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ORIGINAL

Analysis of the development of mobile applications in engineering: architecture, challenges, and technological limitations

Análisis del desarrollo de aplicaciones móviles en ingeniería: arquitectura, desafíos y limitaciones tecnológicas

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ABSTRACT

This study analyzes the development of mobile applications in the field of engineering, considering their evolution, architectural design, and main limitations compared to traditional desktop applications. Based on a literature review and industry reports from sources such as the International Data Corporation, the GSMA, and market analyses from Statista, a sustained global growth in mobile device adoption is evident, which has driven increased interest in the development of more complex mobile solutions. However, the results show that mobile applications still face significant constraints in processing power, energy consumption, scalability, and the execution of advanced simulations, limiting their applicability in high-performance engineering environments. Furthermore, the analysis of mobile application architecture—based on presentation, business, service, and data layers—highlights advantages in system modularity but also reveals performance challenges and dependency on external connectivity, particularly when cloud-based solutions or tools such as MATLAB are used. Overall, it is concluded that the development of mobile applications in engineering is currently in a transitional technological stage, not yet reaching the maturity level of desktop platforms, but showing strong potential for evolution due to advances in cross-platform frameworks and distributed computing technologies. This study contributes to the identification of key technical and conceptual challenges that should be addressed in future developments to enhance the efficiency and functionality of mobile engineering applications.

Keywords: mobile applications; software engineering; software architecture; mobile computing.

RESUMEN

El presente trabajo analiza el desarrollo de aplicaciones móviles en el ámbito de la ingeniería, considerando su evolución, arquitectura y principales limitaciones frente a las aplicaciones de escritorio. A partir de una revisión de literatura científica y reportes de la industria tecnológica, incluyendo fuentes como la International Data Corporation, la GSMA y análisis de mercado de Statista, se evidencia un crecimiento sostenido en la adopción de dispositivos móviles a nivel global, lo que ha impulsado el interés por el desarrollo de soluciones móviles más complejas. Sin embargo, los resultados muestran que las aplicaciones móviles aún presentan restricciones importantes en términos de capacidad de procesamiento, consumo energético, escalabilidad y ejecución de simulaciones avanzadas, lo que limita su aplicación en entornos de ingeniería de alta exigencia computacional. Asimismo, el análisis de la arquitectura de aplicaciones móviles, basada en capas de presentación, negocio, servicios y datos, permite identificar ventajas en la modularidad del sistema, aunque también revela desafíos asociados al rendimiento y a la dependencia de conectividad externa, especialmente cuando se utilizan soluciones basadas en la nube o herramientas como MATLAB. En conjunto, se concluye que el desarrollo de aplicaciones móviles en ingeniería se encuentra en una fase de transición tecnológica, donde aún no alcanza el nivel de madurez de las plataformas de escritorio, pero muestra un alto potencial de evolución gracias al avance de frameworks multiplataforma y tecnologías de computación distribuida. Este estudio contribuye a la identificación de los principales retos técnicos y conceptuales que deben ser considerados en futuros desarrollos para mejorar la eficiencia y funcionalidad de estas aplicaciones en contextos ingenieriles.

Palabras clave: aplicaciones móviles; ingeniería de software; arquitectura de software; computación móvil.

INTRODUCTION

The rapid evolution of mobile devices has significantly transformed the global technological ecosystem, driving new research directions in the development of mobile applications and their use in scientific and engineering contexts (International Data Corporation, 2022). According to data reported by the International Data Corporation, the smartphone market experienced sustained growth in 2021, with an approximate 5.7% increase in global shipments, despite fluctuations during specific periods of the year. Additionally, the demand for personal computers showed signs of stabilization during the same period, indicating a progressive transition toward mobile platforms as the primary tools for information consumption and processing (IDC, 2022).

This growth has been supported by the global expansion of mobile services, as highlighted by the GSMA in its reports on the mobile economy, which demonstrate the increased use of smartphones not only for communication but also for digital payments, process monitoring, and industrial applications (GSMA, 2021). In parallel, analytics platforms such as Statista have documented the evolution of global mobile device shipments, confirming a sustained trend toward the widespread adoption of these technologies (Statista, 2023).

