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Identification of challenges and solutions for smartphone mobile application development using quality function deployment (QFD): The case of Iran ecosystem

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Abstract

The growing prevalence of smartphones has led to the emergence of numerous individuals and small companies venturing into the realm of mobile application development (MAD). The MAD ecosystems are highly dynamic, facing constant challenges stemming from financial, social, cultural, and economic factors. Addressing and resolving these challenges is of paramount importance, particularly when considering the involvement of innovative, diverse, and youthful talents in application development.

This paper introduces a novel approach by applying the Quality Function Deployment (QFD) matrix to connect and prioritize challenges and their corresponding solutions within the context of mobile application development in the Iranian mobile application development ecosystem.

The study reveals three primary challenges: "insufficient government financial support," "lack of knowledge in management and deficient management skills," and "absence of meaningful learning from previous experiences and other MAD ecosystems in the international markets." These challenges are identified as crucial hindrances to the effective enhancement of the MAD ecosystem. Consequently, tailored solutions are proposed for each challenge, aiming to address and overcome these obstacles for the sustainable growth of the mobile application development landscape in Iran.

Keywords: Mobile Application Development, Quality Function Deployment (QFD), Challenges, Solutions, Iranian MAD ecosystem

1. Introduction

The widespread use and accessibility of smartphones, coupled with internet penetration and the adoption of wearable devices, have spurred numerous companies to venture into the development of various types of mobile applications (MAs). The attractiveness of this market is underscored by its current substantial size and a projected high Compound Annual Growth Rate (CAGR) of 14.4% annually in the future. Despite the presence of 11 key players in the market, the diverse needs of users create opportunities for new entrants. Governments can play a pivotal role in supporting these new players through the provision of smart development support packages. However, the intricate challenges and the interdependence of solutions in this market pose a significant risk. Many companies and government sectors, in their pursuit of market share and technological advancements, grapple with erroneous decisions, resulting in setbacks and losses in their strategic plans and investments (Apoorv, 2023).

Statista's projections indicate that the total revenue generated in Mobile Application Development (MAD) is anticipated to reach around 613 billion dollars by 2025. This substantial revenue is derived from diverse sources, including advertising, non-free prepaid downloads, subscriptions, and in-app purchases. In 2021, the estimated number of available applications in various digital markets surpassed six million. Moreover, the projected revenue is expected to exceed 1000 billion dollars by 2023, reflecting the robust growth trajectory of the MAD industry (Statista, 2021, 2023). Globally,

the field of MAD has contributed significantly to employment, with an estimated 30 million individuals engaged in this sector in 2019 (Statista, 2021). To provide a localized perspective, reports from Iran, particularly from platforms like Café Bazaar, reveal that the industry experienced a turnover of more than 350 billion Tomans in 1998. During this period, over 127 thousand applications were available, developed by a total of 67,000 MAD developers since the industry's inception. Of these, 29,000 developers remain active today (Bazaar Café, 2022). To gain a comprehensive understanding of Iran's standing in the MAD industry, the paper explores the ratio of value-added by MAD to the country's GDP. Comparing this ratio with the global average, the study finds that the average mobile application development value added to the GDP ratio index for the world in 2017 was approximately 0.004, whereas Iran reported an index of 0.0003. Despite the existing gap, it's crucial to note that Iran has witnessed exponential growth over the last five years in comparison to the global average. In this period, global application sales increased by 350%, while Iran experienced a remarkable surge of 900%, making it nearly three times faster than the global growth rate (Bazaar Café, 2022).

The primary aim of this paper is to delineate the challenges impeding the success of Mobile Application Development (MAD) in Iran, leading to a shortfall in achieving the targeted financial turnover. Uniquely, this study employs Quality Function Deployment (QFD) to correlate these challenges with tailored solutions. QFD is a robust tool for translating qualitative customer requirements (What) into quantitative engineering characteristics (How). Widely utilized in decision-making for product design and production, QFD facilitates the alignment of customer expectations (What's) with product features (How's) during the design and development process (Pedarpour et al., 2022; Aydarov et al., 2018). The challenges within the MAD sector (What's) are identified through an extensive literature review and interviews. Simultaneously, solutions to these challenges (How's) are determined using the same methodologies. The QFD method is then applied to establish the intricate relationships between the challenges and their corresponding solutions. Careful ranking of these solutions is conducted, providing a structured approach to addressing and mitigating the identified challenges in the MAD landscape in Iran. This methodology allows for a comprehensive understanding of the issues and offers a systematic framework for devising effective solutions to enhance the overall performance and success of the MAD industry in the Iranian context.

The structure of this article is as follows: Section 2 provides the background information on challenges and solutions in Mobile Application Development (MAD). Section 3 outlines the research methodology employed in this study. Moving on to Section 4, the research results and achievements are detailed. Finally, Section 6 concludes the study by summarizing key findings and insights obtained throughout the research process.

2. A Brief Review on Research Background & Theoretical background

2.1. MAD challenges and solutions

The central focus of this paper is the identification of challenges impeding the growth of Mobile Application Development (MAD) and the provision of effective solutions to overcome these obstacles. The research background section is bifurcated into two key components: challenges and solutions. Furthermore, these challenges and solutions are categorized into distinct groups, encompassing financial aspects, regulatory frameworks, environmental factors, market dynamics, and internal variables within companies, including production and technical or management skills. By comprehensively addressing challenges and proposing specific solutions within these categories, the research aims to contribute to the strategic advancement of the MAD sector, fostering sustainable growth and innovation. This structured approach facilitates a nuanced understanding of the multifaceted challenges faced by the industry and offers targeted solutions for each identified impediment.

Financing has consistently emerged as a pervasive obstacle for various organizations; nonetheless, its significance is notably amplified for companies harboring new and innovative ideas. Investors often grapple with the decision to invest in fields characterized by substantial market ambiguity. Governments, recognizing the inherent risks in such investments, commonly undertake a share of this risk by instituting rules and regulations and allocating funds in these circumstances. This critical interplay between financing, innovation, and risk mitigation has been a focal point in the research endeavors of several scholars. For instance, studies by (Davila, Foster, and Gupta,2003) as well as (Nielsen and Keuschning,2004) have delved into this very issue, shedding light on the challenges and strategies associated with financing innovation in the corporate landscape. These references underscore the importance of navigating financial challenges, especially in industries marked by high levels of uncertainty, and provide

valuable insights for organizations and policymakers grappling with similar concerns.

Marketing and sales are widely recognized as significant hurdles in the development of smartphone apps. Numerous research studies have been conducted to explore potential solutions to the challenges associated with effectively marketing and selling mobile applications. In a study conducted by (Gutierrez and Xu,2006), the critical variables and factors contributing to the success of mobile-related products, services, and apps were examined. The study identified several key factors that play pivotal roles in determining the success of mobile applications: Understanding and addressing these critical variables can significantly contribute to overcoming marketing and sales challenges in the smartphone app development landscape. By emphasizing factors such as ease of access, customer confidence, and usability, developers can create applications that not only meet user needs but also stand out in the competitive market. The findings of studies like the one conducted by (Gutierrez and Xu,2006) provide valuable insights for practitioners seeking effective strategies to navigate the complexities of marketing and sales in the mobile app industry.

