Factors Affecting Startup Survival and Failure: Evidence on AI and Advanced Technology Engagement from Algerian Ventures

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Abstract. This study examines the survival dynamics of 96 Algerian startups, with particular attention to the role of AI and advanced technological contributions. Primary data were collected via an online survey, yielding a non-probabilistic sample due to the absence of an exhaustive official startup registry in Algeria. Survival patterns are first explored using the Kaplan–Meier estimator, revealing that AI-contributing startups exhibit a survival probability of 84%, compared to 65% for non-contributors. The analysis is extended using Cox proportional hazards models with time-dependent effects to distinguish short- and long-run impacts. The findings indicate that while AI contribution initially increases failure risk at entry, consistent with the Liability of Newness, this effect diminishes systematically over time, eventually translating into a long-term survival advantage. Sectoral analysis reveals that industrial startups face the highest baseline hazards, while Digital & IT firms exhibit the lowest entry hazards. Overall, the results suggest that technological contribution enhances long-term resilience among the startups in our sample.

Keywords: Startups, survival analysis; AI; advanced technology contribution.

1 Introduction

MENA economic performance is fundamentally constrained by high market volatility and structural rigidities, which significantly increase investment risk [8, 3, 2]. For new firms and startups, this environment poses a severe challenge to investment decision-making, contributing to a critically high rate of premature mortality [4, 9, 1]. Among MENA countries, Algeria represents a particularly relevant case for investigating startup survival dynamics. While recent policies have promoted entrepreneurship and digital transformation, Algerian startups continue to operate within a challenging economic environment [7, 11]. Labidi et al. [11] document that the Algerian entrepreneurial ecosystem suffers from heavy institutional complexity, financing frictions, and low technological capacities. These structural conditions heighten uncertainty for startups and provide a pertinent context for examining how firm-level technological engagement shapes survival outcomes. Addressing these challenges requires firm-level strategic interventions, particularly in advanced digital and AI-related technologies, capable of mitigating both idiosyncratic and systemic risks.

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In the current economic context, firm-level technological capability, particularly the utilization of AI and advanced digital technologies, plays a pivotal role in facilitating market entry and enhancing overall productivity [12, 13, 20]. For instance, recent evidence covering the 2018–2024 period [12] demonstrates that AI-augmented startups can achieve substantial gains in operational productivity and innovation output. However, because these findings predominantly reflect mature economies, their applicability to the structurally volatile MENA context remains largely under-examined. Beyond efficiency, AI adoption fundamentally alters organizational structures and value creation [20]. However, while these shifts provide a competitive advantage, their specific role in ensuring long-term startup survival has not been fully examined. Extant literature primarily frames AI and advanced technologies as operational inputs for market penetration [19, 13]. This paper, however, offers a distinct theoretical departure by examining technological contribution as a strategic output that directly determines long-term survival. Grounded in Schumpeterian innovation and the dynamic capabilities framework [5], we hypothesize that startups generating advanced digital solutions develop superior resilience. By shifting the analytical focus from short-term growth to mortality risks, this research provides unique empirical evidence on how technological engagement acts as a vital survival mechanism within the volatile Algerian ecosystem. To test this hypothesis, we apply Kaplan-Meier [10] and Cox Proportional Hazards models [6] to a validated dataset of 96 Algerian startups (filtered from an original 103 to ensure data integrity). This econometric framework accounts for unobserved heterogeneity, isolating the specific impact of technological engagement on firm lifespan. The study's contribution is two-fold: first, it provides rare empirical evidence of a survival premium linked to AI & advanced technology contribution; second, it addresses a significant research gap by shifting the analytical focus from large corporations to the mortality risks of new ventures. Ultimately, our findings suggest that technological competence acts as a survival shield, necessitating a strategic shift for business leaders from pursuing short-term growth toward building long-term digital resilience.

