IT Spin-Offs Challenges in Developing Countries

Strategic Framework for IT-Enabled Spin-Off Ventures

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***Abstract*—IT-enabled spin-off ventures in developing countries' higher learning institutions have the potential to transform academic research into commercially viable products, thereby fostering economic and technological progress. However, practical implementation faces significant challenges, particularly in conflict areas, such as limited resources, socio-political instability, skill gaps, weak intellectual property laws, and inadequate frameworks for protecting innovation. Objective: This study aims to mitigate these challenges by proposing a strategic framework that leverages universities' available resources to promote IT-enabled spin-offs. This framework addresses barriers and converts challenges into opportunities. Methods: This case study focused on higher learning institutions in developing countries. Specifically, this study examines the unique constraints faced by Palestinian higher learning institutions in conflict zones in order to design a tailored IT-enabled spin-off framework. Results: The proposed framework aligns with the National Development Plan and offers pathways for universities to overcome practical barriers. It emphasizes transforming research output into sustainable IT spin-off ventures that support entrepreneurship and innovation. Conclusions: This study highlights the critical need for a new strategic framework for higher learning institutions that incorporates IT-enabled spinoffs as a guiding principle to promote innovation and entrepreneurship. The proposed framework addresses current gaps and provides actionable solutions for advancing sustainable development in conflict-affected regions.**

Keywords*—IT spin-off framework; higher learning; IT challenges; spin-off; framework; developing countries; entrepreneurship; innovation

I. Introduction

Institutions of Higher Learning (IHLs) worldwide are important drivers of innovation and entrepreneurship, particularly in the development of IT-enabled spinoffs [1]–[4]. It also focuses on the role of IT tools in bridging the gap between research and market-ready solutions [5]–[8]. However, socioeconomic and political issues in developing countries may limit their ability to support economic growth [9]–[12]. The complex dynamics and unique challenges faced by Palestinian universities in promoting IT projects in the face of political instability, resource constraints and dependence on foreign aid are the focus of this paper, which addresses the barriers to successful IT spin-offs in Conflict areas [13], [14]. Palestinian universities, especially university colleges, face many obstacles because of their limited autonomy, economy, and external dependencies, although IT spinoffs are essential for promoting technological innovation and economic resilience by facilitating the transition from academic research to market-ready products [15]–[17]. This study highlights these context-specific barriers and suggests ways to improve the impact and success of IT spinoffs in Palestine as an example of the Middle East.

II. Literature Review

A. IT Spin-Offs in Higher Learning Institutions

Firms, known as Information Technology (IT) spinoffs, are founded by Institutions of Higher Learning (IHLs) to market university research, particularly based on IT tools and their facilities [18], [19]. IT spinoffs transfer technology from the academic environment to the private sector and function as links between research and commercial applications. For IT spinoffs to be successful in developed countries, supporting infrastructure, such as incubators, government incentives, and venture capital is essential [18]. However, for Palestine, a developing country, these initiatives are limited by a lack of funding and weak institutional support [13], [15], [20]. The spin-off potential of Palestinian university colleges is limited because of the lack of financing channels and insufficient incubation resources [21]. Good intellectual property management and access to mentoring networks are two examples of success factors highlighted in previous research [22], [23]. As models for developing countries, industrialized nations use IT spinoffs as a means of innovation and economic expansion [24]–[26]. Therefore, higher learning institutions can commercialize research results through IT spinoffs that promote entrepreneurship and innovation [24], [27].

B. Challenges in Developing Nations

Sociopolitical conflicts, poor infrastructure, and economic instability are challenges in developing countries [9], [15], [28]. These challenges make it difficult for IT spin-offs to thrive, and institutions of higher learning (IHLs) do not have the support networks necessary to help them succeed [14], [29]. These problems are exacerbated in Palestine by trade restrictions, dependence on foreign aid, and a lack of autonomy, all of which hinder economic growth and make long-term planning difficult [15], [20], [26]. Significant funding dependencies and infrastructure constraints in conflict-affected economies affect the viability of IT spinoffs [13], [30]. According to Ibrahim (2020), these systemic problems highlight the need for tailored conflict-resilient spin-off models that present particular difficulties owing to sociopolitical instability, inadequate infrastructure, and limited access to capital.

