects, Bridge projects and Cubicost

The data collected from these interviews were systematically analysed using NVivo software, which facilitated the identification of key themes and patterns. This method provided a comprehensive understanding of current practices and challenges, essential for developing effective microservices solutions to enhance contract drafting processes.

4. RESEARCH FINDINGS

4.1 SELECTION PARAMETERS OF CONTRACT TYPES IN CONSTRUCTION PROJECTS

From the interviews, several main findings emerged. The project's size was widely recognised as a valid parameter, with respondents like R3, R4, R6, R8, R12, R13, R15, and R1 highlighting its importance, though there were calls for clearer definitions, such as distinguishing between monetary and time-based size (R6). The type of project was deemed crucial, with respondents such as R3, R7, R12, R15, and R18 highlighting that different contracts are suitable for specific project types, like road construction projects in Qatar (R12). The procurement type was universally acknowledged as critical by all 14 respondents, with examples like the FIDIC Red Book being used for employer-designed projects. However, the complexity of a project was largely dismissed as too vague by respondents like R1, R2, R3, R4, R6, R7, R8, R11, R12, R13, R15, and R18, with several suggesting its removal as a selection parameter (R3, R13). Design responsibility was considered essential, as noted by respondents such as R1, R3, R4, R7, R8, R12, R13, R15, and R18, as different forms of contracts specify usage based on who holds design responsibility. The source of funding was highlighted as crucial by all 14 respondents, especially when contracts are tailored for specific funding agencies like the Asian Development Bank (ADB) or the World Bank (R11). Jurisdiction was emphasised by R1, R3, R4, R8, R11, and R18 as a necessary consideration due to varying legal requirements in different regions. Lastly, project duration was noted as important by respondents such as R3, R7, R8, R11, R12, and R13 for aligning contract types with project timelines and budgets.

The literature supports the importance of project size, type, procurement method, and design responsibility in contract selection. For instance, traditional contracts often involve architects in design roles, while the Design-Build method consolidates design and construction responsibilities (Chappell, 2021; Surahyo, 2018). Public/Private Partnerships (PPP) and Turnkey Contracts/EPC, which allocate comprehensive project responsibilities, align with the interview findings on funding sources and contract comprehensiveness (Bailey, 2011; Hinze, 2010). However, the interviews highlighted jurisdiction more prominently than the literature, suggesting it is a critical factor often overlooked. Additionally, the feedback suggested removing complexity as a parameter, a point of deviation from some literature that includes it as a significant factor (Chappell, 2021).

4.2 CHALLENGES IN MANUAL DRAFTING AND DOCUMENT PREPARATION

Interviews highlighted several challenges in manual drafting and document preparation, categorised into issues related to document preparation, stakeholder involvement, and existing tools. Document preparation challenges were notably attributed to human errors, such as data transfer mistakes, as emphasised by respondents like R12 and R15. Delays in information provision from stakeholders were also a significant issue, affecting the

timeliness of drafting (R7). Additionally, repetitive tasks increased the likelihood of errors, with respondents like R14 pointing out the time-consuming nature of the process.

Stakeholder-related challenges included difficulties in managing undue influence and changing requirements, complicating the drafting process (R5, R9). Security concerns were another major issue, with respondents like R11 stressing the need to protect sensitive information, a sentiment echoed by R7 regarding current communication methods' inadequacies.

Existing tools also posed challenges, particularly email chains, which were criticised for their inefficiency in document tracking and collaboration (R6, R4). Another highlighted issue was the inability to restrict document access and pass on knowledge effectively, making it difficult to manage information securely and consistently (R14, R6).

Comparing these findings with the literature, there is significant alignment, particularly regarding the issues of syntactic ambiguity and the importance of clarity in contract language, as noted by Adams (2018) and Paris (2015). However, the interviews provided additional insights into the practical challenges of using email and existing tools for document management, which are not extensively covered in the literature. The issue of stakeholder influence is more vividly illustrated in the interviews. The literature also emphasises the need for regular contract updates and the risks of relying on outdated templates (Fox, 2008; Stark, 2014). This correlates with the challenges noted in passing knowledge and managing stakeholder inputs in the interviews.

4.3 FEATURES REQUESTED IN CONTRACT DRAFTING TOOLS AND INTEGRATION WITH MICROSERVICES ARCHITECTURE

Based on the interviews, several key features emerged as necessary for an effective contract drafting application. Respondents highlighted the need for version control (R2), access to project data from any location (R1, R3, R4, R6, R7, R8, R10, R14, R15), the ability to create and save templates (R4), and real-time collaboration (R4, R7, R8, R9, R10, R11, R13, R14, R15, R16, R17). Additionally, features like document tracking (R1, R2, R3, R6, R8, R12, R14, R15), grammar correction (R2), and machine learning capabilities (R9) were also emphasised. Other suggested features included exporting in various file formats (R2, R3, R4, R6, R8, R11, R13, R14, R15, R16, R17), and customisable data validation (R2, R3, R6, R7, R13, R14, R18).

Current technologies, including basic text editors and standalone tools, often fall short in delivering these requested features. For instance, while platforms like Google Docs offer version control and real-time collaboration (Espenschied, 2020), they lack advanced document tracking and integration capabilities across different applications (Aggarwal et al., 2021; Ibba, 2022). Tools like MS Word provide grammar correction but are limited in offering integrated solutions for machine learning or comprehensive document management (Parfitt et al., 1993; Tereso et al., 2014). The problem lies in the fragmented nature of existing technologies which handle discrete tasks without cohesive integration (Vukomanović et al., 2012).

MSA offers a promising approach to address these limitations. By modularising the application into independent, deployable services, MSA can integrate diverse features such as version control, real-time collaboration, and machine learning capabilities. For instance, a microservice could handle version tracking, another could manage access to project data, and yet another could facilitate real-time updates and collaborative drafting

(Barros & Dumas, 2006; Richardson & Ruby, 2007). This modular approach allows for seamless integration of various features, enhancing overall efficiency and user experience. MSA can also support real-time data validation and grammar correction by incorporating specialised services (Jamshidi et al., 2013; Gorín et al., 2011). However, existing solutions often lack comprehensive MSA applications for legal drafting, indicating a gap that needs addressing to fully leverage microservices' benefits (Gorín et al., 2011).

5. CONCLUSIONS

This study aimed to explore the feasibility of utilising microservices architecture for contract document drafting in the construction industry by identifying essential selection parameters, addressing associated challenges, and determining necessary features for integration. The research effectively achieved its objectives by employing a qualitative approach, which prompted conducting interviews with 18 industry practitioners. However, the findings are limited by the focus on qualitative data from interviews, which may not fully represent all industry perspectives, and the exclusion of quantitative analysis of existing tools' performance.

The key findings indicate that project size, type, procurement method, design responsibility, and funding source are critical parameters in contract selection, with jurisdiction being highlighted more in interviews than in existing literature. Challenges identified include human errors, stakeholder delays, repetitive tasks, inefficiencies with existing tools such as email chains, and significant concerns over security and document tracking. The features most desired for a microservices-based solution include version control, real-time collaboration, machine learning capabilities, and customisable data validation. Current tools are fragmented and lack comprehensive integration, highlighting the need for an advanced, modular approach.

Implementing microservices architecture can address these issues by modularising features and improving integration, leading to more efficient and secure document management. For construction industry practitioners, this translates to enhanced workflow and better document handling. Academia can further investigate the detailed implementation of MSA in legal drafting, evaluating its impact on efficiency and exploring its integration with AI and machine learning technologies. Future research should focus on practical application strategies and the broader implications of MSA in contract drafting.

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