The paper also delves into the examination of environmental factors that lie beyond the control of entrepreneurs, posing crucial obstacles to their success. In a comprehensive study, macroeconomic variables, such as bank loan profits, inflation, and potentially various other factors, were identified as influential elements that can either directly or indirectly impact the overall success of entrepreneurs and their projects (Arasti, Zandi, and Talebi, 2012). Furthermore, another study explored the most impactful factors contributing to the success of entrepreneurs in this context. Independence in the country, the availability of fundamental infrastructures and platforms for technology-based product developers, and the absence of teamwork and group activities, as well as a lack of organizational culture, were identified as significant variables (Sadatrasoul et al., 2022; Chitsazan et al., 2017). These findings highlight the complex interplay between external environmental factors and internal organizational dynamics, shedding light on the multifaceted challenges that entrepreneurs face in the pursuit of success. Understanding these factors is instrumental for entrepreneurs and policymakers alike, as it enables the development of strategies that address both external macroeconomic influences and internal organizational aspects to foster a conducive environment for entrepreneurial endeavors.

In a study focused on the mobile entrepreneurship ecosystem in Southern Africa, three primary challenges—Funding, Commercial, and Technical Support—were identified as significant hurdles (Nyamaka, Botha & Biljon, 2018). This underscores the multifaceted nature of challenges faced by entrepreneurs in the region. Another study conducted a comprehensive examination of technical challenges affecting the success of mobile application development. Nine crucial challenges were identified through a literature review, and an additional four challenges were revealed through interviews. These challenges were categorized across three types of mobile applications—native, web, and hybrid—including issues such as fragmentation, testing, reuse of codes, lack of tools support, lack of expertise, compatibility, and security (Ahamd, Feng, Asim & Yousif, 2018). This highlights the diverse and technical nature of obstacles faced in the mobile application development landscape. Additionally, rules, regulations, and legal considerations pose significant obstacles to MAD entrepreneurial activities. A study by Bamshad, (Talebi & Yazdani,2021) emphasized that the lack or inefficiency of precise rules and regulations in new fields in Iran is a major predicament for entrepreneurs. This is exacerbated by the need for multifaceted licenses from various public and government organizations in the MAD ecosystem. Interestingly, this issue is not as prevalent in many developed countries, indicating a unique challenge in emerging markets. Furthermore, (Fartash et al.,2022) extracted five growth challenges specifically for Pioneer Knowledge-based ICT Firms, contributing additional insights into the intricate challenges faced by entrepreneurs in the information and communication technology sector. These collective findings underscore the diverse and complex landscape of challenges in mobile entrepreneurship, spanning financial, technical, regulatory, and growth-related domains. Understanding and addressing these challenges are critical for fostering a supportive environment for mobile application development and entrepreneurship.

Table 1 in the appendix summarizes external and non-technical application development challenges. In the following sections, a list of challenges that have been extracted in literature are presented in **Table 1**. Last four columns of Table 1, represents the four professional experts which have been asked to add and also comment on the necessity or lack of necessity of the challenges in Iran considering that they are extracted from literature studies for the world. It should be emphasized that some challenges have been added by experts, which have not been mentioned in the literature. Considering that this research is exploratory in nature,

and therefore challenges whose existence in Iran was not make sense by experts were removed.

Table 2 in the appendix provides a list of solutions discussed in the literature. In this table, four experts have been asked about the efficiency of the relevant strategy in Iran and add more if they see new solutions by their own ideas and experience. In other words, the evaluation of the challenges and solutions raised in the literature by taking into account the situation in Iran, has been done by four active experts in the industry in **Table 1** and **2**. Finally, the challenges and solutions are mapped using QFD and final results are found.

2.2. Quality function deployment (QFD)

Quality Function Deployment (QFD) was originally formulated by Shigeru Mizuno and Yoji Akao in the 1960s as a quality system designed to efficiently deliver services and goods to customers by attentively addressing their needs and ensuring satisfaction (Vinayak and Kodali, 2013). Traditionally, QFD has been employed to systematically translate customer requirements into technical specifications, essentially mapping needs to features (John et al., 2014). Notably, QFD has found application in the domain of mobile government services, playing a role in mapping these services to citizens' needs (Zheng and Pulli, 2012). In studies focusing on government services, such as the work conducted by Alsaadi et al. (2018), QFD has been utilized to identify citizens' requirements through focus group discussions. These requirements were then categorized into distinct classifications, and technical specifications were developed to effectively map them.

The implementation of QFD serves three primary goals:

1.**Identifying Customer/Citizen/Client Needs and Wants:**
The initial step involves comprehensively understanding and articulating the needs and desires of the customers, citizens, or clients.

2.**Translating Needs into Characteristics and Specific Factors:**
QFD facilitates the translation of identified needs into specific technical characteristics and factors.

3. **Building and Delivering a Quality Product or Service:**
The ultimate objective is to create and provide a high-quality product or service by concentrating on customer, citizen, or client satisfaction.

By adhering to these goals, QFD acts as a robust methodology for ensuring that products and services are aligned with the expectations and requirements of end-users. In the context of mobile application development, QFD proves to be a valuable tool for systematically linking challenges to corresponding solutions and prioritizing them based on their impact on customer satisfaction and overall success.

3. Research Methodology

In this section, a combination of descriptive, exploratory, and quantitative approaches is employed, leveraging Quality Function Deployment (QFD) with the House of Quality (HOQ) matrix as the primary tool. The HOQ matrix is a widely utilized QFD tool in the literature and serves as the main matrix for QFD methodologies (Alsaadi et al., 2018). The general steps of the HOQ method involve capturing the "Whats" (customer requirements) and linking them to the "Hows" (technical requirements) to address these customer needs.

1. **Phase 1: Develop the Set of Customer Needs (What's):**
The initial phase involves identifying and articulating the set of customer needs or requirements.

2. **Phase 2: Measure Customer Importance/Priority:**
Assign priorities to customer needs, gauging their relative importance or significance.

3. **Phase 3: Identify the Technical Requirements (How's):**
Determine the technical requirements necessary to address and fulfill the identified customer needs.

4. Phase 4: Create a Correlation Matrix of the Technical Requirements:
Develop a matrix that correlates the technical requirements, establishing relationships and dependencies.

5. **Phase 5: Create a Relationship Matrix Between Customer Requirements and Technical Requirements:**
Construct a matrix that illustrates the relationships between customer requirements and the identified technical requirements.

6. **Phase 6: Perform Competitive Benchmarking:**
Evaluate and compare the performance of the identified technical requirements against those of competitors in the industry.

7. Phase 7: Prioritize the Technical Requirements:

Prioritize the technical requirements based on their correlation with customer needs and competitive benchmarking.

8. Phase 8: Determine Which Technical Requirement to Deploy:
Make informed decisions on which technical requirements to prioritize and deploy, ensuring alignment with customer priorities and industry benchmarks.

Furthermore, the methodology of this study benefits from the design of 5 questionnaires aimed at enhancing its argumentative power and credibility, which are respectively:

1. **Phase** 2: Closed-ended format interview questionnaire;

Phase 3 Two distinct questionnaires for Delphi method:

"Challenges Questionnaire" comprising 37 factors;

2. "Solutions Questionnaire" comprising 24 factors;

3. **Phase** 4 Pairwise comparison between the identified challenges and solutions questionnaire;

4. **Phase** 5 AHP solution addresses the challenges questionnaire.

By applying the HOQ matrix and systematically progressing through these steps, the research methodology aims to establish a robust framework for linking and prioritizing challenges and solutions in the context of mobile application development in Iran. This approach ensures a comprehensive understanding of customer needs and facilitates the identification of tailored technical requirements to address these needs effectively.

3.1. Appling QFD to MAD sector in IRAN

This section customizes and details the eight HOQ steps followed:

Phase-1: **Obtain challenges and solutions Through Systematic Literature Review (SLR)**

The Systematic Literature Review (SLR) is a rigorous process designed to systematically identify, select, and critically appraise relevant research (Dewey, A. & Drahota, A. 2016). This study uses this method on challenges and solutions in Mobile Application Development (MAD) before the review is conducted. It entails devising a meticulously planned search strategy with a clear focus or in response to the defined question: "What are the main challenges and solutions in Mobile Application Development (MAD)".