C. Key Issues in IT Spin-Offs in Developing Nations

1) Funding and financial constraints: In developing countries, limited access to financial resources continues to be a major barrier [31], [32]. The scalability and sustainability of spin-offs are affected by the lack of government funding for IT initiatives [8], [33], [34]. Inadequate venture capital funding leads to unsustainable dependence on foreign aid for long-term spin-off investments [35]. Palestine's heavy reliance on foreign aid limits the availability of venture capital and leaves new companies and spin-offs without funding [15], [21]. Given the growth of the IT industry, these financial limitations make it challenging for colleges to obtain long-term funding for IT spin-offs [20], [36], [37].

2) Political instability: Political unrest in countries such as Palestine makes it dangerous for companies to operate there, and discourages long-term investment in IT spin-offs [9], [15], [34], [36], [37]. Security and political stability risks discourage investment and increase operating costs. These elements affect spin-offs, particularly in areas such as Gaza, which are prone to conflict and have fragile infrastructure [35], [37], [38]. These factors limit possible collaborations and partnerships among Palestinian universities as foreign investors view them as risky. These challenges are compounded by trade and movement restrictions, particularly in Gaza, which limits access to resources and markets [21].

3) Skill gaps and development in the IT sector: Lack of qualified IT professionals limits the potential of knowledge-based spinoffs [8], [17], [39]. Training programs and international partnerships are essential to address these gaps [40], [41]. Despite the growing youth population, Palestine lacks adequate training programs for advanced IT skills, creating a skill gap in the labor market. This gap changes the quality and scalability of IT spinoffs because qualified professionals are crucial in developing innovative solutions [41]–[43].

4) Technological, digital access and infrastructural limitations: Inadequate infrastructure, such as unreliable Internet and electricity, pose a significant barrier [8]. These limitations prevent higher learning institutions from providing conducive environments for IT ventures [16], [37], [44]. Palestinian rural areas lack infrastructure to support digital innovation, hindering access to the IT skills needed for spin-offs [15], [19], [37], [41], [45]. The disparity between urban and rural areas in Palestine, in terms of digital infrastructure, significantly limits the development of IT spinoffs. Rural areas face a digital divide with limited access to high-speed Internet and advanced technological tools essential for IT learning and business operations [16], [45]–[47].

5) Intellectual property and the legal framework: Weak intellectual property (IP) laws and limited legal frameworks in developing countries hinder spinoffs' success because innovations are not adequately protected [15], [23], [36], [48], [49]. Inadequate legal frameworks and weak intellectual property rights make it difficult for Palestinian entrepreneurs to protect their innovations [15], [37]. These gaps reduce incentives for local innovation and discourage foreign partnerships because intellectual property protection is a crucial factor in collaborative decisions [19], [20], [22], [23], [50]. Table I shows key challenges to IT spin-offs in developing nations.

TABLE I. KEY CHALLENGES TO IT SPIN-OFFS IN DEVELOPING NATIONS

Challenges	Description
Funding Restriction	Insufficient financial resources [40]. Reliant on external help and no risk capital available [20], [21], [36].
Unstable Politics.	Security problems lead to operational disruptions Limited expansion due to security threats and conflicts [9], [16], [36], [37]
Skill Gaps	Shortage of skilled IT professionals ([15], [41], [51]
Technological Limitations	Inadequate infrastructure [8], [15]
Deficiencies of Infrastructure	Lack of adequate technological resources in rural communities [21], [37]
Intellectual property (IP) gaps and legal obstacles.	Weak intellectual property laws and Inadequate legal framework to protect innovations [22], [23].

