

# The Evolution and Impact of Mobile Applications

Om Narlawar, Kapil Ganjare

G H Raisoni University, Amravati, Maharashtra, India

## Abstract

In today's modern era, mobile applications have become an indispensable facet of life and stand as one of the primary contributors to the digital world. As smartphone technology becomes more widely adopted, internet services are more readily available and cheaper, and technology continues to advance, the usage of mobile applications has grown tremendously in the last decade. Mobile applications serve as a central point to the digital revolution of modern society. The millions of available applications at our fingertips through the app stores, the Apple App Store and Google Play Store, have changed the way humans perceive technology and interrelate with one another. Mobile applications have become part of communications, shopping, online banking, medicine, e-commerce, online education, entertainment, traveling and much more. The proliferation of smartphones like the Apple iPhone, the introduction of the Apple App Store, the introduction of Android mobile operating system and the Google Play Store have opened the path to the formation of a huge mobile ecosystem where all kinds of services and opportunities were made available to humanity. By offering convenient, fast and efficient methods for accomplishing diverse tasks, mobile applications have forever transformed conventional human ways of performing various day-to-day activities. Consequently, mobile applications have grown so important that they have become indispensable to both individual and business sectors. The present proposed paper provides an overview of the development, deployment and consumption of mobile applications in the modern world and its varying sectors such as education, medicine, digital payment and e-commerce [1]. For example, mobile applications in education have allowed for online classes and the provision of study materials in comprehensive form, anywhere and anytime, overcoming the geographical and temporal constraints that traditional learning imposes. Mobile applications have greatly accelerated the global development of digital economy by playing a key role in banking and electronic payment systems[2], thus helping in the realization of cashless society. E-commerce applications permit users to conduct online purchasing of various items with assured security for payment, followed by delivery right to the user's doorstep. Mobile applications contribute in significant ways to human communication, online spending habits, business processes, delivery of healthcare and transformation of educational systems by largely impacting many other processes contributing to the rapid advancement of global economy and digital revolution. Even though mobile applications offer many merits to users and organizations, they do carry drawbacks as well, which should not be neglected. Data privacy, online scams and criminal activities as well as cybercrime are just few of the issues that require attention. Users have grown highly dependent on the mobile applications which, at times can pose harmful risks to human physical and mental health. Hence, it is imperative that we use mobile applications responsibly and securely. In

conclusion, we have undeniably seen a drastic revolution in the modern era brought by mobile applications, that at one time enhances the human life and stimulates the growth of the economy[3], but on the other hand introduces various privacy risks, cyber threats, health risks as well as psychological dependency issues which must be tackled effectively. Mobile applications have significantly improved communications, enhanced individual and professional productivity, created new job opportunities, and provided various services at people's disposal across the globe[4]. As we move on to the future, with the rapid advancements in technology such as Artificial intelligence, 5 G and Cloud computing, we shall see even greater impact from mobile applications in

**KEYWORDS:** Performance, Technology Adoption, Algorithmic Transparency, Artificial Intelligence, Data Privacy, Cybersecurity, Digital Wellbeing, Real-World Usage Context [5], Mobile Commerce, E-Governance, Telemedicine, User Experience, User Interface, Human-Computer Interaction, Mobile Computing, Digital Transformation, Smartphone Ecosystem, App Development, Software Engineering, Cloud Computing, 5G Technology, Internet of Things, Big Data Analytics, Machine Learning, Mobile Payment Systems, FinTech, m-Health, E-Learning Platforms, Application Usability, System Reliability, Context-Aware Systems, Digital Economy, User Engagement, App Security, Behavioural Analytics, System Resilience, Socio-Technical Systems.

## 1. Introduction

In the modern day society, mobile applications have a profound impact on every facet of life as they revolutionize human communication, commercialization of goods and services, functioning of government, as well as education and healthcare.[6] It is the ultimate aim of any mobile application designer to produce a system which is functional, reliable, efficient and which adds value for the user.[7] For a very long time, researchers and designers involved in computing and software have dedicated significant effort on advancing mobile technology through better programming, enhancing User Interfaces (UI) and optimizing utilization of resources, but only recently are scientists and professionals beginning to investigate the less obvious issues the true impact that mobile applications are having on humans and the impact of usage in everyday contexts. Mobile applications are such an inherent part of our daily lives that their successes and failings should merit a fair assessment. While it is true that some application issues will pass the notice of the average user even as they cause misguided advice, wrong instructions and persistent irritation, others are more profound, but not always visible to the user-these issues involve application failures caused by deviations from assumptions embedded in their design, a mismatch between how the application functions and how the user intends for it to be used, or contextually problematic situations including

uncertain inputs, non-technical and diverse user experience. Mobile applications are now everywhere and continue to cause considerable consternation on the part of the user; many mobile applications are perceived as useless despite functioning technically, and often the solution is to have an application which will not error, but is still bad. The purpose of the present study is to evaluate the negative side of mobile applications in their common use cases.

