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Mobile applications and internet banking for Greek enterprises

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Abstract: This paper examines how mobile applications, when tightly integrated with Internet banking, can accelerate the digital transformation of Greek enterprises. It synthesizes the technology stack (UI modules, data management, gateways, messaging, and security), regulatory context, user experience determinants, and market dynamics, and complements these with case-style insights and a brief EU comparison. Findings indicate that, although online and mobile banking penetration in Greece has lagged behind EU averages, mobile access is now the primary driver of uptake. The integration imperative—shared services/APIs over reliable back-ends—emerges as the central technical enabler, while perceived security (confidentiality, strong authentication, non-repudiation) remains the dominant adoption barrier. User experience quality and multichannel consistency strongly influence usage frequency and trust, and legacy infrastructure plus skills gaps constrain delivery speed. The trajectory points to the convergence of mobile and web banking, with branches shifting toward advisory roles. Practical recommendations include a mobile-led product roadmap, investment in resilience and observability of back-end services, rigorous multi-factor authentication (MFA)/device binding and risk controls, a unified design system across channels, and analytics-driven customer relationship management (CRM) for personalization. Overall, the paper offers an end-to-end view connecting technology, regulation, and strategy to guide executives and practitioners in scaling secure, user-centric mobile banking within Greece's banking ecosystem.

Keywords: *Banking system, Greek enterprises, Mobile applications.*

1. Introduction

Mobile applications constitute computer programs developed specifically for use on various mobile devices. Their pivotal role in contemporary technology underscores the necessity of a comprehensive examination of their defining characteristics, typologies, and predominant development trends. Such an overview precedes a focused analysis of the integration of mobile applications within the context of Internet banking, a significant service offered by many enterprises. Internet banking itself experienced its inception in 1995 and has since undergone continuous enhancement, marked by a rapid increase in adoption rates. Greece represents a notable case of contemporary management challenges in this domain. Greece's evolutionary path in Internet banking offers strategic insights for numerous institutions, as banks continue to evaluate new service models and operating environments, particularly given the low number of Internet banking subscribers to date. Mobile applications tend to play a critical role in the effort to digitally transform enterprises and retailers across Greece. The strategic importance of these technologies warrants an in-depth presentation of their fundamental characteristics, distinct categories, and emergent development trends. Such a framework enables a subsequent examination of their deployment within the Internet-banking channel, a service domain that constitutes a case of enormous importance for the ecosystem of Greek enterprises.

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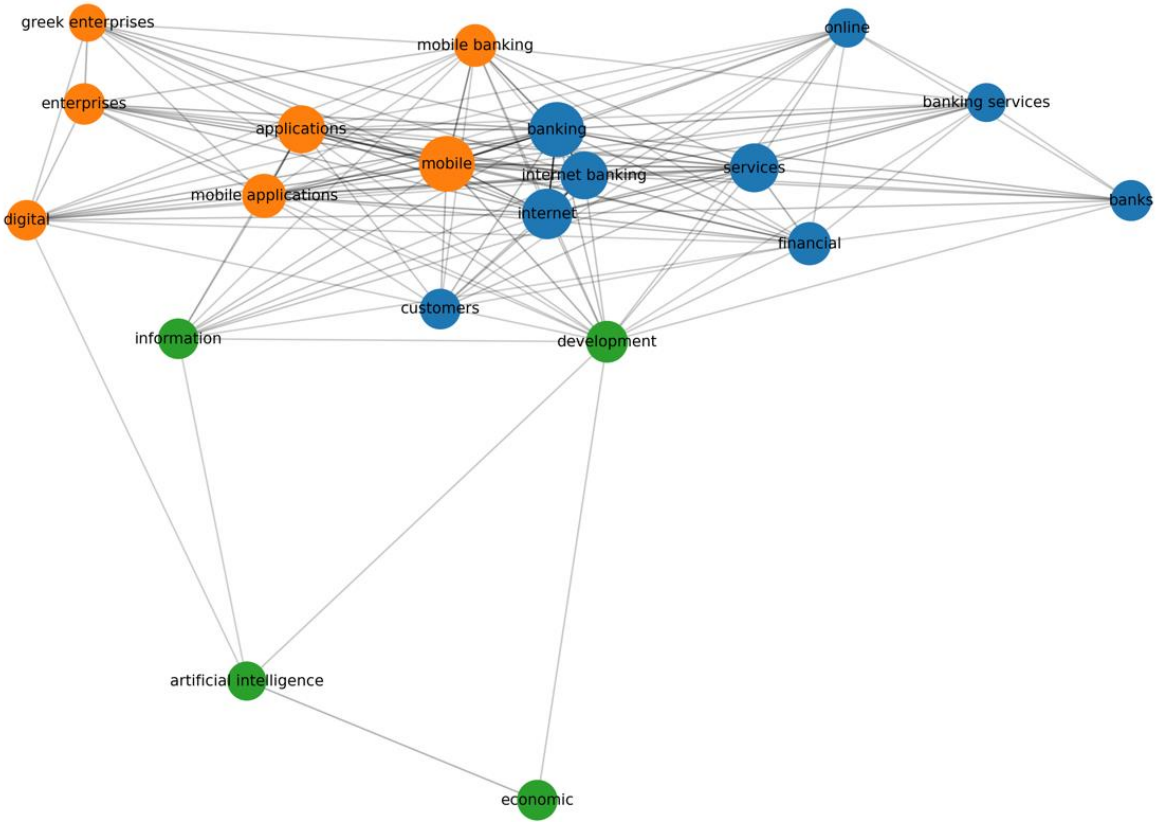

Figure 1.
Mobile Applications and Internet Banking (authors' scheme).