Therefore, Suitable search terms are selected in order to ensure no appropriate article is missed. The search terms used are a variety of combinations of below mentioned words, which are almost equivalent, were searched. In fact, 3 by 5 by 3 (total 45) different search scenarios were explored: (Mobile Application Development = Application Development, Mobile apps development); (Challenges = problems, issues, limitations, obstacles); (Solutions = action, initiative). Boolean operators are used to combine major search terms. Exclusion criteria are articles before 2005 and articles which investigate the technical challenges of MAD. Then the abstract of the articles are read. Those removed articles are which they are entirely irrelevant from their abstract. Finally, a selection from the initially selected shortlist of papers, the decision is made upon reading the entire articles and selecting the ones that meet the selection criteria.

Phase-2: Data Collection and Finalization and Completion
Improvement Via Semi Structured Interviews

Semi-structured interviews with Mobile Application Development (MAD) experts play a crucial role in gathering insights, validating challenges, and extracting additional information. Semi-structured interviews with experts are held for two primary purposes at this stage. First, these challenges and obstacles of development in the industry are discussed from their perspective, and then the appropriate challenges are confirmed through further studies. Closed-ended format interview questionnaire is used to extract additional challenges/solutions as a data collection tool for gathering data from MAD market/economy experts. Carefully a panel of 18 MAD experts representing diverse roles within the industry is selected. This includes participants from the IRAN Ministry of ICT, the IRAN Vice Presidency for Technology and Knowledge-Based Firms, as well as business development managers and CEOs in the MAD sector. Based on their availability four of them are interviewed scheduled 30–60 minutes.

Phase-3: Combination of the SLR and the Interview Results Using Delphi Method

The Delphi process, incorporating insights from new high professional experts along with challenges and solutions from Systematic Literature Review (SLR) and interviews, is employed to iteratively refine the understanding of challenges and solutions in Mobile

Application Development (MAD). Delphi process with the involvement of new high professional experts is initiated. Given pragmatic considerations such as time, access, and expenses, a panel of four experts is chosen. This decision aims for a balance between empirical viability and the richness of expert insights. Two distinct questionnaires are developed, for the first initial iteration of the Delphi process. These questionnaires are crafted to elicit expert opinions and ratings on the identified challenges and solutions in MAD. Then the experts are asked to rate the importance of factors using a Likert scale ranging from one to five. This rating system enables a nuanced evaluation of factors, with a focus on their significance in the context of MAD. Conducting several iterations of the Delphi process, experts are allowed to provide feedback, reassess factors, and refine their opinions. The iterative nature of this approach facilitates consensus-building and refines the understanding of critical factors in MAD. A threshold for factor selection, considering factors with a rating score of more than three as significant is set. This criterion ensures the identification and prioritization of factors that attain a collective consensus of importance from the expert panel. Justifying the decision about the panel size as empirical and pragmatic aligns with the constraints of time, access, and expenses. The selection of four highly professional experts reflects a balance between resource limitations and the need for diverse expertise. By employing the Delphi process with an empirical decision on panel size and iterative refinement, this methodological approach ensures a systematic and consensus-driven exploration of challenges and solutions in the dynamic field of Mobile Application Development.

Phase-4: Establishing pairwise Comparison of Challenges Using Correlation Matrix

In this phase, a Likert scale ranging from 1 ('Strongly Disagree') to 9 ('Strongly Agree') is employed to assess and rank each Challenge/Solution. This process involves administering a questionnaire to individuals closely associated with the Mobile Application Development (MAD) industry. The primary objectives are to gauge the perceived importance of challenges and the potential efficacy of solutions in addressing each challenge. Then averaging and then normalization is done one the results. Due to the lack of sufficient space, the relevant table could not be presented in the article.

Phase-5: Establishing Pairwise Comparison of Solutions Using Correlation Matrix of AHP Method and Extracting the Solution/Challenge Influence

To gauge the effectiveness of each solution in addressing specific challenges within Mobile Application Development (MAD), the Analytic Hierarchy Process (AHP) is employed. The AHP correlation matrix, utilizing a Likert scale of nine, facilitates a comprehensive evaluation. A Likert scale ranging from one to nine for the evaluation process is employed. This scale allows for a nuanced and detailed assessment of the extent to which each solution addresses specific challenges. Experts assign scores on the Likert scale based on their judgment and experience. Scores provided by experts for each solution is aggregated, then averaging the Likert scale ratings is done. Averaging helps in obtaining a representative and consolidated measure of the perceived effectiveness of each solution. Normalization of the averaged scores for variations in individual expert scoring tendencies, bring scores to a common scale for meaningful comparisons. Then the correlation matrix to quantitatively assess the impact of each solution on specific challenges is utilized. The matrix serves as a valuable tool for decision-makers to prioritize solutions based on their efficacy in addressing critical challenges.

Phase-6: Creating Pairwise Comparison of Solutions

During this stage of the methodology, the focus is on conducting pairwise comparisons among proposed solutions within the Mobile Application Development (MAD) context. The objective is to elucidate the extent to which these solutions can interact with each other post-implementation. This comparative analysis provides insights into the potential synergies or conflicts that may arise when multiple solutions are concurrently employed. Respondents are tasked with selecting scores from the range of (-1, 0, +1), each indicative of a specific relationship between two solutions:

- **+1: Alignment and Positive Impact**

Represents an alignment relationship where the two provided solutions exhibit a positive impact on each other. This suggests that implementing both solutions simultaneously results in a mutually beneficial outcome.

- **0: Irrelevancy and Unaffected Solutions**

Indicates that the two solutions are irrelevant to each other, and implementing one does not affect the other. There is no discernible positive or negative impact when these solutions are conducted simultaneously.

- **-1: Inverse Relationship and Potential Negative Impact**

This signifies an inverse relationship where conducting two strategies simultaneously may lead to a potential negative impact. This highlights the importance of considering potential conflicts or counterproductive outcomes when implementing certain combinations of solutions.

The pairwise comparison exercise provides a nuanced understanding of the interplay between solutions, enabling stakeholders to make informed decisions about the strategic deployment of multiple solutions within the MAD ecosystem. The resulting scores contribute to a comprehensive view of how different solutions may complement or conflict with each other, guiding decision-makers in optimizing their approach to address challenges effectively. This stage serves as a crucial step in enhancing the strategic planning and coordination of solutions for sustained positive outcomes in MAD.