D. ICT, IT Spin-Offs and Development in Conflict Area

1) ICT: Definition and Impact

Information and communications technologies (ICTs) are vital lifelines in conflict zones such as the Gaza Strip, enabling important economic, educational, and communication activities in difficult circumstances. ICTs create, process, store, and sharing information [52]. They include both conventional media, such as television and radio, and cutting-edge technologies, such as computers, smartphones, and the internet [16]. ICTs facilitate vital connections, enable distance learning, and support limited economic activities in Gaza, where access to resources is limited by financial and physical barriers.

2) Access to ICT and digital skills in conflict areas: Access to ICT is particularly challenging in conflict zones such as Gaza, where infrastructure damage and economic hardship make access to even basic ICT tools difficult. This situation is consistent with [16], [37], [53] that ICT ownership without digital skills is insufficient, as Gazans not only face difficulties in obtaining devices but also in maintaining a reliable internet connection and access to relevant digital resources available in Arabic. Youths in Gaza are also affected by skill shortages. Despite being born in the digital age, they often lack the digital skills required for contemporary employment and education. Reports from the Palestinian Central Bureau of Statistics (PCBS) also emphasize the importance of "information literacy," which involves using digital resources to solve problems, and "technical literacy," which involves using hardware. The shortage of skilled workers in Gaza exacerbates local inequalities and disadvantages for people who do not have access to and cannot use ICTs efficiently.

3) Digital divide in conflict areas: Digital divide is defined as inequality in access to ICTs at all socioeconomic levels. In Gaza, this divide takes on different forms. Internet and device access in Gaza continues to lag behind international standards, owing to a lack of infrastructure and severe economic constraints. Since local ICT infrastructure is less developed than in other regions, political and geographical isolation has exacerbated this inequality. According to Norris (2001), the "social" and "democratic" divisions are influenced by social status, class and isolation and also lead to limited access and participation in Gaza. Gazans' access to international information networks, employment opportunities, and social integration are hindered by these divisions.

4) ICT for development (ICT4D) in the gaza context: ICT4D initiatives have proven crucial in conflict zones, but they face particular difficulties in Gaza. In these areas, early top-down supply driven ICT4D models often fail because they do not engage the community or consider local realities [16], [54]. Achieving effective ICT4D in Gaza requires addressing not only the operational divide (e.g., not just device access and infrastructure) but also political and cultural differences that impact usefulness and accessibility [37], [54]. Likewise, ICTs enables young people in Gaza to have distance learning and skill development, both of which are essential for future employment.

5) IT spin-offs and incubators at IHLs in conflict areas: Establishing IT spin-offs and incubators within Institutions of Higher Learning (IHLs), despite external constraints, can be a big step towards innovation [19] and economic resilience in conflict areas such as Gaza. University research or academic initiatives can lead to IT spinoffs, enabling universities to support technological advancement, nurture entrepreneurial talent, and directly impact local economies. These incubators enable researchers and students to turn their ideas into profitable businesses, opening doors to economic growth despite limited mobility and external financing [15], [55].

E. Factors Affecting IT Spin-Off Success

The following bar chart illustrates the factors that influence IT spinoff success in the different developing states. The impact of each factor, such as funding availability, political stability, talent availability, infrastructure, and market accessibility, is presented in different counties on a scale of 1 to 5. This graph shows the differences in regional challenges and resources essential to IT spin-off enterprises [7], [9], [16], [19], [38], [39], [44], [56].

Fig. 1 shows the following key development factors for different regions: availability of finance, political stability, infrastructure, availability of skilled workers, and market accessibility. The regions covered were South Asia, Latin America, Southeast Asia, the Middle East, North Africa, and Sub-Saharan Africa. Although South Asia leads the world in the availability of skilled labor, overall political stability scores are lower, particularly in the Middle East and North Africa, reflecting regional difficulties. Infrastructure performance is good in Southeast Asia and Latin America, whereas financing availability varies, with the Middle East, North Africa, and sub-Saharan Africa achieving mediocre results. Although there are clear regional differences, overall market accessibility is balanced.