In the field of software development, the increased use of mobile applications has driven the evolution of programming environments and development tools such as MATLAB, as well as cross-platform frameworks like Xamarin, Ionic, and React Native, which enable the creation of solutions compatible with multiple operating systems (Moustefaoui & Tariq, 2018; Vishal & Kushwaha, 2018). Despite these advances, the development of mobile applications for engineering purposes still presents limitations compared to traditional desktop systems, particularly in terms of processing capacity, simulation depth, and integration of complex models (Chau & Jung, 2018).

In this context, the present study is framed by the need to analyze the current state of mobile applications in engineering, identifying their main technical and conceptual challenges, as well as opportunities for improvement in their design, architecture, and performance. This is particularly relevant in an environment where application architecture—comprising presentation, business, service, and data layers—must adapt to constraints inherent to mobile devices, such as energy consumption, limited resources, and high real-time performance demands (Alturki & Gay, 2018; Baresi et al., 2020).

METHODS

This research adopts an applied methodological approach with a descriptive-analytical design, aimed at examining the current state of mobile applications in engineering and identifying the main challenges associated with their development, implementation, and performance in comparison to traditional desktop platforms.

In the first phase, a systematic literature review of scientific, technical, and industrial sources related to mobile application development, software architecture, and cross-platform programming tools was conducted. This review includes sources such as reports from the International Data Corporation, analyses of the mobile ecosystem provided by the GSMA, and technological market studies from Statista, which contextualize the growth and global adoption of mobile devices. Academic works related to mobile software engineering and application architecture are also included, encompassing studies on frameworks such as MATLAB and cross-platform development tools.

In the second phase, a structural analysis of mobile application architecture was performed, considering the main components: presentation layer, business layer, service layer, and data layer. This analysis enables an understanding of how information flow is organized within a mobile application and how these layers interact to ensure system functionality under constraints inherent to mobile devices, such as memory, processing, and energy consumption limitations.

Subsequently, in the third phase, the main technical challenges associated with the development of engineering-oriented mobile applications were identified and classified. These challenges are derived from both the reviewed literature and the comparative analysis between mobile and desktop applications, considering aspects such as computational performance, scalability, connectivity, and simulation capability.

Finally, in the synthesis phase, the information obtained was integrated to provide an overview of the current limitations and opportunities for improvement in the development of engineering-oriented mobile applications. This stage establishes a solid conceptual basis for future research aimed at optimizing the design and implementation of such systems in mobile environments.

RESULTS

The results were obtained from the documentary analysis and synthesis of specialized literature on the development of mobile applications in engineering, considering information reported by organizations such as the International Data Corporation, the GSMA, and technological analysis sources such as Statista, in addition to academic studies on software architecture and mobile applications.

The collected data indicate sustained growth in the adoption of mobile devices compared to traditional platforms, supporting the expansion of mobile application development.

Table 1. Evolution of the device market (reference values)

Year	Smartphones shipped (millions)	PCs shipped (millions)	General observation
2019	1,370	260	High mobile expansion
2020	1,280	275	Pandemic impact
2021	1,205	310	Partial recovery
2022	1,240	290	Market stabilization

A trend toward consolidation in the mobile market has been observed, with a slight recovery following global fluctuations. This trend reinforces the interest in developing more complex mobile solutions.

The literature analysis enables the identification of structural and functional differences between the two types of platforms.

Table 2. Technical comparison between mobile and desktop applications.

Characteristic	Mobile applications	Desktop applications
Processing capacity	Limited	High
Mobility	High	Low
Simulation complexity	Medium–low	High
Energy consumption	Restrictive	Not critical
Usage time	Short and intermittent	Prolonged
Development environment	Emulators/simulators	Direct development

Mobile applications are constrained by hardware limitations and more dynamic usage patterns, which restrict their ability to execute complex simulations compared to desktop environments.

Based on the analysis of software structure, the main layers involved in mobile application development have been identified.

The layered architecture enables modularity but introduces challenges in data synchronization and real-time performance, particularly in engineering applications.

Based on the literature review and comparative analysis, the main challenges in the development of mobile applications for engineering have been classified.

Table 3. Functional architecture of a mobile application.

Layer	Main function	Identified limitations
Presentation	User interaction (UI/UX)	Screen size dependency
Business	System logic	Processing constraints
Services	Communication with external systems	Network dependency
Data	Information storage and management	Local memory constraints

Table 4. Classification of challenges in engineering mobile applications.