A pertinent sector-specific investigation of Internet banking in Greece explores the historical evolution of the phenomenon, delineates the rationale behind its advanced penetration, and provides a concise overview of the regulatory framework within which the phenomenon operates [1].

2. Overview of Mobile Applications

A mobile application, also known as a smartphone app, is a software program designed specifically to run on a mobile device such as a phone, tablet, or watch. These applications minimize user interaction, provide ergonomics, and increase speed and usability. Outside of business and mobile financial services, mobile applications are typically organized by task or purpose. For example, weather-related applications provide real-time weather monitoring, traffic monitors measure road speed and congestion, and news alert applications source information from various websites and provide condensed versions of relevant news stories or text alerts. In the context of the mobile financial services and banking industries, the applications are designed to track the status and use of financial assets and privileges with sufficient security and ease of use. Although mobile applications are widely used within business environments, mobile financial applications remain a frontier to be conquered by enterprises, with only a few mobile strategies in place.

The design and development of mobile applications within these sectors are governed by a variety of factors, including the type of application, the desired technology, the objectives of the solution, the business model, and the business area. However, successful mobile activation and operation depend on further considerations, implying that the integration and management of such applications require strategic planning and understanding. Classifications of mobile applications help in identifying different

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types and assessing trends to aid in the decision-making process during the planning phases of software solutions [1].

2.1. Definition and Importance

Porter and Heppelmann describe three technological components that enable the connection of physical objects to the internet and to one another "anything-connecting-technologies". These components—the physical elements (e.g. chips, sensors, actuators), the connection elements (e.g. WI-FI, BLE, 5G) and the brain elements (software and analytical tools)—form the basis of internet-of-things (IoT) infrastructures and research, which in turn facilitates the development of mobile applications linking banking accounts to smartphones. Notably, as of early 2015, approximately half of all online banking customers worldwide used mobile applications to access their accounts [1].

2.2. Types of Mobile Applications

Mobile applications extend the capabilities of mobile devices by providing additional uniform, integrated services [1]. The constraints of limited input devices in handheld devices have driven ongoing innovation and adaptation of input technologies, user interfaces, and interaction design. Mobile applications also support connectivity to remote services, enabling the transmission of location, identity information, and various forms of contextual information. Mobile application developers frequently confront a wide range of device limitations when designing their products. Wireless communication applications operate on devices with limited bandwidth. A variety of different input and output devices are used by digital wireless personal communication systems [2]. Emerging multicore architectures imposed a variety of constraints and challenges on mobile application development and deployment. Pervasive and mobile computing systems are commonly deployed on heterogeneous, resource-constrained mobile platforms running multiple concurrent resource-dependent mobile applications (for example, text messaging, search, and web browsing). A broad range of important mobile applications is now available, including mobile mapping and assistance, mobile commerce and business, location- and context-enhanced services, location-based games, mobile sensor data collection, mobile social networking, and many others. Applications beyond context-aware web search, recommendation, and advertising systems include mobile social media and mobile social networking systems used to coordinate and support groups of people. Companion apps extend the functionality of physical products (for example, smart home, smart appliances, and health and fitness systems). Mobile visual search leverages the cameras and connectivity of modern smartphones in order to enable visual searches for objects and coordinates. Gamification services attempt to drive user behaviour and incentivization through the introduction of game-like mechanics (for example, Foursquare). Developers also provide online services and toolkits that enhance mobile applications with functionality such as analytics, monetization, databases, and social integration.

2.3. Trends in Mobile Application Development

Mobile application development trends are guiding Greek enterprises into the third wave of their digital transformation. The number of personal computers will reach saturation, and mobile spending via smartphones is forecasted to increase strongly. The countries in which the highest mobile share of digital media spending are expected are greater China, Singapore, Norway, Ireland and the UK, followed by Greece, Australia, South Korea and the United States. Greece is the country with the highest Facebook penetration of population (77.5 percent). Despite of this, about 95 percent of the crowd-sourcing activities remain untapped. In addition, a significant number of people realize that their devices can do a lot more than make phone calls and send text messages. With more users subscribing to data plans, downloading applications and becoming more digitally literate, it allows for expanding the network of possibilities offered to the smartphone crowd.

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3. Internet Banking in Greece

Internet Banking (IB) is a new area of the economy and finance that integrates several disciplines such as technology economics, finance, and security. Since the Internet is a relatively low cost and pervasive infrastructure, IB can be effectively used for different financial applications. IB delivers many opportunities for business and commerce that have been already realised by many companies that offer services to their customers. Internet banking integrates the entire banking system of a country and increases efficiency by enabling customers to perform various whole banking activities in most developed countries. The Internet and satellite communication technologies provide many opportunities for conducting banking transactions. Developments in telecommunications and the Internet make it easier for customers to participate in banking transactions in which several different countries operate. The development of IB technologies plays a significant role in increasing the globalisation and internationalisation of financial markets [1].