Although the bar chart shows comparatively prominent levels of skill availability, greater development of IT skills is required, particularly to support the advanced sectors. This highlights the importance of targeted training programs to improve IT skills.

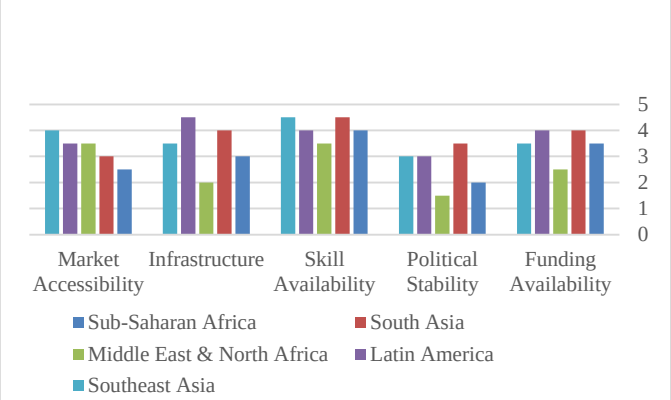

Fig. 1. Factors affecting IT-spin-off success in developing countries.

III. METHODOLOGY

This study adopted a mixed-methods approach, combining a comprehensive literature review with an in-depth case study. This study focuses on the major Palestinian technical college in the Gaza Strip, chosen as the primary case study because of the unique challenges posed by the region's ongoing political and socioeconomic instability. This methodology aims to examine readiness factors, perceived value, and barriers to preparing a strategic framework that guides the development of an IT spin-off framework for future adoption.

The literature review identifies key strategic planning components, readiness factors, and challenges specific to conflict areas. Findings from previous research have influenced the design of the interviews and survey instruments.

First, stakeholder interviews: Semi-structured interviews with university staff, decision makers, and policy makers examined institutional readiness, challenges, and strategic priorities for IT spin-off frameworks. Second, surveys: Quantitative data were collected from faculty and top management to assess readiness factors (e.g., skills, infrastructure), barriers (e.g., funding, political instability), and strategic considerations [7], [20], [30].

Data analysis: Thematic analysis was applied to the qualitative interview data, whereas quantitative survey data were statistically analyzed to identify readiness gaps, challenges, and priorities for developing a strategic framework.

Ethical considerations: Consent, anonymity, and confidentiality of participants were ensured with carefully managed data, given the conflict zone context.

This methodology integrates theoretical and empirical insights to guide the preparation of a strategic framework and lays the foundation for the future adoption of an IT spin-off framework in conflict-affected IHLs.

IV. Case Study: Major Technical College in Palestine

Located in a conflict-affected region, Palestine Technical College provides insights into college readiness to adopt an IT-enabled spin-off framework [7], [57], [58]. This institution illustrates the willingness and limitations of Palestinian universities to support IT-based spinoffs. Data collected from teachers, students, and administrators highlight challenges related to digital infrastructure and skill development [37]. Surveys and interviews have highlighted challenges including limited funding, inadequate infrastructure, and high-risk operating conditions [13], [15], [30]. Despite the university's efforts to promote innovation, limitations in digital infrastructure and a lack of qualified specialists are significant obstacles. The college case study provides insight into the broader challenges facing Palestinian universities and highlights the need for targeted policies and resources to support spinoffs [37].

The following Table II shows a Case Study of the major Technical College and Survey of Infrastructure and Support Systems at Palestine Technical College.