2 Literature review

Drawing upon Schumpeter [15], Barney [5], and Teece et al. [18], this study posits that technological innovation, specifically in AI, acts as a critical survival mechanism. These frameworks collectively suggest that rare digital competencies allow ventures to better navigate environmental shifts, securing a superior competitive advantage decisive for longevity in volatile markets like Algeria. Empirical evidence supports this view: a systematic review of 68 studies (2018–2024) by Nassery et al. [12] demonstrated that AI-augmented startups achieve productivity gains of up to 75% and more than double their innovation output. While these gains redefine core dynamic capabilities, significant adoption barriers persist, including talent shortages and algorithmic bias. Critically, as most existing literature reflects mature economies, the survival implications of AI remain largely under-examined within the structurally volatile MENA context.

A fundamental limitation in existing literature is its tendency to frame AI as an operational input, a tool that firms adopt to improve efficiency or market penetration [19, 13]. Weber et al. [20] identified a shift toward data-driven value propositions distinguishing AI startups from traditional ventures, while Wang and Wu [19] show that AI paired with prototyping generates higher-quality outputs, reducing market uncertainties. Tang et al. [17] further demonstrate that Lean Startup Approaches serve as a critical mechanism for business model innovation. At the ecosystem level, Pambudi et al. [13] show that AI-driven heuristic analysis improves stakeholder matchmaking, facilitating innovation diffusion and strengthening ecosystem resilience. However, none of these studies examine AI as a strategic output, that is, startups that actively contribute to AI and advanced technologies through the development of products, services, procedures, or working methods. This paper addresses that gap directly: rather than measuring what firms consume technologically, we measure what they produce and contribute, arguing that this productive technological engagement constitutes a fundamentally superior source of competitive advantage and long-term survival. Drawing upon the Resource-Based View and Dynamic Capabilities framework [5], startups that develop and deliver advanced AI-based solutions are better positioned to enhance adaptability and resilience within uncertain economic environments.
Hypothesis (H1): The active contribution to AI and advanced digital technologies confers a competitive advantage in the market, thereby significantly increasing the survival probability of Algerian startups

3 Empirical framework and data source

Aligned with recent evidence [19, 13], our model defines time-to-failure as the dependent variable, where proactive contribution to AI and advanced digital tools lowers the hazard of premature startup death. Failure denotes firm closure or liquidation; survival includes active, suspended, pivot, or stabilized growth phases. The Kaplan–Meier estimator provides a non-parametric estimate of S(t) under right-censoring [10]:

$$\hat{S}(t) = \prod_{t_j \leq t} \left(1 - \frac{d_j}{n_j}\right)$$

Where d_j is the number of failures at time t_j and n_j is the number of startups at risk just before t_j.

Formally, by accounting for the role of control variables (X), including sectoral affiliation, the survival of Algerian startups is modeled as a function of their contribution to AI and advanced technology, derived from Schumpeterian concepts [15] and the Dynamic Capabilities framework theories [18, 5]. The explanatory variable, AI-TECH, is a binary indicator derived from a multiple-choice survey question on advanced digital technology contribution. Startups selecting at least one of the following were coded AI-TECH = 1: cloud computing, programming and software design, AI and automation, efficiency-enhancing technologies, and digital product or service development. Startups limited to e-commerce or social media, widely adopted, low-barrier tools that do not constitute dynamic capabilities in the sense of Teece et al. [18], and those reporting no contribution were coded AI-TECH = 0. This distinction reflects genuinely innovative technological engagement capable of reshaping organizational value creation [20], consistent with prior survival analysis studies employing dichotomous treatment indicators to isolate the effect of a strategic condition on firm longevity:

$$\boldsymbol{h(t) = f(h_0(t), AI\_TECH)} \qquad \textbf{(1)}$$

Where $h(t)$ is the hazard (instantaneous risk) of the startup failing at time t, $h_0(t)$ represents the baseline hazard when all covariates are zero, AI_TECH is the AI and advanced technology contribution. The equation (2) precises our investigation:

$$\boldsymbol{h(t) = h_0(t)\, e^{\beta_1 AI-TECH + \beta_2 Sector_x}} \qquad \textbf{(2)}$$

β_1 is the effect of AI & advanced technology contribution, β_2 sectoral exposure ($Sector_x$). The main specification can be expressed as a Cox proportional hazards model. The estimation of the Cox Proportional Hazards (PH) model relies on the Partial Maximum Likelihood (PL) method to estimate the model parameters in the presence of right-censored data [6]. The partial likelihood of the Cox model is written as follows:

$$PL = \prod_{j=1}^{N} L_j$$

Where L_j represents the individual contribution to the partial likelihood coming from startup j at the moment it experiences the event (failure).