IB systems are still fairly limited in emerging markets and different countries have overlooked the potential of online technologies at the outset of the technological revolution which represents a missed opportunity for catch-up development and human development. The Greek market for IB is still very small, providing online financial services to only 8% of households. Increasing internet use and awareness of banking services via the internet, however, supports the promising outlook for the expansion of online banking services in the country. The sudden increase of Internet penetration and the spike of investments and new entrants in the Greek online-banking sector mark a very clear ownership shift in the future of the European banking market. The pace of the technological change is unprecedented and reinforces the notion that Internet financial services will outpace the penetration of financial Internet services in mature markets such as the U.S. and Northern and Southern Europe. This is the core effect of the internationalisation of capital markets and the upgrading of the national financial market. IB transactions currently cover wire transfers, bill payments, and account information enquiries. Domestic trades are permitted using financial brokers. Since the IB penetration in Greek banks is still quite low, the majority of consumers prefer to continue accessing their accounts through traditional methods or telephone. Internet banking users in Greece were expected to increase by at least 200% by 2003, reaching an estimated 5 million users. By 2005, 70% of the population was projected to perform transactions through mobile banking and 8–9% through digital television.

3.1. Historical Development

Internet banking was developed in parallel with the evolution of the Internet and its widespread use for business applications. It took only four years to move from the initial idea to the first implementation of online banking services. This rapid adoption led to numerous innovations and to reduced time-to-market cycles, driving significant competitive advantage; it took the Web only six years to become a widespread medium. Early online banking services largely continued the traditional way of delivering banking products, including issuing cards, making transfers, credit and deposit accounts, and safety deposit boxes. Yet the wide dissemination of the Web brought innovative banking products and formats, as well as changes in the historical role of banks. Online banking is viewed by retail consumers as an additional delivery channel, as complete contact with the bank requires a networked PC with access to a browser and the Internet, and phone banking is a more direct and user-friendly delivery channel. International and local banks in Greece tend to offer the same banking approach. The combination of retail banking accounts for cash inflows and outflows, loans, credit cards, mortgages, and wealth management is targeted at individual customers and small and medium enterprises. Nearly all banks offering retail banking services also provide online banking [1].

3.2. Current State of Internet Banking

Internet banking experienced a compelling rise in Greece during the early 2000s following the adoption of regulation 174/2000 on Payment Services and Ministerial Decision 2663/2001 regarding money remittances . Although the e-commerce and internet banking markets remain nascent, supplier

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banks consider the development of information systems vital and pursue aggressive investments to ensure the successful emergence of ubiquitous, customer-centric banking [1]. In contrast to communities with broader access to modern telecommunication networks, only very few Ελληνικές τράπεζες undertake systematic market research, segment analysis, precise rationalization of options, or the formulation of clients' preferences, and even fewer are aware of their accomplishments and client perceptions. Typical high-value customers tend to demonstrate a significant degree of loyalty, and due to their sophistication and historical banking interaction, they are especially receptive to internet banking services.

3.3. Regulatory Framework

The rapid growth of mobile applications serving the Internet Banking ecosystem and the user demand for financial transactions across all sectors have underscored the importance of the regulatory framework within which this industry operates. Security concerns stemming from potential risks inherent in Internet-based transactions and the general need for regulatory protection have prompted governmental, banking, and European Union authorities to enact a comprehensive set of laws, principles, and guidelines to establish the proper structure for operating Internet Banking. Regulations address fundamental questions such as the prerequisites for licensing business activities in Greece, the conduct of business, and the protection of Internet Banking users, as well as monitoring the overall security of online transactions through governance. A study of Internet Banking Regulations in Greece reveals a set of fundamental rules designed to safeguard both services and users alike.

4. Integration of Mobile Applications with Internet Banking

The integration of mobile applications with Internet banking delineates a collection of interoperable components coordinated by sophisticated operational rules. The resulting functionalities orchestrate the digital transformation of traditional banking processes into customized engagement paths that support critical entrepreneurial activities and secure constructive customer relationships. Technical components include user interfaces, software modules, data management systems, and communication protocols. Mobile applications provide straightforward and economically viable solutions for delivering Internet and financial services. Users can perform financial transactions (payments, money transfers, credit card management) by leveraging actual positions, analyzing preferences, or pre-registering inquiries. Cost-effectiveness, operational simplicity, and added-value services remain the primary grounds for adopting mobile interfaces to Internet-hosted banking. The wide use of mobile technology has further raised reliability concerns among potential users, who apparently prove demanding about access safety [1]. Regular updates, clear procedures, and the timely delivery of related information set the necessary framework for encouraging an increasing number of applications to serve a variety of categories and degrees of sophistication.

4.1. Technical Aspects

Mobile applications and internet banking play a pivotal role in the digital transformation of Greek enterprises.

Mobile applications can be classified into three categories: native applications, web applications, and hybrid applications. Native applications are developed specifically for a particular mobile platform (Android or Apple), offering fast performance and the ability to utilize all built-in features of the smartphone. Web applications operate entirely within a browser and require network connectivity to function. Hybrid applications combine elements of both native and web applications, allowing for cross-platform deployment via web technologies, while still supporting offline mode and local file access. The advent of frameworks such as Apache Cordova enables developers to create hybrid applications that run across multiple platforms, including Android, iOS, and Windows. Since the introduction of the first online banks, Internet banking has undergone significant growth, evolving into an established service

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used by a substantial portion of the Greek population. The internet facilitates interactions with financial institutions, allowing users to conduct various financial transactions online without the need to visit physical bank locations. Greek banks operate within a regulatory framework that promotes the development of online financial services. Examples include Egnatia Bank, whose website provides organized information, a range of services, and an extensive FAQ section. However, inconsistencies between the Greek and English versions of the site and the limited availability of online services in English are noted [1].