TABLE II. Case Study – Major Technical College in Palestine

Factor	Current Status	Challenges Identified
Infrastructure	Limited as utilities are irregular. Energy and digital resources are scarce.	Limits continuous IT operations. Frequent interruptions in digital access. Frequent internet and power interruptions
Funding	Minimal, dependent on subsidies and grants.	Lack of sustainable sources of financing
Competence development	Limited and needs further development.	Lack of trained IT specialists. Limited access to continuing learning programs
Political Environment	Elevated levels of instability impact business continuity and impact the way companies operate.	Prevents long-term planning, growth, and scalability.

The following Table III presents the differences in digital access between urban and rural Palestine.

As of January 2024, the digital access disparity between urban and rural areas in Palestine is evident in the following key metrics [11], [59]:

TABLE III. Differences in Digital Access between Urban and Rural Palestine

Metric	Rural Areas	Urban Areas
Population Distribution	22.3%	77.7%
Internet Penetration	11.4%	88.6%
Mobile Connections	17.8%	82.2%
Social Media Users	59.5%	40.5%

According to these numbers, there is a clear digital divide: City dwellers have better access to social media, mobile connectivity, and Internet services than compatriots living in rural areas. Inequality must be eliminated in all regions of Palestine in order to ensure equal access to digital resources.

V. Results: Framework for IT Spin-Offs in Developing Nations

Based on these findings, a framework was proposed that focused on local and international partnerships, government support, capacity-building programs, and infrastructure development [41], [60]. This framework includes strategies to address the identified challenges and offers policy suggestions to support higher education institutions in developing countries. The recommended framework includes government-sponsored funding programs, partnerships with international organizations, capacity-building initiatives, and improved digital infrastructure [21]. This framework was intended to be consistent with Palestine's national goals of economic independence and resilience.

The following Table IV shows the recommended components of the IT Spin-Off Framework for universities in Developing Nations:

TABLE IV. Recommended Components IT Spin-Off Framework

Components	Description
Local and International Partnerships	Collaboration with global organizations. Working with global technology companies to improve capabilities.
Government Support	Incentives, Financial and policy assistance.
Funding Programs	Government-sponsored venture funds for start-ups [15], [20], [30].
Capacity-Building Programs	Training and skills development [41], [51]. Digital skills training initiatives in rural areas [45]
Infrastructure Investment	Technology and facility improvements [8]. Investing in robust digital infrastructure and IT resources [16], [21], [37], [61])

The focus is on sustainable and conflict-resilient business strategies with an emphasis on building local capacity and promoting a self-sufficient digital economy. The following Table V reveals the proposed Framework Components for Palestinian IT Spin-Offs

TABLE V. Framework Components for Palestinian IT Spin-Offs

Components	Description	Challenges Addressed	Expected Outcomes
Funding Support	Establish a multi-source fund with contributions from government, NGOs, and private investors.	Limited funding and dependency on aid.	Sustainable financial backing for start-ups.
Skill Development	Implement digital and technical training, focusing on IT and entrepreneurship.	Skill gap in IT and entrepreneurship.	Trained workforce ready for spin-off creation
Infrastructure Improvement	Invest in stable internet, digital resources, and reliable power supply for HEIs in Gaza.	Poor digital access and infrastructure	Improved operational environment for tech ventures

Partnerships and Networking	Develop connections with global tech firms and NGOs for mentorship, knowledge-sharing, and investment opportunities.	Lack of collaboration and mentorship	Access to resources, networks, and enhanced innovation capacity.

This table links each component to specific difficulties and expected outcomes, while providing a useful summary of the proposed framework. Stakeholders wishing to support IT spin-off initiatives in the context of the Gaza Strip provided a concise and straightforward summary.

VI. Strategic Framework for IT-Supported Spin-Off Companies in Conflict Areas

Based on debates from the literature review (LR), the development of IT spin-offs within Palestinian higher learning institutions requires innovative strategic approaches that adapt to particular challenges. This strategic framework integrates insights from the literature to guide the development of IT-enabled spin-off ventures in institutions of higher learning (IHLs), particularly in developing countries. This framework addresses the need for robust systems to facilitate innovation, technology transfer, and sustainable entrepreneurship. The framework aims to leverage information and communication technologies (ICT), remote collaboration, and international partnerships to enable IHLs to achieve sustainable economic and social impacts through innovation.