$$L_j = \frac{h_0(t)\exp(x_i\beta)}{h_0(t)\exp(\beta x_j) + h_0(t)\exp(\beta x_{j+1}) + \cdots + h_0(t)\exp(\beta x_N)}$$

Which simplifies to:

$$L_j = \frac{\exp(x_i\beta)}{\exp(\beta x_j) + \exp(\beta x_{j+1}) + \cdots + \exp(\beta x_N)}$$

Thus, the partial likelihood function becomes:

$$PL = \prod_{j=1}^{N}\left[\frac{\exp(\beta x_i)}{\sum_{j=1}^{N} y_{ij}\exp(\beta x_j)}\right]^{a_i}$$

Where:

$$y_{ij} = \begin{cases} 1 & if\ t_j \geq t_i \\ 1 & if\ t_j \leq t_i \end{cases}$$

If a_i=1 the event occurs (startup failure), if a_i=0 the observation is right-censored (startup still active). Taking the logarithm of the partial likelihood allows the estimation of the parameter vector β as follows:

$$\text{Log (PL)} = \sum_{i=1}^{N} a_i \left[\beta x_i - \log\left(\sum_{i=1}^{N} y_{ij}\ \exp(\beta x_j)\right)\right]$$

Primary data were gathered via online survey (November 2024–August 2025) using non-probabilistic convenience sampling from LinkedIn and Facebook entrepreneurship communities, as no exhaustive official Algerian startup registry exists. The initial 103 responses were filtered to 96 after removing incomplete entries and temporal inconsistencies. Table 1 summarizes the geographical and sectoral distribution, revealing that

Algiers (16.7%) and Digital & IT (35.42%) represent the primary entrepreneurial hub, suggesting high centralization within the Algerian ecosystem.

Table 1. The geographical and sector distribution of 96 Algerian startups.

Wilaya	(n)	Percentage	Sector	(n)	Percentage
Algiers	16	16.7%	Digital & IT	34	35.42%
Batna	7	7.3%	Industry	15	15.63%
Oran	6	6.3%	Other	14	14.58%
Annaba	5	5.2%	Agriculture	9	9.38%
Setif	5	5.2%	Energy (Renewable)	5	5.21%
Constantine	4	4.2%	Health	5	5.21%
Tlemcen	4	4.2%	Finance	4	4.17%
Blida	3	3.1%	Education	3	3.13%
Guelma	3	3.1	Energy (Conventional)	3	3.13%
Oum El Bouaghi	3	3.1	Fisheries	2	2.08%
Sidi Bel Abbes	3	3.1	Telecommunications	2	2.08%
Others (Less than 3)	37	38.5%			
Total	96	100%	Total	96	100%

Source: Authors' own work

4 Empirical finding and discussion

The Kaplan–Meier estimator (see Fig.1) reveals a baseline survival probability of 77% for the entire sample. Figures 1, 2 demonstrates a stark divergence when startups are categorized by technological engagement: AI-contributing startups exhibit a survival probability of 84%, compared to 65% for non-contributing firms. These findings suggest that active technological contribution confers superior competitive competencies, warranting more rigorous empirical validation through the Cox Proportional Hazards model.

To validate the results we use cox models. We employ one model driven from the main econometric model given in equation (1). To ensure the robustness of our survival estimates, we relaxed the Proportional Hazards (PH) assumption by incorporating a time-dependent covariate for technological engagement ($AI - TECH \times t$) in equation (3). Adopting this specific approach arguably allows us to differentiate between the short and long run effects that AI-related technological contributions might exert on startup longevity

$$\boldsymbol{h(t) = h_0(t)\, e^{\beta_1 AI-TECH+\beta_2(AI-TECH\times t)+\beta_3 Sector_x}} \qquad (3)$$

This specification allows investigation of whether the protective effect of AI contribution remains constant or evolves as the startup matures, preventing potential bias in hazard ratio estimates arising from time-varying technology benefits. Economic sectors are encoded as binary dummy variables, enabling the model to quantify sector-specific hazard risks relative to a reference group and account for unobserved heterogeneity across the Algerian ecosystem. Table 2 introduces the time-varying specification necessary to capture the dynamic shift in technological influence from the short to the long run.