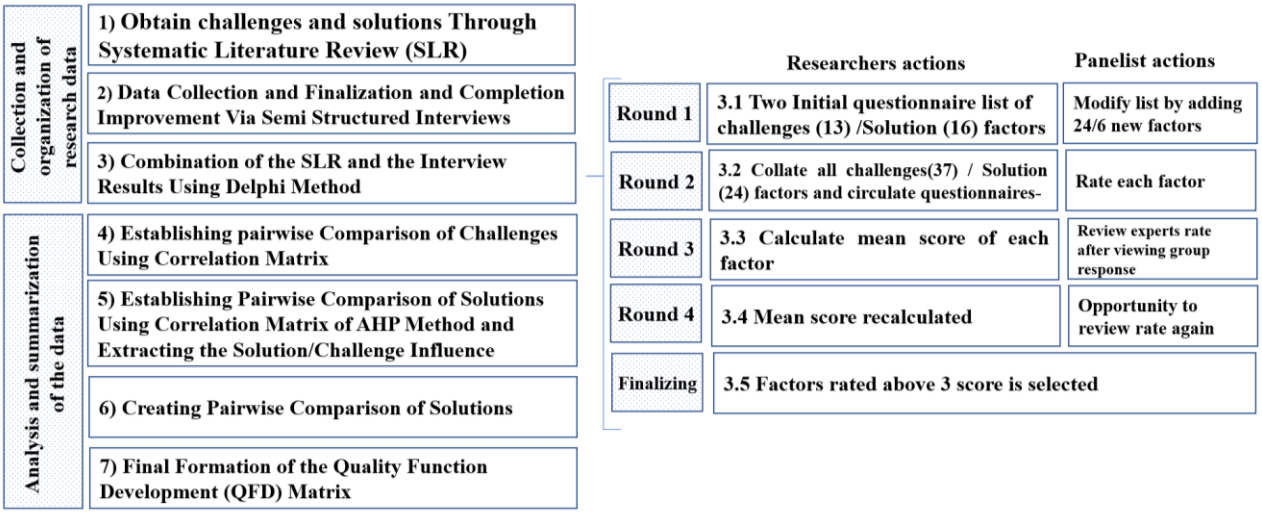


Fig 1. The Different Phases of Conducting a Research

Phase-7: Final Formation of the Quality Function Development (QFD) Matrix

After the normalization process and establishing relationships between solutions and challenges, the next step involves matrix multiplication. This involves multiplying the normalized matrix by the challenge matrix. The outcome of this multiplication provides a precise ranking and prioritization of solutions. From this result, the priority solutions are extracted.

4 . Research Results & Discussion

The outcomes of the implementation of the seven phases, as detailed in the previous section, are summarized in this segment.

Phase-1: which was comprehensively addressed in the research background section, focusing on Mobile Application Development (MAD) as an official entrepreneurial activity, has yielded a consolidated list of challenges and solutions. The following challenges and corresponding solutions are proposed, approved by experts, and aligned with the comprehensive tables 1 & 2 provided from the background and extracted from the experts can be found in the paper's appendices.

1. The absence of government financing and support (the development of useful and effective financing programs in the form of facilities, grants, and investments for this particular sector);
2. The absence of financial incentives and bonuses from the government (the lack of helpful financial incentives, including taxes, export bonuses, etc.)
3. The absence of collateral (which is often due to their individuality or micro-enterprise nature, they do not have sufficient collateral to use the current support provided);
4. Deficiency in raising capital;
5. The absence of venture capitalists;
6. Significantly high interest rates of bank facilities;
7. Sales & marketing issues;
8. The lack of proper knowledge of the current market (the lack of effective market research reports, etc.);
9. Inappropriate selection of target markets;
10. The absence of transparent and proper rules & regulations (particularly in-app store, applications, etc.);
11. The absence of a proper grading system and the lack of official registration of innovative ideas and copyrights;

12. Non-skilled labor and the absence of sufficient workforce;
13. The lack of experience in developing success tales in the industry;

The proposed solutions derived from the research background segment are further elaborated upon in the following section. It's important to note that these solutions are also documented in **Table 2** in appendix 2, providing a comprehensive reference for readers. Each solution is detailed to provide a clearer understanding of the recommended approaches to address challenges in Mobile Application Development (MAD).

1. Intellectual policymaking in terms of government fundings;
2. Intellectual policymaking by the government in the form of financial bonuses and taxes;
3. Entering and captivating venture capitalists;
4. Independency and internal financing (using the ownership capital for work advancements;
5. Acquiring capital earning skills;
6. The development of facility packages appropriate to the cash flow of field operators by banks (the design of proper interest rates and repayment schedules commensurate with the revenue stream of the developers);
7. Financial government support for high-risk venture capitalists;
8. Lowering the interest rates and establishing equitable interest rates by banks;
9. The establishment of a market recognition system prior to entering product design and development;
10. The development of appropriate copyright laws to protect innovative ideas;
11. Adjustment and adaptation of the current rules & regulations of the system;
12. The development of a mechanism for creating, training, and maintaining specialized workforce and personnel;
13. Acquiring sufficient managerial and entrepreneurial skills before the launch;
14. The attempt to create a networking system as well as a team spirit amongst the staff members and activists in the industry;
15. The documentation and organization of the past activities conducted in the field of entrepreneurship and the obtainment of experience from previous successful and failed projects in terms of counseling;
16. The re-establishment of macroeconomic indicators (such as inflation, exchange rate, interest rates on bank deposits, etc.);

Phase-2: To ensure the robustness of the identified challenges and solutions from the initial phase, the outcomes were presented to a panel of four expert interviewees. These experts, possessing both academic and managerial backgrounds, were selected based on their extensive experience in relevant fields:

- **Expert No1**: Over 10 years in the venture capital industry;
- **Expert No2**:15-year experience in the field of IT and Knowledge management;
- **Expert No3**: 15-year experience in the field of IT and Mobile applications;
- **Expert No4**: 12 Years of professional activity in IT industry.

In order to identify challenges and solutions, interviews with experts have been continued until we reach convergence in the answers.

Additionally, the conducted extraction and coding procedures in the interview resulted in newly identified challenges for MAD, which will be further described on the following page:

1. The perspective of maximum potential return on capital in the country and the current parallel markets such as gold, stock exchanges, and many more, in which investments develop significantly higher returns in a short time;
2. High return on capital expectancy in a short period, in addition to high liquidity in such a way that if another suitable investment opportunity is presented, the capital will be directed towards that investment by the investors;
3. Traditional and classical investments in the current well-known industries and the lack of risk-taking to invest in new fields;
4. The limited size of digital domestic markets as well as Persian-speaking market in the entire world (which is approximately estimated at 200 million users), in addition to the absence of reputable digital content publishers with sufficient knowledge on the market and a history of international marketing of digital content and sales of such products;
5. The absence of recognition of most developers of the field such as private individuals, in support programs provided by government agencies, including the Ministry of Information & Communication Technology, the Ministry of Islamic Guidance and Culture, in addition to the Innovation & Prosperity Fund and the National Development Fund and more;
6. The absence of proper laws to protect the rights of the developers and the unbalanced entry of

application distribution network firms, which may potentially target the markets for smartphone app stores (for example Miket, Bazaar Café, etc.), as well as mobile and virtual operators, value-added service companies, in addition to also having a significant impact on both reduction in profit margins as well as the overall motivation of developers to continue their operation in this industry;

7. The collection of excessive taxation from content-based product exporters in the country in case of complete formality and transparent activities;
8. The absence of digital borders and the inability to collect income tax and value-added tax from foreign developers and opportunistic integration of distribution networks with foreign developers;
9. Sanction-related issues, which potentially include the absence of resource obtainment in terms of either currency or branding in the digital space of external mobile apps, including Google App & App Store, in addition to providing open-source software to the publishers;
10. The possibility of a recession;
11. The lack of online payment culture in society for using applications, particularly content-based apps that are used amongst the members of the community;
12. Lack of communications and specialized events such as teamwork events that can significantly aid in the transfer and exchange of experiences, etc.;
13. The absence of proper pricing rules & regulations;
14. The absence of proper knowledge in management on experiences and achievements of activists in Iran and the rest of the world;
15. The lack of creative and innovative individuals of primary products in the following stages;
16. Excessive recognition of the technological layer and neglect in the business part;
17. The process of coding and extraction of the results of interviews has also led to the addition of the following potential solutions for the mobile app industry;
18. The establishment of capital injection and professionalize investors, to create a portfolio of various investments;
19. Financing through crowds based on the type of products available in the industry;
20. Entering more optimal and extensive markets by increasing the overall knowledge and awareness on the targeted markets;
21. The authorization of publishers and directing them to detect crucial and significant exporting target markets;
22. Recognition of individuals and micro-enterprises that produce apps in government and public sector programs;
23. The development of digital rules & regulations to collect revenue and value-added tax from smartphone app developers and their publishers;
24. Assembling specialized events constantly by entrusting them to an expert on teamwork, etc.;

Phase-3: The Delphi process initiated with the administration of two distinct questionnaires: the "Challenges Questionnaire" comprising 37 factors and the "Solutions Questionnaire" comprising 24 factors. The participating experts were tasked with reviewing and rating these factors. The mean scores were then calculated, and experts were given the opportunity to review and rate new factors that emerged during this process. An iterative approach was adopted, with mean scores recalculated after each round of expert input. Experts had multiple opportunities to reassess and provide further ratings. The process continued until a final set of factors was identified based on predefined criteria. Finally, the factors' mean scores are calculated and the ones which have the score above 3 are selected. At the end 15 challenges and 15 solutions are selected. Due to the divergent perspectives of experts, their consensus required 4 stages in the Delphi process in order to converge. The W value in Kendall's test or Kendall's W equal to 0.67 indicates a relatively strong agreement between the ratings given by experts. The value of 0.67 indicates that the level of agreement between the judges is generally high, but there are some significant differences in the ratings. This value indicates that the experts agree to a large extent on the evaluation of the items, but this agreement is not absolute and there are still differences of opinion.