A. Foundational Pillars

Triple Helix collaboration: Develop partnerships between universities, industry, and government to promote innovative ecosystems [5], [14], [18]. Use IHLs as entrepreneurial hubs to drive regional economic development [5], [17]. Policy and Institutional Alignment: Align the framework with national policies such as the Palestinian National Development Plan [21]. Close policy gaps to promote entrepreneurship and innovation in IHLs [9], [19]. Resource Optimization: ICT is used to overcome resource limitations and enable remote operations and virtual collaboration [2], [5], [20]. Develop hybrid incubation models to connect local innovators with global markets and investors.

B. Key Components

Innovation and Research Development: Promoting interdisciplinary research addressing local and regional challenges [3], [5], [30]. Focus on resilience-focused technologies such as e-learning and agricultural innovation. Leveraging Remote Collaboration and Digital Platforms: Develop online incubators or hybrid incubation models that enable remote virtual mentoring, collaboration, and market engagement. Connect students and educators with global experts, investors, and partners to bypass local restrictions [1], [47]. Localized curriculum for entrepreneurial and digital skills development: Implementing specialized training programs in entrepreneurship, digital literacy, and IT management tailored to Gaza's constraints. Equip students with practical skills for both local and remote employment opportunities [27], [62]. Technology Transfer Offices (TTOs): TTOs should be strengthened to manage intellectual property, licensing, and knowledge transfer between IHLs and industries [5], [30]. Partnerships with international organizations for funding and expertise: Partners with international organizations provide financial resources, mentorship, and access to advanced knowledge [5], [22], [47]. ICT as a Key Enabler: Use ICT platforms for analysis, scaling and international collaboration to overcome geographical and economic constraints [15], [16], [53], [61]. Financial and Incubation Support: Providing access to hybrid financing mechanisms, including grants, crowdfunding, and incubation programs tailored to the Gaza Strip context [22], [63].

C. Operational Framework

Opportunity Identification: Use ICT-based analytics to identify local and global market opportunities for spin-off companies [1], [2]. Develop solutions targeting resilience-oriented technologies for conflict-affected regions [6], [24]. Framework Development: Take a bottom-up approach involving local stakeholders to design spinoffs that address community needs [23]. Implementation and Scaling: ICT-enabled pilot spin-offs focus on local challenges and are scalable to similar global markets [6], [24].

D. Sustainability and Impact

Monitoring and Evaluation: Leverage ICT dashboards to track and evaluate spin-off performance in real-time [5], [15], [42], [53]. Community engagement: Engages local communities by involving students, researchers, and community leaders in the development of spin-offs [18], [64]. Alignment with Sustainable Development Goals (SDGs): Align spin-off initiatives with SDGs 4 (Quality Education), 8 (Decent Work and Economic Growth), and 9 (Industry, Innovation and Infrastructure) [37], [47]. Table VI shows strategic framework summary table.

TABLE VI. Strategic Framework Summary Table

Key Area	Description
Foundational Pillars	Triple Helix Collaboration, Policy and Institutional Alignment, Resource Optimization
Key Components	Innovation and Research Development, Remote Collaboration, Localized Curriculum, Technology Transfer Offices, International Partnerships, ICT as Core Enabler, Financial and Incubation Support
Operational Framework	Opportunity Identification, Framework Development, Implementation and Scaling
Sustainability and Impact	Monitoring and Evaluation, Community Engagement, SDG Alignment

E. Expected Outcomes

Increased Spin-Off Creation: Increase in the number of IT-enabled spin-offs that address local and global challenges [3], [5], [23]. Economic and Social Impact: Strengthening local economies through job creation, e-learning, and agricultural technology solutions [20], [65], [66].