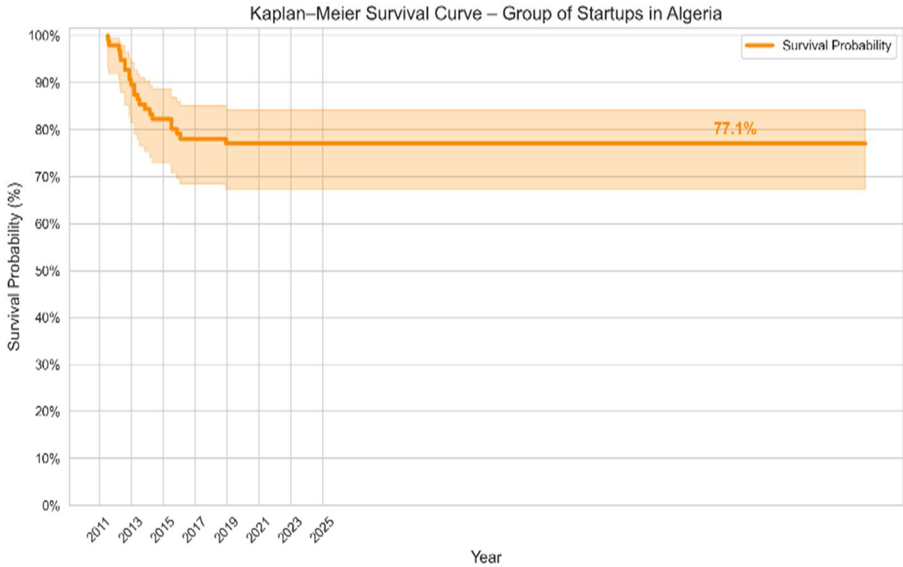

Fig. 1. General Kaplan-Meier curves
Source: Author own work

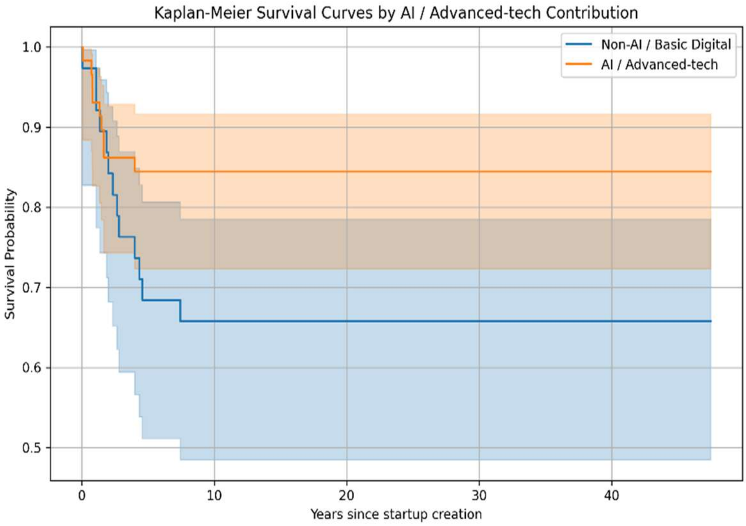

Fig. 2. Kaplan-Meier curves by group
Source: Author own work

Table 2. Full Time-Dependent Cox Estimation across All Economic Sectors (with 95% Confidence Intervals)

Sector / Model	AI-TECH (Entry Hazard)				AI-TECH × Time (Decay Effect)				Sector Dummy (Control			
	β	HR	p	95% CI	β	HR	p	95% CI	β	HR	p	95% CI
1. Agriculture	+4.04***	56.93	< 0.001	[7.51 – 431.56]	-0.67*	0.51	0.098	[0.23 – 1.13]	+0.12	1.13	0.906	[0.15 – 8.71]
2. Digital & IT	+3.59***	36.33	< 0.001	[5.20 – 253.76]	-0.44	0.64	0.209	[0.32 – 1.28]	-0.45	0.64	0.455	[0.20 – 2.06]
3. Education	+3.91***	50.07	< 0.001	[5.84 – 429.30]	-0.50	0.61	0.353	[0.21 – 1.74]	-0.73	0.48	0.482	[0.06 – 3.68]
4. Industry	+4.28***	72.31	< 0.001	[9.87 – 529.60]	-0.58	0.56	0.130	[0.26 – 1.19]	+1.36***	3.91	0.009	[1.40 – 10.96]
5. Health	+3.99***	53.98	< 0.001	[7.13 – 408.52]	-0.64	0.53	0.114	[0.24 – 1.17]	+0.56	1.75	0.470	[0.38 – 8.01]