Phase-4: In this stage of the article, a supplementary questionnaire was administered to facilitate a comprehensive comparison between the identified challenges and solutions. The insights gathered from twenty staff members and activists in the field of Mobile Application Development (MAD) across different age groups, genders, occupations, ethnicities, geographical locations, and income levels in order to lend greater credibility to the research findings are selected. They are questioned crucial in evaluating the perceived importance and effectiveness of each factor. Next, the process of averaging and normalization are also implemented, after the collection of data is complete, resulting in a 15*20-dimension (factors*experts) matrix. **Table 3** shows the final results which are extracted by weighted averaging of the aforementioned matrix. The table encapsulates the

weighted average scores for each challenge and solution, providing a synthesized perspective on their perceived importance and effectiveness. This comparison contributes to a nuanced understanding of the factors, offering insights into their relative significance as perceived by industry stakeholders.

Table 3. The Complete & Comprehensive Table of Pairwise Comparisons

No	Challenge Name	Normal weight	Questionnaire sequence number
1	Lack of government financial support	0.0755	7
2	Lack of knowledge management implementation	0.0708	14
3	Weak managerial skills	0.0702	6
4	Uneconomical plans	0.0681	5
5	Lack of competitive market	0.0678	4
6	Weaknesses in capital raising skills	0.0675	3
7	Lack of risky investors and lack of support for them	0.0669	9
8	Lack of comprehensive team building events in the field of content	0.0666	13
9	Lack of clear rules and regulations	0.0661	11
10	No collateral	0.0654	1
11	Lack of proper knowledge of the market	0.0649	15
12	Not so big domestic markets and Persian language markets	0.0644	2
13	High bank rates	0.0632	10
14	Lack of government financial incentives	0.0628	8
15	Problems of sanctions for entering the foreign market and payment sphere	0.0599	12

Phase-5: In this stage of the study, the Analytic Hierarchy Process (AHP) correlation matrix was employed to assess the extent to which each solution addresses the identified challenges. The Likert scale ranging from 1 to 9 was utilized for this purpose, and the results were subjected to averaging and normalization. Considering that the numbers of the AHP questionnaire scale are between 1 and 9 and this part of the QFD matrix has three states (high influence, normal influence, and no influence), it was decided that in the final HOQ, the numbers between 0 and 3 as the lower limit, the numbers between 3 and 6 as the middle limit and numbers between 6 and 9 as the upper limit of the QFD matrix.
Also, table (4) provides valuable information on the precise impact of each challenge and its appointed solutions, to help determine the capability of the solution against challenges; besides, all the interviewees are also asked to purposefully fill in the required cells in the table using this method. Additionally, the pairwise comparison approach is once again implemented in Table 4, which functions as an abstracted version of the results.

Phase-6: In this phase of the study, an essential table was crafted to unravel the relationships among solutions. Participants, including experts and respondents, were solicited to assign a grade between (-1, 0 & +1) based on their perceived interactions between different solutions. The culmination of these responses was averaged, and a triple interval between (-1 & +1) was established to denote the relationships. Furthermore, the conclusion is formed by calculating the average of the obtained responses and conducting a triple interval between (-1 & +1), as summarized and shown in the following Table 5. Additionally, the Inconsistency Ratio is also calculated to be 0.06, which is lower than 0.1 and can potentially indicate a slight incompatibility amongst the implemented comparisons

Table 4. The Prioritization of the proposed solution

No	Solution name	Normal weight	Questionnaire sequence number
1	Creating a knowledge management system	0.079258	12
2	Government support for venture capitalists	0.074518	4
3	Develop the necessary rules and regulations to register ideas	0.073616	8
4	Develop appropriate laws and regulations and amend laws	0.072311	5
5	Acquire the necessary managerial and entrepreneurial skills	0.072306	6
6	Acquire the necessary skills in raising capital	0.071215	11
7	Reducing interest rates on loans by banks	0.070077	9
8	Detailed knowledge of the market before entering	0.069380	10
9	Internal financing	0.068877	7
10	Perform feasibility studies before starting work	0.063858	14
11	Entry of venture capitalists	0.062758	1
12	Government protection policies	0.062488	2
13	Government financial incentive policies	0.059367	3
14	Reform of the prevailing climate (economic, sanctions)	0.051085	15
15	Moving towards team building in the field of content	0.048888	13

Table 5. The correlation matrix of Solutions

The Relationship Amongst Solutions	Entry of venture capitalists	Government protection policies	Government financial incentive policies	Government support for venture capitalists	Develop appropriate laws and regulations and amend laws	Acquire the necessary managerial and entrepreneurial skills	Internal financing (owner capital)	Develop the necessary rules and regulations to register ideas	Reducing interest rates on loans by banks	Detailed knowledge of the market before entering	Acquire the necessary skills in raising capital	Creating a knowledge management system	Moving towards team building in the field of content	Perform feasibility studies before starting work	Reform of the prevailing climate (economic, sanctions)
Entry of venture capitalists	۱														
Government protection policies	۱	۱													
Government financial incentive policies	۱	۱	۱												
Government support for venture capitalists	۰	۰	۰	۰											
Develop appropriate laws and regulations and amend laws	۰	۰	۰	۰	۱										
Acquire the necessary managerial and entrepreneurial skills	-۱	-۱	-۱	-۱	۰	۱									
Internal financing (owner capital)	۰	۰	۰	۰	۱	۰	۰								
Develop the necessary rules and regulations to register ideas	۰	۰	۰	۱	۰	۰	۰	۰							
Reducing interest rates on loans by banks	۰	۰	۰	۰	۱	۰	۰	۰	۰						
Detailed knowledge of the market before entering	۱	۰	۰	۱	۰	۱	۰	۰	۰	۰					
Acquire the necessary skills in raising capital	۰	۰	۰	۰	۰	۱	۰	۱	۰	۰	۱				
Creating a knowledge management system	۰	۰	۰	۰	۰	۱	۰	۰	۰	۰	۰	۱			
Moving towards team building in the field of content	۰	۰	۰	۰	۰	۱	۰	۰	۰	۱	۰	۱	۰		
Perform feasibility studies before starting work	۱	۰	۰	۰	۱	۰	۰	۰	۰	۰	۰	۰	۰	۰	
Reform of the prevailing climate (economic, sanctions)															

Phase-7: Quality Function Deployment (QFD) Matrix Analysis is used to achieve synergy. In this pivotal step, the culmination of calculations and analyses from preceding phases manifests in the establishment of the Quality Function Deployment (QFD) matrix, as showcased in Table 6. This matrix serves as a comprehensive representation of the research achievements, encapsulating the intricate relationships among challenges and proposed solutions.