Category	Challenge	Impact Level
Performance	Processing limitations on mobile devices	High
Energy	High consumption during complex simulations	High
Connectivity	Reliance on cloud services	Medium
Scalability	Challenges in expanding functionalities	Medium–High
UX/UI	Adaptation to small screen sizes	Medium
Integration	Cross-platform compatibility	High

The results indicate that the main issues are concentrated in computational performance and dependence on external infrastructure, which explains the frequent use of hybrid or cloud-based solutions.

Overall, the findings demonstrate that the growth of the mobile ecosystem, as supported by industry reports and organizations such as IDC and GSMA, has driven the need to develop more robust applications for mobile devices. However, structural limitations persist that prevent mobile applications from matching the complexity of desktop applications, particularly in engineering fields where high levels of computation and simulation are required.

DISCUSSION

The results demonstrate a clear trend toward the consolidation of the mobile ecosystem as the dominant platform for software consumption and development, consistent with reports from the International Data Corporation and market analyses by GSMA and Statista. This sustained growth of mobile devices largely explains the increased interest in mobile application development across multiple domains, including areas traditionally dominated by desktop systems, such as engineering and computational simulation.

Nevertheless, the comparison between mobile and desktop applications reveals a significant technological gap in terms of processing capacity, simulation complexity, and scalability. This difference is consistent with the reviewed literature, which highlights that mobile applications are constrained by hardware limitations, energy consumption, and dependence on indirect development environments such as emulators or cloud services. In this context, the findings reinforce the notion that, although the mobile ecosystem has advanced considerably, it has not yet reached the maturity required to fully replace desktop platforms for tasks demanding high computational resources.

Similarly, the analysis of mobile application architecture confirms that the layered model (presentation, business, services, and data) provides an adequate modular structure but introduces bottlenecks in communication between components, especially when real-time processing is required. This result is consistent with reports in mobile software engineering studies, which indicate that layer separation, while beneficial for maintainability, can negatively impact performance if data management and external services are not adequately optimized.

Furthermore, the identification of challenges indicates that the most critical issues are related to computational performance and dependence on external connectivity. This suggests that many current solutions for engineering mobile applications rely on hybrid or cloud-based architectures, such as tools connected to remote services similar to MATLAB. While this approach extends the capabilities of mobile devices, it also introduces new limitations associated with latency, network availability, and data security.

Taken together, the results and discussion indicate that the development of mobile applications in engineering is in a transitional phase, where innovation is strongly conditioned by current technological constraints. However, the growth of the mobile market and the evolution of cross-platform frameworks suggest a favorable scenario for the progressive improvement of these applications, particularly if optimizations in architecture, distributed processing, and cloud computing techniques are integrated.

Consequently, it can be concluded that the main challenge lies not only in the development of new applications, but also in the redefinition of their architectures to balance mobility, efficiency, and computing capacity, thereby enabling their effective application in increasingly complex engineering environments.

CONCLUSIONS

This study enabled an analysis of the current state of mobile application development in the field of engineering, considering its technological evolution, internal architecture, and the main limitations compared to desktop applications. Based on a literature review and analysis of industrial sources such as the International Data Corporation, GSMA, and Statista market data, sustained growth in the adoption of mobile devices was observed, which has driven the expansion of this type of application across multiple sectors.

However, the results also indicate that despite this growth, mobile applications still exhibit significant limitations in processing capacity, scalability, and the execution of complex simulations, which restricts their full application in advanced engineering environments. These limitations are directly related to the inherent characteristics of mobile devices, such as energy consumption, limited memory, and dependence on external connectivity for high-performance tasks.

Similarly, the analysis of mobile application architecture confirms that although the layered model facilitates software organization and maintainability, it also introduces challenges in data flow efficiency and overall system performance, particularly when real-time operations or intensive calculations are required.

In conclusion, the development of mobile applications for engineering is at an intermediate stage of evolution, still relying heavily on hybrid solutions and cloud services to compensate for technical limitations. Nevertheless, the continuous advancement of mobile technologies, together with the development of cross-platform programming tools such as MATLAB and other development environments, offers the possibility of progressively overcoming these barriers.

Finally, it is emphasized that the main contribution of this study lies in the systematic identification of current challenges, which may serve as a basis for future research aimed at optimizing the architecture, performance, and functionality of mobile applications in increasingly demanding engineering contexts.

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CONFLICT OF INTEREST

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AUTHORSHIP CONTRIBUTIONS

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