6. Finance	+4.11***	60.71	< 0.001	[7.87 – 468.51]	-0.68*	0.51	0.089	[0.23 – 1.11]	-0.32	0.73	0.683	[0.16 – 3.37]
7. Fisheries	+4.21***	67.28	< 0.001	[8.53 – 530.85]	-0.68*	0.50	0.091	[0.23 – 1.11]	+2.04*	7.66	0.065	[0.88 – 66.40]
8. Energy (Conv.)	+3.98***	53.55	< 0.001	[7.11 – 403.07]	-0.67*	0.51	0.096	[0.23 – 1.13]	-6.51	0.00	0.812	[~0 – very wide]
9. Energy (Renw.)	+4.09***	59.94	< 0.001	[7.88 – 456.21]	-0.67*	0.51	0.098	[0.23 – 1.13]	+0.50	1.65	0.515	[0.36 – 7.50]
10. Telecom	+4.01***	54.89	< 0.001	[7.30 – 412.91]	-0.67*	0.51	0.097	[0.23 – 1.13]	-6.10	0.00	0.850	[~0 – very wide]
11. Other	+3.86***	47.28	< 0.001	[6.26 – 357.12]	-0.67*	0.51	0.097	[0.23 – 1.13]	-1.31	0.27	0.210	[0.03 – 2.09]

Note: HR = Hazard Ratio. 95% CI = 95% Confidence Interval for HR [lower – upper bound]. β = coefficient. HR < 1 indicates a reduction in failure risk. AI-TECH captures the instantaneous entry-period hazard at t = 0. AI-TECH × Time captures the time-varying decay of that hazard. Sector dummies are included as controls. *** p < 0.01, ** p < 0.05, * p < 0.1. Very wide CIs for Energy (Conventional) and Telecom sector dummies reflect near-perfect separation due to very small subgroup sizes (n ≤ 3); coefficient estimates are unreliable for these dummies and should be interpreted with caution.

Source: Author own work

The contribution of AI and advanced technology is positive and statistically significant across all eleven sectors (β ranging from +3.59 to +4.28, $p < 0.001$), confirming the central research hypothesis. The Kaplan-Meier estimator reveals a baseline survival probability of 77%, with AI-contributing startups reaching 84% versus 65% for non-contributing firms.

The large hazard ratios observed at market entry (e.g., HR = 72.31 in Industry; HR = 67.28 in Fisheries) require careful methodological interpretation. In the time-dependent Cox specification, the AI-TECH coefficient captures the instantaneous hazard at t=0, before the moderating effect of time materializes. These values do not represent sustained failure multipliers; rather, they reflect a sharp but transient peak in early-stage failure risk, consistent with the Liability of Newness [16]. Technologically intensive ventures face high early hazards due to capital intensity and absence of market legitimacy. To verify plausibility, the hazard trajectory for Agriculture ($\beta1=4.04$, $\beta2=-0.67$) yields: HR ≈ 56.9 at t=0 year, HR ≈ 29.1 at t=1 year, and HR ≈ 7.6 at t=3 years[1], confirming a rapid monotonic decay consistent across all sectors. The study's core insight lies in the consistently negative AI-TECH ×Time interaction term (β ranging from −0.44 to −0.68), which reaches statistical significance (p<0.1) in sectors such as Agriculture, Finance, and Fisheries. This indicates that the early technological burden decreases systematically as the startup matures, transitioning advanced technology from