4.2. User Experience Considerations

User experience represents the synthesis of all elements comprising the online banking journey, encompassing variables such as network capabilities, content relevance, device performance, and individual user attributes. The intensity and nature of these interactions influence design decisions, shaping interfaces that strive for intuitive operation and efficiency. Despite substantial advancements, internet banking often falls short of fully aligning with the intricate and evolving preferences of its diverse user base. Successful online banking implementations transcend technological prowess, embedding themselves within the quotidian habits of customers and revealing unforeseen functional requirements in the process. Essential to this accomplishment are adaptable platforms and services capable of accommodating temporal variations in usage, seasonal fluctuations, and the heterogeneous behaviors of the clientele [1]. The challenge of reconciling diverse objectives, user behaviors, and available technologies underscores the pivotal role of user experience as a strategic linchpin; its absence constitutes a principal source of business risk. Addressing this complexity necessitates a foundational textual framework that not only facilitates technical communication but also guides the design of interfaces and information architectures. For Greek enterprises, the integration of mobile applications with internet banking systems magnifies these considerations. The deployment of mobile, accessible, and autonomous services introduces additional technical components and channels for user access, thereby complicating the task of delivering a cohesive and satisfying experience. Successfully harnessing the potential benefits of such synergy demands a nuanced appreciation of the multifaceted influences on user interactions, informed by both empirical evidence and strategic foresight.

5. Challenges Faced by Greek Enterprises

Security, regulatory compliance, and adoption comprise the principal problems encumbering mobile banking in Greece [1]. The assurance of confidentiality, authentication, and non-repudiation constitutes the cornerstone of mobile banking. Customers must be certain that they will not be defrauded of money and that their spending records remain inaccessible to third parties. The establishment of trust, moreover, constitutes a prerequisite to the adoption of mobile banking. Only through trust can customers be persuaded to utilize mobile-banking services on a regular basis. Enhancement of the security architecture on the mobile-access side thus constitutes a sine qua non condition if mobile banking is to flourish in Greece. The enactment of the Law 3421/2005 reflects the legal enactment of the relevant European Directive concerning mobile services accessible through public electronic-communication networks offering publicly available telephone services. Innovativeness in mobile banking represents a further indispensable prerequisite. Creative banks that invest in services extended through diverse channels enjoy a considerable advantage in the banking sector and can attract a larger clientele. Initiatives such as cashing checks and depositing crypto-money through digital cameras implemented in mobile telephony constitute potential avenues of development. Greek banks should therefore seek to exploit the power of mobile technology to provide innovative services and differentiate themselves from the competition.

The satisfaction of regulatory requirements also constitutes an ongoing challenge in the development of Internet banking appropriate for the Greek environment. The rules of conduct introduced because of the Directive and transposed into Greek legislation define the didactic pedestal upon which enterprises may develop the organizational framework and governance system through

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which they extend e-services to the customer. Although these provisions have been clearly stated, they nevertheless require further detailing before the legislative framework attains completion. The Basel Committee, the European Central Bank, and the Bank of England have already formulated directions for the implementation of Internet banking; similar guidance would substantially mitigate the operational hazards that enterprises encounter as they attempt to absorb and comply with the transitional provisions of the Directive and the Law. Finally, firms must address issues related to the deployment and exploitation of the infrastructure by which they realize the benefits of transportation, distribution, and communication that the truth of their digital transformation confers. The successful exploitation of digital channels impels top management to pursue a new understanding of inter-organizational systems, engaging a diverse range of technologies by means of which the enterprise may disseminate its value to a great number of customer segments, each characterized by specific requirements and expectations if it is to appreciate such value fully.

5.1. Security Concerns

Security remains the primary concern when employing mobile applications to access internet banking services in Greece. Mobile banking has not yet become commonplace because many perceive handheld devices as unsafe platforms for banking operations [1]. Mobile applications offer convenience and efficiency, negating the need to visit bank branches or carry passbooks. Users can monitor transactions, transfer funds, and pay bills easily through their mobile phones. Although financial institutions monitor transactions and promptly notify account holders of suspicious activity by, for example, imposing daily transfer limits, the absence of a single security standard for internet banking services deters widespread adoption. Moreover, regulatory authorities demand information to verify that technology permits only accessible functionality in the customer's name. From a user perspective, devices are vulnerable to loss or theft, and managing multiple account contacts can be obstructed by limited screen size.

Despite these challenges, the adoption of mobile browsers on uplink speed-enhanced third-generation networks has expanded the range of mobile internet banking services and widened the potential user base. The capability to access banking services from anywhere at any time, independent of language restrictions, makes mobile commerce solutions an ideal choice for broadening the sector's reach in Greece.