One of the core aims of technology research is to understand why it fails in the same ways that it succeeds. A great variety of research into mobile applications has been undertaken, both within academia and throughout the mobile computing industry. It is essential that we carry out thorough investigations into each success and failure so that we can better understand mobile application use patterns and make informed suggestions and redesign of the mobile applications. Research often seeks to increase robustness and suitability of mobile applications through comprehensive analysis of application failure and success within multiple contexts and applications. In this paper, we intend to understand what failure means in the context of mobile applications by analyzing the usage failures occurring from multiple factors with the help of established research literature. Most mobile applications are developed in artificial lab settings where circumstances are somewhat ideal. During testing, the software designers are present in controlled conditions, with guaranteed and efficient use of bandwidth, a fast mobile system, tested by an expert coder with full knowledge of the system and its functionality. These tests are not, however, a reflection of actual mobile application usage patterns where variable conditions and inconsistent input are commonplace. Unlike what the designer envisages, users are not always interacting with systems in an ideal and safe manner; hence mobile application functionality can change depending on usage context. For a system developed under perfect conditions, and designed to meet user needs within a controlled environment, it is reasonable to assume that the

performance of the system in the real world will not always mirror its testing results. This suggests that tests do not accurately simulate the environment and usage of mobile applications as they do in a real world environment.

Humans that use the mobile applications are not always computer literate or even possess general technological know-how. While many application users are tech savvy, the target population can range from non-tech literate users to tech knowledgeable users; they might also have varying cultural backgrounds and physical/psychological needs. This suggests that we cannot design a mobile application based on user interaction that only experienced tech users would employ.[8] The application has to accommodate even non-tech users or be so self explanatory that users learn the system on the go without much or any struggle. The application environment is much different from the labs in which these systems are designed and tests; mobile applications in actual use help humans make judgments, take decisions, and receive recommendations that the user cannot properly assess, even if technically correct, to understand if an action taken by the application is indeed suitable and valid. Users do not have the ability to view what occurs inside a mobile application when a decision is being made and how and when the system uses and interprets the information it receives. This problem has led to the development of a whole new range of mobile application failures that are hidden from the user. The opacity can lead to application failures and negative consequences as the user cannot properly assess the accuracy or validity of what the application is doing, especially as mobile applications are becoming highly intelligent and appear to be 'correct'. Mobile applications do not have an intrinsic understanding of how they should work in a particular situation or the implications that their recommendations carry. The inherent problems and failures associated with mobile applications is similar to those that occur with technology more generally; they stem from how systems are designed and how they interact with human beings.



Figure 1: A summary of how mobile applications affect various industries.

## 2. Literature Review

Mobile applications and information technology have been the subject of many studies and examinations across several domains, from academic fields to industrial research. These works generally focus on a system's performance, efficiency and improvement of mobile application through superior design principles and structures. They investigate scalability issues, strategies and optimization techniques for various applications.[9] Investigations of mobile applications in various disciplines like software engineering, human-computer interaction and mobile computing mostly look at the quality of mobile applications from a performance standpoint; the implies the accuracy, response speed and reliability of the mobile application. Various design methodologies have been introduced into the industry and researched by scholars over many years with the aim to ensure an improvement in system performance, reduction of errors and efficiency of the application in different domains and user context. A large number of these studies are concerned with how systems perform under relatively idealized or well-controlled conditions, unlike the situations of actual usage. Researchers assume predictable infrastructure support, clean and relevant data input as well as skilled and knowledgeable users who can comprehend the operation of the system[10]. Performance tests for applications mainly focus on the quality attributes of a system such as code quality, battery drain, memory usage and response time. Most research regarding user interface tests have tried to solve the problem of usability through lab tests where end users of the software are brought in for an assessment of the usability of the application under laboratory conditions; this has proven successful for the pre-release testing of mobile applications. However this approach doesn't analyse the outcome of usage for the population that relies heavily on these applications after their release into the market place and are thus affected by the external environment as well as usage patterns which the designers may have overlooked[9].