Improved IHLs Capacity: Universities are becoming entrepreneurial institutions that contribute to regional innovation [5], [12], [17], [19]. Global Competitiveness: Gaza-based spin-offs gain global recognition and scalability through the use of ICT and digital entrepreneurship strategies [25], [34].

The following Fig. 2 illustrates the strategic framework that includes themes and sub-themes, and provides practical opportunities that should be considered and explored if universities in the Gaza Strip could successfully launch and sustain IT spin-offs despite significant constraints.

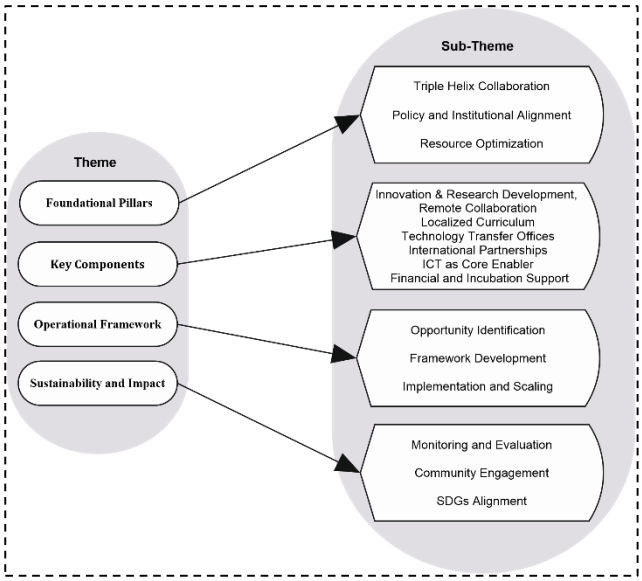

Fig. 2. Strategic framework.

By integrating ICT, remote collaboration, and local strategies, this framework enables IHLs in conflict zones, such as Gaza, to promote IT-enabled spin-offs with local relevance and global scalability. These strategies reflect a commitment to resilience and innovation, enabling universities to thrive despite adversity and achieve meaningful economic and social outcomes.

VII. Conclusion and Recommendations

This study proposes a strategic framework for developing IT-enabled spin-off ventures in higher learning institutions in conflict-affected regions such as Palestine. It identifies key barriers such as funding constraints, political instability, skill gaps, infrastructure limitations, and weak intellectual property protection. Based on a case study of a major technical college in Palestine, this framework addressed specific challenges in the Palestinian context, including leveraging ICT, remote collaboration, and local strategies. This study emphasizes the need for healthy financing mechanisms, increased infrastructure investments, conflict-resistant strategies, skill development initiatives, and sustainable financing models that reduce dependence on foreign aid. It also highlights the importance of establishing partnerships and improving collaborations with international partners to promote IT-enabled entrepreneurship and innovation in challenging environments. Key recommendations include the following.

Although IT spinoffs hold significant potential for economic growth and translation of research into products or services, barriers to success still need to be overcome. Palestine's unique sociopolitical environment requires a tailored approach to promote IT spin-offs within institutions of higher learning (IHLs) that lead to the promotion of entrepreneurship and innovation. While the current study provides valuable insights into the strategic framework, it is limited by the lack of empirical validation, robust statistical analysis, and longitudinal assessment of its long-term impact. Future research should address these shortcomings while incorporating mixed methods approaches, comparative analyses, and stakeholder engagement to enhance the framework's applicability and effectiveness across diverse contexts.

The findings of this study can serve as a basis for developing targeted strategies to promote sustainable IT ecosystems in universities in developing countries. The findings and recommendations provide insights that policymakers, higher learning administrators, and international organizations can use to create an enabling environment for IT spin-offs in Palestine, with the potential for broader applications in developing countries.

Declaration of Competing Interest

The authors declare no conflicts of interest regarding the data or information reported in this study. The authors declare no conflicts of interest.

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