5.2. Regulatory Compliance

The most important law in the banking sector is newsletter 241 / 16-9-2005 [3] of the Bank of Greece which deals with the provision of information services to the public. Despite the fact that Internet Banking does not harbor a direct risk in financial terms for domestic banks, there appears to be a significant risk for bank accounts, personal data, etc. The complexity and diversity of services of Internet Banking are further limited by several restrictive rules of the Bank of Greece and the supervisory authorities, which are regularly announced, implemented, and enforced by the banks of Greece. The rules aim to take advantage of the capabilities of the Internet and adapt them to the logical requirements of a bank operation. Video recording is actively emerging in the banking world, alleviating some of the above restrictions. In addition, the laws for the protection of customer data and the Ministry of Development must be taken into account.

When implementing services on banks' mobile telephony platforms, it must be taken into account that although Greece fully follows European legislation on the protection of citizens from spam messages and unsolicited communication, mobile actions of Greek Commercial Banks are seen by the Ministry of Development and regulatory authorities as resistance to the advertising of service products by other competitor banks and as an abuse of their dominant position in the BP market. The services offered to BP customers vary between the banks. The actions of banks, which are implemented in the framework of compliance with legislation, arise from the input of customer behavior and cybersecurity

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concerns. The complexity and recent development of services currently limits the current use of mobile banking in enterprises.

5.3. Adoption Barriers

The mobile devices revolution has drastically changed everyday communications. Mobile phones, smartphones, and tablet computers are no longer simply communication tools; instead, they have evolved into complex devices supporting additional functionalities, providing users the opportunity to access extended or innovative possibilities for better services [1]. Over the past decade, internet banking has emerged as a prominent mean of information delivery in developed countries. Mobile banking, a more recent concept, represents a further advancement in the digital economy's relationship with information technologies and telecommunications [4]. Greek enterprises encounter numerous challenges in their effort to capitalize on existing and emerging information and communication technologies. As customers and suppliers utilize information systems reinventing commerce in national and global markets, it becomes imperative for companies to seek innovative ways to integrate mobile applications with their internet banking operations, thereby enhancing value and maintaining a competitive edge in the new business paradigm [5-14]. Greek enterprises confront significant obstacles to the adoption of mobile applications and the use of internet banking. These barriers mainly stem from security concerns and the need to adapt to a regulatory framework that has yet to achieve full technological convergence with the capabilities offered by modern telecommunications networks. There also remain numerous adoption challenges and practical difficulties for both enterprises and users of these services. Other constraints relate to inadequate infrastructure and the limited availability of specialized human resources. As new information-processing equipment replaces older models, companies should recognize it as an investment opportunity and develop strategic plans that make optimal use of available resources.

6. Case Studies of Successful Implementations

Mobile applications comprising internet banking have become a fundamental element of enterprises' digital transformation. For enterprises combining mobile apps with internet banking, mobile banking enables enhanced personalization and revenue growth, reaching unbanked populations, and boosting liquidity in existing relationships. Enterprises implementing mobile banking worldwide are ramping up resources to build and launch the next generation of mobile apps that deposit money, pay bills, and deliver customer insights. For Greek enterprises, mobile banking application development represents a frontier opportunity at the intersection of Android and iOS smartphone devices, internet banking services, and ever-evolving technology. Digital banking constructs a new interconnected world characterized by visibility, searchability, selectivity, persistence, and combinability of contents. Digital banking also modifies social and communicative behaviors on the Internet by inducing a constant state of sociability that affects user habits and cultures. Furthermore, by interconnecting online, offline, and mobile domains, digital banking triggers convergence between decentralized, structural, and relational social dimensions. Despite the potential for "digital explosions" to emerge in online social content, disease and pandemic threats have heightened the need to explore the correlation between digital platforms and the real world.

Customer-relationship management (CRM) couples analytics, databases, and business rules and aims to understand customer behavior by offering personalized products or services that enhance retention, nurture long-lasting relationships, and increase profits. Mobile CRM assumes increasing relevance, as digital economy development sparks online trading and allocates additional businesses and transactions to mobile apps. At present, mobile computing remains a major concern in the research community, addressing problems of bandwidth, scalability, and access to databases and heterogeneous data resources. During COVID-19, the use of advanced tools such as cloud computing, big-data analytics, virtual and augmented reality, and artificial intelligence applied to developing mobile-app-services-based communities increased dramatically, serving as a useful support strategy for traditional

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frameworks and proposing new business models to accelerate sustainable development across economic, social, environmental, and energy criteria [1].

6.1. Case Study 1: A Greek Retailer

Mobile applications have been changing the way consumers interact with businesses. Their movable and easy-to-use nature allows for different combinations of features that contribute to the final user experience. Companies that adopt mobile applications have the ability to offer their customers an efficient method of communication and sales channels. The case study can demonstrate a Greek retailer that built a mobile application to satisfy the growing demand from its customers for wireless access to company services. Along with the basic functionality of the application lies the integration with an Internet banking platform, enabling users to perform money transactions and interactive operations using their business accounts. The challenge for companies has become the enhancement of the applications with desirable content and services from their respective fields, which can be offered to customers as added-value content. Consecutively, Internet banking providers have started to review alternative options to attract a wider scope of customers, especially with mobile Internet services available. The retailers and the overall community benefit from an extended approach to completing business operations. Mobile applications offer also a new point for Internet banking to evolve and contribute to the digital transformation of the enterprises in Greece [1].