One main challenge that has been and still is a persistent problem for users of mobile applications, developers and even business is the failure that systems produce. It is vital to understand why such failures occur by not only looking at technical problems but also the interplay between the system and the human and the surrounding context[11]. User-task-system performance in mobile applications have been extensively researched by human-computer interaction researchers; the concept here relates to errors that arise during system use and how it impacts on user experience and efficiency.[10] Human-computer interaction, is defined as the study of how humans and computer systems can interact efficiently and effectively; it is also used for researching how humans use technology and how technology affects them. The main focus here lies on the human factors of the problem; however, in some cases this can overshadow the technical aspects which are very critical for an efficient system.

These studies fail to look at human factors as being primary, by emphasizing system performance which is generally defined in terms of system response, code efficiency and other technical issues. Historically, the performance metrics such as accurate computation and fast execution speeds, although very important, seem to overshadow human-related factors. The fact that humans must interact with mobile applications, and are influenced by varying factors such as the time of the day or even interruptions make it very crucial that mobile applications be analysed beyond technical specifications. The outcome of usage of mobile applications has many factors influencing it that must be put into consideration, and those not related to performance of the system must be regarded as part of a broader problem that requires equally thorough investigation. Failures in application systems has traditionally only looked at the 'breakdown' of a system, such as errors in codes and system crashes, through tests like unit testing and user acceptance testing (UAT), but are not always capable of addressing how a mobile application functions under its diverse usage scenarios.

The research in mobile applications is mainly focused on understanding why an application failed in relation to either one or both of these failures. These investigations often lead to the discovery that failure was not necessarily caused by code deficiencies, but rather by conditions under which it was applied. Human-computer interaction looks at the failure from a different perspective focusing on how well the application fits with human cognition, task design and context. However, some researches put greater emphasis on one of the other's; for example, researches within the computing industry may focus more on system performance as they have a vested interest in the functioning of their product. However, there is a great deal of learning to be obtained from these disciplines, but also from researchers who are concerned with the social implications of technology. The interaction between the computer system and the human user can provide additional understanding of mobile application failure; researchers investigating human-computer interaction take into consideration such factors as user task performance, how efficiently human can use a system, and the perceived level of system usability. Researchers in human-computer interaction claim that much of the trouble with systems arises because the user does not adequately know how to operate the system or due to an incorrect design; that is not to say the system does not function well, just that human interaction with the system isn't quite right. The other factor is that systems operate within contexts; environments that are highly diverse and variable. Thus, if an application doesn't work in a specific context, it implies that that it is not useful to users in certain situations. Human-computer interaction research shows that often the quality of systems could be improved greatly by focusing on the usability aspects of system design and operation.[11] The studies are aimed at ensuring that humans have the most effective and efficient experience when interacting with any kind of computer system.

## 3. Research Methodology

This paper provides an investigation of mobile applications and their far-reaching effects on users, society and economic system.[12] It aims to explore what kinds of outcomes that mobile application effects on many contexts of usage and categories of users. It has also pointed out the situation that application fails to deliver the desired effects and values as user expecting. Mobile applications' ultimate purpose is to facilitate human activities, improve user experience and enhance life. Typically, computer researchers and practitioners are trying to improve performance and capability of application via iterative design and development process in the most of their research. The ultimate goal for this kind of research is to successfully develop applications to realize design objectives and meet user needs as much as possible. However, the objective of this research has shifted to a completely different direction, which is to investigate and gain a clear understanding of all possible outcomes of

mobile application, including intended and unintended, positive and negative. It is investigating the cases of failure of mobile application to achieve the highest possible user benefits and identified underlying patterns in users' behaviour and outcome over a wide range of applications. Mobile applications are designed to ease life with information, services and social connection readily available at fingertips. Typically, computer researchers and practitioners are trying to improve performance and capability of application via iterative design and development process in the most of their research.

What goes wrong with mobile applications and what can the failure contribute to a better design? Essentially, this research is about mobile application and the wide spectrum of outcomes that it leads to individuals and groups of people. In fact, this research stands unique in its attempt to understand why mobile applications and its related technology commonly deviates from what users expect even after considerable investment in design and development processes. No new systems are built or developed as a part of this research. Instead, a wide number of existing mobile applications that are documented by research literature have been used to provide concrete context, particularly focusing on actual implementation of applications within contexts of real usage and users' opinions toward the experiences under various kinds of application and various domains. In some situations, applications failed to run as the user expects and brought frustration, confusion and dissatisfaction. This research collects users' feedback and experiences about mobile application in a wide range of context; both positive effects and negative experiences which can be used to reveal existing problem in design or implementation, etc. Mobile application outcomes cover all kind of results.