Key Elements:

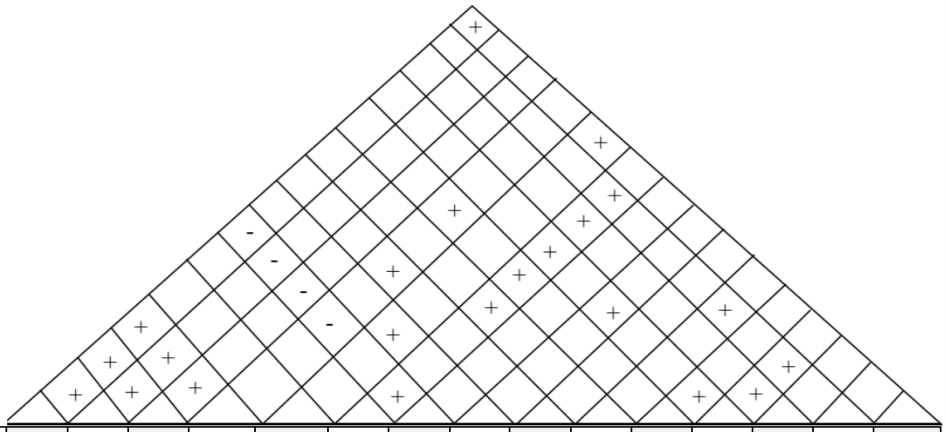
- **Challenges and Weights:** The left column of the middle matrix delineates the identified challenges, each accompanied by its respective weight. This weight signifies the significance of each challenge in the overall MAD ecosystem.
- **Solutions and Weights:** The upper row of the middle matrix presents the proposed solutions; each assigned an importance weight. These weights reflect the perceived efficacy and relevance of each solution in addressing challenges.
- **Triangular Matrix:** Positioned at the top, this matrix outlines the proposed solutions and their overlap weights. It sheds light on the potential

interchangeability of solutions, showcasing the dynamic relationships among them.

- **Central Matrix:** At the core of the QFD matrix, this section denotes the effectiveness of implementing solutions in tackling one or more challenges. The anticipation is that the application of specific solutions will lead to the mitigation of related challenges, fostering a holistic improvement in the MAD ecosystem.

This QFD matrix is a valuable tool for strategizing and implementing targeted interventions, ensuring a harmonized approach to fortify the Mobile Application Development sector in the face of diverse challenges.

Table 6. The Finalized Matrix of the Research & Quality Function Deployment (QFD) Describing the Relationships Between Solutions & Challenges



QFD	Weight of challenges	Entry of venture capitalists	Government protection policies	Government financial incentive policies	Government support for venture capitalists	Develop appropriate laws and regulations and amend laws	Acquire the necessary managerial and entrepreneurial skills	Internal financing (owner capital)	Develop the necessary rules and regulations to register ideas	Reducing interest rates on loans by banks	Detailed knowledge of the market before entering	Acquire the necessary skills in raising capital	Creating a knowledge management system	Moving towards team building in the field of content	Perform feasibility studies before starting work	Reform of the prevailing climate (economic, sanctions)
No collateral	0.0654	9	9	9	9	3	3	9	3	9	3	9	3	1	3	3
Not so big domestic markets and Persian language market	0.0644	1	3	3	3	1	1	3	3	3	9	3	3	1	3	1
Weaknesses in capital raising skills	0.0675	3	9	9	9	3	9	9	3	9	3	9	3	1	3	3
Lack of competitive market	0.0678	1	3	3	3	9	3	3	9	3	9	1	3	3	3	3
Uneconomical plans	0.0681	3	1	1	3	1	9	3	3	3	3	3	9	9	9	1
Weak managerial skills	0.0702	3	1	1	3	3	9	3	3	3	3	9	3	3	3	1
Lack of government financial support	0.0755	3	9	9	9	3	3	3	3	9	3	9	3	1	1	1
Lack of	0.0628	3	9	9	9	3	3	3	3	9	3	9	3	1	1	1

government financial incentives																
Lack of risky investors and lack of support for them	0.0669	9	9	9	9	9	9	9	9	9	3	9	3	1	9	9
High bank rates	0.0632	3	3	3	3	3	3	9	3	9	3	3	3	1	3	3
Lack of clear rules and regulations	0.0661	1	1	1	3	9	1	3	9	1	3	3	3	1	3	3
Problems of sanctions for entering the foreign market and payment sphere	0.0599	1	1	1	1	3	3	3	1	1	3	3	3	1	1	3
Lack of comprehensive team building events in the field of content	0.0666	1	1	1	1	1	3	1	1	1	1	1	3	9	1	1
Lack of knowledge management implementation	0.0708	3	1	1	3	3	9	1	3	1	3	1	9	3	3	1
Lack of proper knowledge of the market	0.0649	3	1	1	3	9	3	1	3	1	9	3	9	1	9	1
Weight of solutions		0.06276	0.06249	0.05937	0.074178	0.0723108	0.07231	0.06888	0.07362	0.07008	0.06938	0.07121	0.07926	0.04889	0.06386	0.051085

Discussion, Evaluations, and Results: Navigating the Landscape of Mobile Application Development (MAD) Challenges and Solutions

In this comprehensive article, the landscape of non-technical challenges and solutions within Mobile Application Development (MAD) is meticulously explored. The findings provide valuable insights into key sectors where real-world experts and regulators can channel their efforts for substantial enhancements in the efficiency and success of MAD. The discussion revolves around addressing the research questions posed throughout the study:

• RQ1) Most important challenges and solutions.

The identification of challenges and solutions brings to light five paramount challenges: "The lack of proper management knowledge on the achievements and experiences of other activists in the industry", "the absence of sufficient financial support from the government", "deficiency in management skills", "inefficient projects due to various factors" and "the lack of a competitive market". On the other hand, the best performing solutions and strategies include: "government support for venture capitalists", "the establishment of a proper knowledge management mechanism", "generating the required rules & regulations to protect innovative ideas", "the construction of various programs for managerial and entrepreneurial skills acquirement", and "the adjustment of the current rules & regulations".

• RQ2) Major challenges can be meaningfully separated from lesser important challenges and focused more.

The examination of the weight importance of challenges, as illustrated in Table 3, reveals a nuanced landscape where the weights are closely aligned. This close proximity among the weights signifies that challenges cannot be easily separated into two distinct groups of more and less important challenges. The intricate interplay and interconnectedness of these challenges underscore the complexity of the Mobile Application Development (MAD) ecosystem, emphasizing the need for a comprehensive and holistic approach to address the array of challenges it presents.

• RQ3) By focusing on a specific and limited number of effective solutions, it becomes feasible to exert influence over a substantial array of important challenges.

Among the 15 solutions outlined, the top seven solutions, characterized by weights exceeding 0.07, emerge as pivotal. These solutions are strategically significant, offering pathways to meaningfully address and alleviate a range of challenges within the Mobile Application Development (MAD) ecosystem. This targeted approach emphasizes the potential for concentrated efforts to yield impactful outcomes across various facets of the MAD landscape.

RQ4) There are transformational solutions, from which implementation of them can create in solving several challenges.

There are not one nor few solutions in which they can solve the several challenges in a transformative manner.

• RQ5) Balance must be observed to solve challenges and it is not necessarily possible to create great growth capabilities by solving some challenges in just one dimension.

Analyzing the problems and the solutions shows that a balance is needed in order to enhance the IRAN MAD ecosystem.

• RQ6) There is a sequence to run the solutions or they can be done in parallel and with a spiral and evolutionary method.

Analyzing the solutions shows that most of the solutions can be run in parallel and therefore a major improvement in IRANs MAD ecosystem can take place in the years ahead.