6.2. Case Study 2: A Greek Financial Institution

Greek banking institutions are addressing a growing demand for mobile services by extending their internet banking to mobile applications; these developments are therefore being integrated into the internet banking platforms developed according to the European Payment Services Directive. This case study presents the approach followed by a Greek financial institution for the development of its mobile internet banking platform [1]. The Greek financial institution selected for the case study is a member of a European network that provides a leading payment solution to 18 countries, including Greece, and more than 1.3 million merchants across Europe. To develop its mobile internet banking platform, the institution concerned the reception of authentication and authorisation requests from both its own merchants and merchants belonging to the European network. Requests should have been handled within the context of the bank's existing internet banking infrastructure, thereby benefiting from the associated payment support process flows along with the available infrastructure for demanding and checking financial information.

The deployed mobile internet banking platform comprises four components: the mobile internet banking application, a Java Gateway for the communication with the mobile operating system, a messaging Gateway for the communication between the Java Gateway and the bank's messaging system, and the bank's existing internet banking infrastructure. The mobile internet banking application exchanges messages with the bank's infrastructure through the Java and Messaging gateways. The same communication process is followed by the bank infrastructure for exchanging messages with the client's browser during internet banking. Developer effort focuses on the development of an application running on the mobile phone, with the gateways implemented by the financial institution.

7. Future Trends in Mobile Banking

The rapid evolution of mobile banking is transforming the banking sector and related services. Innovation and user engagement decide the success of mobile initiatives, especially in digital banking, Internet banking, and mobile applications intended to offer a full range of financial and banking services, replacing conventional branch visits. Mobile banking services are converging with Internet banking, attracting users who may lack computers but possess mobile devices. Over 60 million mobile banking users are active worldwide, forming account plans to perform monetary transactions, even introducing

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mobile money and wallet services. Coupling mobile applications with Internet banking allows enterprises to facilitate and accelerate transactions effectively and swiftly.

Mobile banking operates through two main technologies: Wireless Application Protocol (WAP) and Short Message Service (SMS). Both are proved as accessible, secure, and robust communication channels for banking activities. WAP infrastructures empower financial institutions and third-party service providers to develop advanced services in sectors such as retail stores, restaurants, e-government, logistics, and transportation; mobile transactions constitute a significant part of the new services developed. SMS reduces operational costs for banks and promotes the distribution of inexpensive services, like balance inquiries and transaction alerts. Mobile payments augment business growth opportunities by interfacing between customers, business partners, and financial institutions via mobile phones and other mobile devices. The main mobile banking drivers include an increase in Internet-access mobile devices, improved security mechanisms, convergence of different media and services, and overall cost reduction.

Mobile-banking services are at least as secure as current Internet-banking systems. Nevertheless, mobile banking needs to be an integral part of the overall business strategy to meet customer needs effectively and form a viable channel of future commerce and information delivery. Despite the diversity of financial services available over mobile, transaction banks may face challenges creating effective business platforms that fit client group characteristics and provide concrete benefits. Users have concerns about privacy—disclosure of personal information, data misuse, and reliance on service providers or the network—but strong intentions to use mobile banking services remain evident. The future of Internet banking, combined with the increasingly important role of mobile phones, suggests that financial institutions should take an active part in the transition toward mobile services [1]. Consequently, mobile banking plays a pivotal role in the digital transformation trajectory of Greek enterprises and warrants attention from both practitioners and researchers.

7.1. Emerging Technologies

Mobile applications are widely used today, as they are far more than simple extensions of desktop applications. They focus on specific tasks and aim to serve particular needs in users' daily lives, providing better services tailored to their expectations, whether in terms of how they communicate, find information, pay for something, get goods delivered, or manage their finances. They are an emerging new medium, based on mobile communication technology and as different to the Web as it was to TV when it emerged initially. Internet banking has become a significant competitive factor of banking institutions, and all Greek banks offer comprehensive Internet banking services using the current security standards and the necessary operational tools on their sites. The integration of Internet Banking and mobile applications can increase the range of products and services available to both private and corporate customers and enhance user convenience and service transformation. Internet banking refers to the provision of banking services through the Internet [10, 11]. The Internet is the medium through which information is delivered, and depending on the organization, the customer is able to perform (more or less) a range of transactions, including funds transfer/loan payment, bill payments, and cheque enquiry. Greek banks provide a comprehensive range of Internet banking services to individuals and businesses, and all banks offer monitoring tools for stock-market clients. Web-tellers are enabled to make transactions from any terminal with Web-browser and Internet access, offering convenience and time-saving services to retail customers. Various studies have aimed to understand customers' behavioral intentions toward Internet banking, which is receiving wide attention worldwide. The Internet banking market in Greece is still small, covering only 8% of the population, but as Internet use grows, significant adoption is expected. Greek bankers anticipate accelerated growth over the next five years as customers become less technology-phobic; banks are already enhancing their services and integrating Internet banking as a standard distribution channel. Interviews suggest Internet banking will become dominant, with traditional branches transforming into advisory offices and a reduced share of transactions occurring through branch tellers [1].

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7.2. Predicted User Behavior

Predictions of future user actions provide valuable insights for incorporating mobile applications into internet banking systems. Anticipating user behavior underpins the development of application components and guides the architecture of mobile banking webpages, facilitating effective integration with back-end services. Accurate models enable banks to tailor services to customer needs and expectations.