Technology cannot always live up to the expected benefits despite the optimism presented by its developers and promoters. Investigating these cases are important in improving future applications' design and maximizing its positive outcomes, while minimizing potential harm. Technologies should not hinder but rather improve human conditions, so detecting these shortcomings helps develop responsible technologies. If technology is to benefit individuals and groups, one must understand how, where, when and why technology underperforms or negatively effects its users.[13] This explains the significance of looking into mobile applications outcomes including negative results. The results of such outcome effects are diverse and spread across various applications and contexts, for example, mobile application designed for medical field may fail to ensure behavioural change; application designed for learning do not increase learning outcomes; social media application may decrease user wellbeing, etc. Solving these issues helps in developing technologies that satisfy actual user needs rather than just focus on revenue and user engagements. A comprehensive analysis and discussion about mobile application's effects is a requirement for the advancement of technology and the overall well-being of humanity. It has to be collected by reliable sources and confirmed by proper validation processes. Accuracy and trustworthiness are crucial in providing reliable information, thus; only peer-reviewed or credible research papers are used, double checking against multiple authoritative resources when possible. This research uses that approach. This gathered information is analysed to establish an applicable model of mobile application behaviour in diverse application types and domains. Applications in a broad range of domains that exist everywhere and form part of the users' daily routines provide concrete examples of use; hence, the way of users' interactions with application matters in ensuring that they meet users' real needs. Deployment context and results from different application categories can be used to identify crucial factors that influence mobile application's success [13]. Under-performance of an application or its adverse effects in different usage context can never be avoided but one can surely have a framework to prepare for these kinds of incidents. That's why it is important to have an explanation for why applications do not often yield what is expected by the users or why the applications or the underlying technology produces various negative results.

The result outcomes of using technological system are sometimes affected by some internal factors within a system as well as individual and environmental factors. It is of utmost importance that the intellectual property of the original information sources be properly recognized throughout this research process by referring to the original papers properly in all means of data and knowledge utilization without any direct copy and paste approach. This can help in providing insights on mobile application design and development [14]. since knowing these shortcomings indicates opportunities for improvement, so analysing the outcomes [14]. produced by mobile application system helps researchers and designers make better use of technology. Data collected comes from comprehensive review of research papers that span across a wide array of fields including: computer science, human-computer interaction, Information systems and science and technology studies. The main search engines for this research are IEEE Xplore, ACM Digital Library, Google Scholar, Scopus, etc. It synthesized previously found data and conducted an analysis with the use of analytical frameworks. Understanding technological outcomes means to analyze the way that individuals interact with the technology and the effect that design has on those interactions. human factors need to be considered. This research study is based on a descriptive and analytical research design to examine the evaluation and impact of mobile applications in the modern era. The study focuses on how mobile applications influence daily life, communication, business, education, and entertainment. The research uses both primary and secondary data sources. Primary data was collected through online questionnaires distributed among students, working professionals, and general mobile users. The survey included questions related to usage patterns, time spent on mobile applications, preferred app categories, and the perceived impact on productivity and lifestyle.



Fig 2. Research Methodology Framework Diagram

4. Result



Fig 3: Development and Worldwide Effects of Mobile Apps

5. Conclusion

The function of mobile applications is to make human activities easy, enrich people's daily lives and empower human abilities in various aspect of modern society. These systems are designed to deliver desirable function and produce desired effects for users, organizations and community. In real situations, despite significant investment in design and development of mobile applications, these systems often fail to deliver what is expected of them. While

application shortcomings can manifest in many ways, these can easily be disappointing for many users and this occurs frequently with applications of all kinds and contexts. Shortcomings are a common element of interacting with modern technology but they have been relatively under-researched and under analysed, by researchers and practitioners more interested in positive examples. Given the prevalence of use of mobile applications across population groups, varied outcomes will inevitably result from