5 – Conclusion

Current research contributes to the field of MAD stockholders and government organizations and administers with a comprehensive view of challenges and implementation solutions in real-world. It also contributes with an analysis framework that can be used to derive such insights in other cases. It can also contribute to be used as a basis for formulating effective policies in the field of MAD. The aim of this research was to identify challenges as well as appropriate solutions for MAD in Iran. Towards this aim, QFD is used as a matchmaking framework and the challenges and solutions of the MAD sector were identified with proper data gathering from previous papers, research, websites, news, and finally experts.

The research proposed an integrated framework, which takes a broad perspective on extracting challenges and solutions, integrates Financing, Market, Rules & Regulations, Environmental, Technical & Production and Internal elements and explicitly considers the need for alignment between these elements. Using the framework to analyze Iran MAD, we identified 15 challenges and 15 solutions

Additionally, in regard to the relationships amongst the proposed solutions, it is concluded that the implementation of the solutions, including government financing policies, government incentive policies, obtaining the required skills, the removal of obstacles such as sanctions, and the entry of venture capitalists all can potentially be significantly beneficial for the growth of the industry. Moreover, research showed that some challenges and solutions are interrelated across the different alignment types. This implies that, when proposing implementation of a solution to a specific challenge, it is important to also assess its effects on other parts.

5.1 Theoretical Contributions

The paper adds value to the QFD literature and provides new insight into government development plans which need challenge recognition and ranking and solution extraction and ordering their implementation importance. QFDs engineering approach is applied to translate the MAD industries activist as a voice of citizens to the government solution implementation. SLR is used to extract the challenges in the global and local MADs and the proper solutions are designed after ranking the challenges.

5.2 Practical Contributions

The QFD-AHP-Delphi method provides an effective approach for government authorities, other decision-makers, and MAD activist to recognize which factors require more attention and develop a plan to result in the highest possible MAD activist's satisfaction. In fact, the paper offers an understanding of citizens' perceptions of solutions to the challenges.

5.3 Limitations of the Study and Directions for Future Research

Understanding the limitations of this study is very important. The questionnaire respondents and challenge extraction convergence were one of the limitations of the research as there are different activists in the industry including individual developers which works for themselves or as freelancers, development teams which work together and have and probably will not register a company, small and midsized development companies and finally the digital publishers and local android markets. Expert panelists are also of challenge as the more interviewees the more efficient the results are. Future works could be done on specific sectors of the MAD market using new extensions of QFD including QFD and goal programming (GP), QFD and expert systems, fuzzy QFD, QFD under uncertainty, and dynamic QFD. Solutions projects and their implementation execution sequence could be a good topic for future research and considerations. Also, Technical benchmarking with countries like India, China, and Poland which are Top Countries for Offshore MAD could be done in future studies.

Appendices
Appendix (1)

Table 1. Challenges from Investigated Articles and The Outcome of The Interviewees and Their Opinions on Challenges are shown by stars (*)

Categories	Challenges	Reviewed Articles															Interviewees			
		Motevasseli	Bitab	Chit Sazan	Amiri	Karimi	Arasti	Arasti	Bargar	Rob	Schulten	Boot	Mayer	Davila	Dimo	Alexi	1st Expert	2nd Expert	3rd Expert	4th Expert
Financing	Lack of government financial support (development of effective financing programs in terms of facilities, grants & investments).		*		*	*												*		
	Lack of government financial bonuses (lack of effective financial incentives, including taxes, exported bonuses, etc.).		*		*	*												*		
	The lack of collateral (not having the required collateral to use the current insurances, due to their individuality or completion by micro-enterprises).	*				*		*	*				*					*		*
	Deficiency in capital raising skills.					*			*			*							*	*
	The lack of venture capitalists and mechanisms for sufficient support.									*	*				*		*			
	Significantly high interest rates on bank facilities.						*			*	*									
	Maximum return on capital in-country and the current parallel markets such as gold, stock exchange, etc., which can potentially create higher returns as well as fluctuations and more.																*		*	
	High return expectancy in a short period and, in addition to enhanced liquidity in such a way that if another suitable investment opportunity was provided, the investor's capital will be directed towards that path.																	*		
	Using classical & traditional methods of investment instead of taking risks and investing in new and undetermined fields and areas.																	*		*
Market	Sales & Marketing issues.						*													
	The lack of a competitive market.	*	*		*	*	*													
	Inefficiency in the current size of the domestic market and the Persian-speaking markets (which is estimated at approximately less than 200 million users in the entire world).	*	*		*		*										*			
	Inappropriate target market selection (improper targeting, improper selection, etc.)																	*	*	
	The lack of sufficient knowledge for targeting the right markets																	*	*	*
	The lack of authentic and powerful digital publishers with sufficient knowledge on domestics and international needs as well as the premium cost of access to reputable foreign publishers for apps distribution.																*			

Categories	Challenges	Reviewed Articles															Interviewees			
		Motevasseli	Bitab	Chit Sazan	Amiri	Karimi	Arasti	Arasti	Bargar	Rob	Schulten	Boot	Mayer	Davila	Dimo	Alexi	1st Expert	2nd Expert	3rd Expert	4th Expert
Rules & Regulations	The lack of transparency and proper rules & regulations (for digital stores, applications, etc.)		*					*										*	*	
	The lack of a proper grading system, in addition to the absence of an official registration system for new ideas and copyright laws.		*															*		
	The absence of recognition of many app developers including private intellectual individuals in support programs provided by government agencies, such as the Ministry of Information, Technology & Communications, the Ministry of Islamic Culture & Guidance, the innovation and prosperity fund, the National Development Fund, etc.																*			
	The lack of proper laws to protect the interest of the developers and the unjust entry of application distribution network companies at times, which potentially include markets for mobile app stores (such as Bazaar Café, Miket, etc.), in addition to mobile operators, virtual smartphone operators and value-added service enterprises and a considerable reduction in profit margins and motivational level of developers to their continuous operation in this field.																*			
	The income tax collection, value-added, and many more are the potential variables that can directly impact the exporters of domestic applications by the country of exported destination as well as the country of origin of production (Iran).																*			
	The lack of proper supervision on the import of mobile apps and non-collection of income and value-added tax from the importers of such applications.																*			
Environmental	Inadequate macroeconomic environment (macroeconomic indicators include inflation, exchange rate, interests on bank deposits and, etc.)						*													
	Sanction-related issues that can potentially affect the obtainment of currency and branding in the space of stores from foreign smartphone applications and resources, including Google Play, App Store, in addition to also providing open-source apps to the publisher.																*	*	*	*
	The lack of payment culture and mistrust for using apps, particularly content-based applications that are commonly used by the members of communities.																			*

Categories	Challenges	Reviewed Articles															Interviewees			
		Motevasseli	Bitab	Chit Sazan	Amiri	Karimi	Arasti	Arasti	Bargar	Rob	Schulten	Boot	Mayer	Davila	Dimo	Alexi	1st Expert	2nd Expert	3rd Expert	4th Expert
Technical & Production	Non-skilled labor and lack of sufficient workforce that is required.																		*	
	The lack of specialized events in the industry, including team building events, in addition to the transfer and exchange of experiences and more.							*									*		*	*
	The lack of a proper system of knowledge management and sharing experiences and various achievements in this industry with the other activists from Iran and the rest of the world.						*											*	*	*
	Non-economic nature of the implemented projects (due to improper project management, in addition to the lack of using new production methods, etc.)	*						*				*		*				*	*	
	Inappropriate evaluation of projects.																			*
	The lack of proper pricing rules & regulations.																	*		*
	The absence of innovative individuals with ideas in the next stage and the conduct and implementation of the projects.																		*	
Internal	Internal deficiency of managerial skills.		*	*	*		*									*				
	The lack of teamwork culture.			*																
	The lack of experience in launching different types of apps or projects.						*									*				
	Excessive attention to the technological layer and neglect of the business part.																		*	