8. Comparative Analysis with Other Countries

Mobile banking continues to expand at a rapid pace in Europe, and the situation in Greece is no different: demand is rising fast, and the expansion of mobile Internet access is boosting the adoption of mobile financial services. Greece has a high penetration of mobile (100%), with more than 50% of customers owning a smartphone and substantial adoption of mobile Internet (>40%). However, the country has a low uptake of financial services relative to the rest of Europe, with penetration rates for active mobile banking at just over 10%, while the average across Europe is 30%. Greece therefore has the potential to increase active mobile-banking penetration substantially. Greek banks recognize the need to improve their mobile-banking offerings, not only to increase adoption postulated by current mobile Internet trends but also to counteract declining traffic through alternative channels. Nonetheless, they are aware that, before implementing fully fledged mobile-banking strategies, they need to address the core issues on supply and demand. Greek banks could learn from countries with more experience in mobile banking and secure a competitive advantage by timely and strategically addressing past mistakes and aligning closely with the emerging requirements of the market.

Banks in other countries have been working on mobile-banking strategies for many years and have thus gained valuable insight that can be adopted in the Greek context without any additional market research, allowing the banks to focus on the development of innovative functions and adequate offers. In the early stages of mobile-banking development, the emphasis was on the availability of multifunctional applications, and adoption increased rapidly when these offered functionalities beyond simple stock quotes. The services offered should therefore be multi-channel and designed to fully complement each other [11]. In classic e-banking, Greek consumers show extreme caution. In many cases, the customers who do use commercial Internet banking avoid transactions that require authorizations and opt for simple stock quotes or order histories, mirroring the initial development of mobile banking in other markets. A direct correlation is evident between concerns about the security of personal and financial information and the likelihood of using Internet banking. These concerns are mainly focused on the misuse of personal data; the loss of information, assets, and money; and feelings of insecurity about the Internet [1]. The implementation of multifactor authentication mechanisms and triple encryption would reduce the perception of Internet-banking risk, which forms the foundation of mobile financial services and could significantly increase adoption. The lack of suitable terminals supporting payments is universally recognized as one of the most important factors constraining the development of mobile payments. Greece clearly fits this criterion, with only very limited acceptance, making the roll out of card-free solutions difficult. The availability of simple and accessible solutions that address the absence of home broadband (e.g., prepaid dedicated data cards) is crucial to increasing adoption. The impact of these solutions has been demonstrated in markets such as France, where out-of-home usage is particularly relevant. The maturity and security of solutions for the key steps of payment and clearing can provide the basis for the widespread adoption of technology. Greece has yet to develop a clear regulatory framework covering mobile payments and e-money. Offering clear and consistent architecture to provide regulatory guidelines would help eliminate the excessive fragmentation that currently prevails and would help provide a commercial basis for growth

8.1. Mobile Banking in the EU

Mobile banking constitutes an essential phenomenon within the current digital transformation of Greek enterprises. At the European level, statistics indicate that approximately half of Internet users in

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the European Union conduct online banking, and a quarter manage their accounts via smartphones or tablets .

8.2. Global Trends and Innovations

The world economy is dominated by multinational companies that operate on a global scale. In order to expand their operations, many companies implement a "follow the customer" strategy, which means that a company that loses a customer also loses potential future business from this customer. To keep existing customers and attract new ones, many companies have implemented Reverse Logistics strategies to reduce the cost of the outward supply chain. One of the major objectives of Reverse Logistics is to achieve a 100 percent excellent level of service, which requires providing customers with an efficient returns management system that can fulfil their needs [15-29]. Mobile phones have become more popular than any other electronic device, surpassing even other media such as radio and television. Due to the rapid growth of smart phones, the mobile application market is also expanding quickly and millions of new applications are being developed for different domains such as social networking, gaming, business, and health [1].

Mobile banking, or m-banking, has become an increasingly important service, allowing customers to conduct financial transactions remotely using their mobile devices. Mobile banking services are typically accessed via a dedicated mobile website or a specialized software application. While a multitude of mobile applications spanning various categories are available, mobile banking remains one of the most widely used and rapidly growing applications in the mobile domain. Several technical components work in harmony to facilitate the integration of mobile applications with online banking, encompassing aspects such as application protocol, communication and security protocol, supporting systems, and standardization. These components collectively enable a seamless and secure mobile banking experience, ensuring that customers can conveniently access and manage their accounts through their mobile devices.

9. Recommendations for Greek Enterprises

Mobile applications, particularly when integrated with internet banking, play a pivotal role in the digital transformation of Greek enterprises. To capitalize on the ongoing convergence of these technologies, Greek companies should adopt a multifaceted approach. Strategically, businesses ought to formulate clear policies that align mobile services with overarching corporate objectives and the evolving preferences of the mobile internet user base [1]. Technologically, investment is essential for the adaptation or complete redesign of e-banking applications to suit mobile platforms, ensuring responsive layouts and user-friendly interfaces that cater to the convenience and immediacy demanded by modern consumers. Furthermore, enhancing customer personalisation through the integration of communication and transaction functions fosters deeper engagement and satisfaction, while leveraging the pivotal role of user experience can differentiate services in a competitive marketplace [29-37]. Such recommendations, rooted in current research and formulation of strategic, technological, and engagement-oriented initiatives, aim to position Greek enterprises at the forefront of mobile banking innovation.