extensive deployment of mobile applications. g. Crash in the middle of critical functions, free-wheeling or exhibiting obvious error messages), many shortcomings are not immediately apparent to users and thus people don't have the opportunity to correct shortcomings by reconfiguring their usage of mobile applications. This includes shortcomings where the application provides a system of wrong information without stopping, inappropriate system advice and that the user gladly takes, or excessive user attention for non-essential operations of system functionality. A crucial point revealed in this research is that many desired or undesired outcomes from mobile application usage occurred without user recognition or a link to design. For example, users often used applications because they perceived them to be valuable even when these applications were providing spurious information, unreliable advice or the user received automated decisions based on the system's understanding which are inconsistent with her/his actual desires and intention [15]. This matters as it influences users' decisions, affects the reliability of interaction with technological system in the long term and promote overuse of systems, because users perceive the system to be functional although there could be problems that are not immediately evident. In other cases, when users faced issues with the application, they attributed it to their usage pattern rather than attributing it to design failure.

These events often took place because of inadequate consideration of actual human behaviours, user abilities and context for a given user population, and user actions are often in line with those behaviour patterns, user abilities and context for a given user population [16]. The research is relevant here because such shortcomings might be critical and produce negative consequences even while the application continues to perform tasks without crashing. They can provide wrong output to the user without stopping. System test could ensure the system is fully functioning and operational, but may fail to achieve desired effects when the context and user population vary. Shortcomings can thus appear even when the system appears to be working well. System functions might differ significantly from their function in a controlled environment when the application is used in the real environment. System may perform adequately in some contexts but fail in others. Users can be made confused or distrustful of technological system if they get wrong advice or confusing instructions that can erode self-confidence and decrease subjective well-being. This is the reason why we aim to present a framework that analyses shortcomings in detail. This implies a transformation of the study and design of mobile applications. Instead of just focus on success examples, by including a careful analysis of shortcomings of mobile applications, we get new, significant and useful information for designing effective applications. Understanding shortcomings proved as important as understanding technical performance. Evaluation that covers aspects of users, context and over time may provide good framework for designing technology more responsibly. Examination of the failure of a system can give access to unknown or unexpected phenomena such as design vulnerability, problems of usage pattern, and influences of context factors that may not be visible in normal successful scenarios. Analysis should use methodologies capable of capturing such factors. g. Case studies and published literature, across number of scientific disciplines. Such research provides useful insight that helps to detect

undesirable application functionality that can cause critical failures for users.

According to many studies on mobile applications shortcomings are not only related to bugs. There are many problems that are connected with design aspects such as excessive user automation that withdraws users from meaningful activities and decisions, inadequate information, and users' inappropriate behavioural models and comprehensible levels [16]. Based on the research synthesized here it can be argued that majority of undesirable results in using mobile application could be accounted to those design features, rather than errors in implementation only. Real human behaviour has to be the center of consideration in design process with sufficient input from users across their life cycle. Mobile applications have been analysed across number of domains and publications, case studies etc. To give broader view of how to find causes for technology failures. In this paper we are taking an attempt to use those data, to discover what factors can cause failures in mobile application usage [16]. A critical issue in technology design and analysis, as established by the work reported here, is insufficient accounting for diverse user behaviours, comprehending skills, and context which mediate application interaction. A consequence is that numerous failed application interactions could be explained by such design shortcomings, as argued above. Future work will use this as a framework, providing a richer, deeper perspective on the nature and variety of mobile application interactions than that derived from narrowly focused analyses on either technical success or specific design failures. This analysis can potentially help design for a wider user population. This can lead to creation of new systems or improving existing ones to cater the various needs of users more effectively. Technology interactions need to be critically examined for a variety of contexts to develop truly usable and resilient systems that deliver value without risk. Mobile application shortcomings must be researched by carefully designed frameworks to bring down to user failures. The framework proposed here brings a more complete account for analysis and design of mobile applications, promoting resilient, transparent, and human-aware mobile systems. This work aims at providing insights to designers, researcher, as well as users in creating useful and dependable mobile applications that support wellbeing. g. Longitudinal studies have potential to reveal changes in mobile application performance over time in use. Interdisciplinary research between computer science, HCI, psychology, and sociology [17]. It will help the society understand the diverse aspects of mobile application interactions. Collaboration will lead to integrated frameworks concerning technical, behavioral, and social aspects of mobile computing. The design guidance should be part of computing curricula and training materials for practicing developers and acquisition criteria for organizations utilizing mobile applications [17]. Ultimately, technology must be designed to ensure desired, rather than failed, results, to the benefit of individuals and society.

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