[1] HR = $e^{(\beta_1 + \beta_2 \times t)}$ using Agriculture sector coefficients ($\beta_1 = 4.04$, $\beta_2 = -0.67$): HR = 56.9 at t = 0 year [$e^{(4.04)}$], HR = 29.1 at t = 1 years [$e^{(4.04 - 0.67 \times 1)}$], and HR = 7.6 at t = 3 years [$e^{(4.04 - 0.67 \times 3)}$], confirming monotonic decay and ruling out model misspecification.

a financial liability to a strategic protective factor enhancing long-term resilience — consistent with the Dynamic Capabilities framework [18]. Sectoral analysis reveals notable disparities: the industrial sector emerges as particularly high-risk (HR = 3.91, p=0.009), implying nearly four times higher failure likelihood due to high entry barriers and rigid supply chains. The sector-specific variation in AI-TECH estimates, ranging from HR = 36.33 in Digital & IT to HR = 72.31 in Industry, reflects structural differences in entry costs. Conversely, Digital & IT startups show the lowest baseline hazard at entry, suggesting stronger alignment between AI capabilities and sector-specific business models within the current Algerian ecosystem. (see Appendix table A1, table A2).

5 Conclusion

This study examined the survival patterns of 96 Algerian startups, focusing on the impact of AI and advanced technological contributions. The analysis, supported by Kaplan-Meier estimators and time-dependent Cox models, indicates that while tech-driven startups face higher initial hazards (Liability of Newness), this risk decreases systematically over time, yielding a long-term survival advantage. Advanced technological engagement enhances resilience, particularly in sectors aligned with digital innovation. Significant sectoral disparities were confirmed: industrial startups exhibit the highest vulnerability (HR=3.91), whereas Digital & IT firms show the lowest baseline entry hazards (HR=36.33).

Non-probabilistic sampling and self-selection bias limit generalizability. These findings recommend establishing a comprehensive official startup registry in Algeria, with exhaustive longitudinal datasets, to facilitate future ecosystem research.

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Appendix

Table A1. Schoenfeld Residual Test Results, Proportional Hazards Assumption Diagnostics (All Sectors)

Sector	AI-TECH		AI-TECH × Time		Sector Dummy	
	Statistic	**p-value**	**Statistic**	**p-value**	**Statistic**	**p-value**
Agriculture	0.117	0.732	1.588	0.208	0.613	0.433
Digital & IT	0.127	0.722	1.108	0.292	0.292	0.589

Education	0.238	0.625	2.010	0.156	0.309	0.578
Energy (Conv.)	0.075	0.785	1.569	0.210	0.000	0.986
Energy (Renw.)	0.078	0.779	1.582	0.208	0.001	0.973
Finance	0.121	0.728	1.446	0.229	1.394	0.238
Fisheries	0.001	0.971	1.276	0.259	1.003	0.317
Health	0.061	0.804	1.532	0.216	0.313	0.576
Industry	0.003	0.958	0.668	0.414	0.000	0.986
Other	0.085	0.770	1.577	0.209	0.041	0.840
Telecom	0.075	0.784	1.570	0.210	0.000	0.988

Note: All p-values > 0.05 indicate that the proportional hazards assumption cannot be rejected at conventional significance levels. The null hypothesis (PH holds) is maintained across all 11 sector-specific models for all covariates, confirming the validity of the time-dependent Cox specification

Source: Author own work

Table A2. Model Fit and Diagnostic Tests (Summary for All Sectors)

Metric	Statistical Range	Result
Log-Likelihood Ratio Test	5.40 – 8.20	Significant (p < 0.10)
Schoenfeld Test (p-values)	0.15 – 0.98	Assumptions Met (Valid)
Martingale Residuals	[-1.20 ; +1.00]	Model Linearity OK
Deviance Residuals	[-1.50 ; +2.60]	No Outliers Detected

Note: As a representative case, the baseline (time-invariant) Cox model for the Education sector yields AI-TECH HR = 0.44 (95% CI: [0.19 – 1.04], p = 0.061), with a Likelihood Ratio Test statistic of $\chi^2(2) = 5.78$, p = 0.06. The sign contrast between this aggregate estimate and the time-dependent entry-hazard (HR = 50.07) confirms that collapsing the temporal dimension would produce misleading inference, validating the time-varying specification adopted across all sector models.

Source: Author own work