9.1. Strategic Planning

Strategic planning for mobile applications and Internet banking is mandatory, given that global trends dictate them as key tools in strategic business development and operational information systems. In order to serve existing and potential customers in a competitive and demanding market, organizations must orient their activities towards competitive advantages such as flexibility, multi-tasking, availability, and speed. This is achieved via communication technologies, information, data, knowledge, and services mobility. Smartphones, portable and versatile devices that, through the downloading and installation of tailor-made software, turn into tools with unlimited capabilities, are a vital axis in enterprises' strategic planning and e-business initiatives. They provide easier, faster, and

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more efficient access to resources; moreover, since the number of users grows exponentially every year, the use of smartphones and applications constitutes the most promising channel for the communication and penetration of new services to an extended customer base. Enterprises that have embraced this need have developed or are developing dedicated applications. Let us consider the example of a typical Greek retailer who already exploits smartphones and "classical" e-commerce and a financial institution provider of Internet Banking services planning its development strategy towards mobile platforms [1]. Various examples illustrate the results of successful mobile banking implementation, indicating short- and medium-term trends in Greece.

9.2. Enhancing Customer Engagement

Public-sector entities can impose formal information-technology procedures on a limited number of suppliers. For example, in Italy, the Italian General Navigation (IGN) ordered the embedded-systems software in its newly developed vessels from one engineering company. The administrative officials specified a few of their safety requirements and mandated the use of targeted software-development procedures.

Table 1.
Mobile Applications and Internet Banking (authors' table)

Theme	Conclusion	Evidence/Notes	Implications	Recommended Action
Adoption Status	Internet banking adoption in Greece has historically been low, but mobile access is accelerating uptake.	Early 2000s: ~8% households; rising internet/mobile use projected strong growth.	Large headroom for market expansion.	Target non-users with mobile-first onboarding and incentives.
Strategic Role of Mobile	Mobile apps are the practical channel to extend and personalize banking services.	Smartphone penetration + user habits shift daily tasks to mobile.	Higher retention and cross-sell via personalized journeys.	Develop a mobile-led product roadmap with clear KPIs (activation, MAU, NPS).
Integration Imperative	Value arises by tightly integrating mobile apps with Internet-banking back ends.	Interoperable components: UI, data management, gateways, messaging, security.	Operational efficiency and consistent UX across channels.	Build shared services/APIs; prioritize reliability, latency, and failover.
Security as Primary Barrier	Security perceptions (confidentiality, authentication, non-repudiation) block adoption.	Regulators and users emphasize risk to funds and personal data.	Trust is prerequisite for usage frequency.	Strengthen MFA, device binding, transaction limits, anomaly detection, and clear comms.
Regulatory Alignment	Rules exist but require clearer operationalization for mobile contexts.	BoG circulars, EU directives; banks implement but gaps persist.	Compliance burden can slow rollouts.	Map controls to specific journeys; maintain living compliance checklists.
User Experience (UX)	UX is a strategic linchpin; weak UX causes business risk.	Heterogeneous devices, seasonal load, diverse behaviors.	Better UX improves adoption and reduces support costs.	Invest in research, accessibility, and performance budgets per screen.
Infrastructure & Skills	Legacy infrastructure and limited specialized staff hinder progress.	Need upgrades and capability building.	Bottlenecks in delivery speed and quality.	Prioritize core-platform modernization and targeted hiring/upskilling.
Multichannel Consistency	Mobile, web, and branch must complement each other.	Early stages favored multifunctional apps; now seamless journeys dominate.	Inconsistent flows reduce trust and usage.	Define shared design system; align policies (limits, KYC) across channels.

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Mobile Payments Tech	WAP/SMS and app-based flows remain viable with proper security.	Payment & clearing maturity drives usage.	Broader acceptance points and UX simplicity are critical.	Expand acceptance, optimize key flows (P2P, bill pay, QR), minimize steps.
Market Position vs EU	Greece lags EU averages in active mobile/online banking but has high growth potential.	EU ~half of users bank online; Greece historically lower but rising.	Catch up gains available for first movers.	Benchmark leaders; fast follow proven features and service levels.
CRM & Personalization	Mobile CRM plus analytics lifts engagement and revenue.	Converging online/offline/mobile data enables relevance.	Higher LTV and lower churn.	Deploy event-based messaging, offers, and A/B testing tied to financial health.
Future Outlook	Mobile + Internet banking convergence will dominate distribution; branches shift to advice.	Digital habits and device ubiquity reinforce this trajectory.	Distribution costs fall; digital share of transactions rises.	Plan for branch-light models and digital-first servicing.

Thus, the contractors, to gain the right access to execute the contract, had to comply with the procedural requisites. However, such exclusive dependencies are unusual in the supply chain; if mandatory technical requirements exist, they are generally limited to few commercial areas [1].

10. Conclusion

Mobile banking constitutes a subset of mobile commerce (m-commerce), characterized by the provision of financial services such as banking and trading via wireless communication networks. Within the context of mobile banking, mobile applications represent a vital innovation introduced into the financial sector during the era of wireless communications. For Greek enterprises, mobile applications have emerged as the most effective mechanism for aligning Internet banking with contemporary technological trends. Financial institutions that allocate resources to develop mobile applications for Internet banking substantially enhance the supply of automated services, thereby advancing the digital transformation of their operations [1]. In summary, mobile applications constitute the preferred channel through which Greek enterprises satisfy the requirements of businesses and households for Internet-based banking services, thereby projecting the sector towards a more flexible, comprehensive, and unified future.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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