Appendix (2)

Table 2. Summary of Solutions investigated by reviewed articles and experts' opinions

Categories	Solutions	Articles										Experts			
		Bitab	Bunj Shafiyi	Amiri	Rob	Burger	Walker	Mayer	Dimo	Lich	Alexi	1st Expert	2nd Expert	3rd Expert	4th Expert
Financing	A change of perspective in both capital and budget management.													*	
	Government economic policies and financing.	*	*	*								*	*		*
	Government financial incentive policies.	*	*	*								*	*		*
	Economic outscoring.												*		
	The entry of venture capitalists.		*	*					*	*	*		*		*
	Internal financing (which often requires the use of the owner's capital).				*	*							*	*	
	Acquiring sufficient capital raising skills.													*	
	Acquiring bank loans.						*	*							
	The government support for venture capitalists.								*	*	*		*		*
	Lowering interest rates on bank loans for such projects.						*	*					*		

Categories	Solutions	Articles										Experts			
		Bitab	Bunj Shafiyi	Amiri	Rob	Burger	Walker	Mayer	Dimo	Lich	Alexi	1st Expert	2nd Expert	3rd Expert	4th Expert
Market	Sufficient market knowledge before entering the market.												*	*	*
	Constantly attempting to enter new and broader markets.											*	*		
	The more optimal presence of publishers in the market and approaches of captivating international markets.											*			
Rulers & Regulations	The development of proper rules & regulations for the registration of innovative ideas.		*	*								*	*		
	The development and adjustments of the current rules & regulations.	*	*	*								*		*	
	The complete recognition of app developers and content in the support programs of the Ministry of ICT & Postbank.											*			
	Approving laws of obtaining a guarantee from the publisher firm for the app developers, to not use the programmed source code.											*			
	Excessive taxation of content-based exporters at home, due to the previous taxes charged by the publishers and producers to which the application software and content were exported.											*			
	Sufficient supervision to value-added tax as well as income tax on foreign program publishers in Iran.											*			
	Elimination of unnecessary government interventions.	*													
Environmental	The reformation of environmental climate by the government and related institutions (sanctions & stability in the market)			*											
	Holding a variety of conferences to encourage such approaches and the introduction of these innovations.												*		
Technical & Production	Technical & production efforts to captivate and retain the specialized workforce.													*	
	Scientific pricing and researchers.														*
	The conduct of feasibility before the launch.														*
	The use of team development of content approaches.											*			
	The establishment of a knowledge management system in the firm.													*	
	Continues corporation with innovators until the last stages of production.													*	
Internal	Focusing on the corporate business layer and preparing a fundamental structure for teams.													*	
	Acquiring the required managerial and entrepreneurial skills before launch (training)			*							*		*	*	*
	Creating a team spirit amongst the employees of the company.													*	
	Studying the past activities of entrepreneurship and gain experience from previously completed projects.										*				

References

Ahamd, A., Feng, C., Asim, S M., yousif, A. (2018). An Empirical Study of Investigating Mobile Applications Development Challenges, SPECIAL SECTION ON SOFTWARE STANDARDS AND THEIR IMPACT IN REDUCING SOFTWARE FAILURES ,6, 17711-17728.

Ahammeda, F., Azeem A., (2013). Selection of the most appropriate package of solar home system using analytic hierarchy process model in rural areas of Bangladesh. Renew Energy. 55: pp. 5-11.

Alsaadi, M. R., Ahmad, S. Z., & Hussain, M. (2018). A quality function deployment strategy for improving mobile-government service quality in the Gulf cooperation council countries. Benchmarking: An International Journal, 25(8), 3276-3295.

Apoorv P, Akanksha P , Vineet K , (2023). Mobile Application Market by Type, alliedmarketresearch, by segment report.

Arasti, Z., Zandi, F., & Talebi, K. (2012). Exploring the effect of individual factors on business *failure in Iranian new established small businesses. International Business Research, 5(4), 2.

Aydarov, D., Klochkov, Y., Ushanova, N., Frolova, E., & Ostapenko, M. (2018). Developing Plans for QFD Based Quality Enhancement. System Performance and Management Analytics, 241-249.

Beck, T., Demirgüç-Kunt, A., & Maksimovic, V. (2008). Financing patterns around the world: Are small firms different. Journal of Financial Economics, 89(3), 467-487.

Bamshad, V., talebi, k., yazdani, h., (2021). A Systematic Mapping Review and analysis of cognitive science in Opportunity Identification Literature: 1994-2018. Journal of Entrepreneurship Development, 14(1), 1-19.

Bunj Shafiyi. (2018). International confrance on Applied Research in Management & Industrial Engineering, Investing in small midsized ventrures, Tehran, IRAN.

Boot, A. W. (1999). European lessons on consolidation in banking. Journal of Banking & Finance, 23(2-4), 609-613.

Chavis, L. W., Klapper, L. F., & Love, I. (2011). The impact of the business environment on young firm financing. The world bank economic review, 25(3), 486-507.

Chitsazan, H., Talebi, K., & Mohebali, A. (2017). Identifying and Prioritizing the Most Common Methods of Bootstrap Financing in IT-based Start-ups. Journal of Entrepreneurship Development, 10(1), 61-79.

Davila, A., Foster, G., & Gupta, M. (2003). Venture capital financing and the growth of startup firms. Journal of business venturing, 18(6), 689-708.

Dewey, A. & Drahota, A. (2016) Introduction to systematic reviews: online learning module Cochrane Training https://training.cochrane.org/interactivelearning/module-1-introduction-conducting-systematic-reviews

Fartash, K., Baramaki, T., Saremi, M. S., & Sadabadi, A. A. (2022). The Growth Challenges of Pioneer Knowledge-based Firms of ICT. Journal of Science and Technology Policy, 15(3), 41-54(in persian).

John, R., Smith, A., Chotipanich, S. and Pitt, M. (2014), "Awareness and effectiveness of quality function deployment (QFD) in design and build projects in Nigeria", Journal of Facilities Management, 12 (1) 72-88.

Gutiérrez, J. A & Xu, G.(2006). An exploratory study of killer applications and critical success factors in m-commerce. Journal of Electronic Commerce in Organizations (JECO), 4(3), 63-79.

Karimi, A., & Bozarjomehri, S. (2014). Phenomenology of experiences and entrepreneurs' perceptions of entrepreneurship phenomenon; A qualitative study. Journal of Entrepreneurship Development, 7(3), 467-486.

Nyamaka , A., Botha, A., Biljon, J,. Marais, M. (2018). Challenges Botswana's Mobile Application Developers Encounter: Funding, Commercial and Technical Support, 2018 IST-Africa Week Conference (IST-Africa).

Pedarpour, A., Haghighi-Rad, F., Abtahi, A.R. (2022). A QFD-TRIZ Hybrid Method for a Hygiene Product. Int.J. Sysytematic Innovation, 7(1), 18-34.

Sadatrasoul, S. M., Asadifar, R., Shokri, H. R., (2022). Identify policy tools to develop technological collaboration of large industrial companies with knowledge-based companies, Innovation Management Journal, 80.

Statista Research department. (2021). Mobile app revenue worldwide 2017-2025, by segment report.

Szczepanski, Martin.(2018). European app economy, State of play, challenges and EU policy. From ERPS (European Parliamentary Research Service): http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2018)621894

Vinayak, K. and Kodali, R. (2013), Benchmarking the quality function deployment models, Benchmarking: An International Journal,20(6), 825-854.

Zheng, X. and Pulli, P. (2012), "Improving mobile services design: a QFD approach", Computing and Informatics, 26(4),369-381.

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