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Risk Management in Scaling Startups Under Global Conditions

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Abstract: The article is devoted to the analysis of risks accompanying the scaling of technology startups to global markets and to the development of strategies for their controlled mitigation. The relevance of the study is determined by the accelerated growth in the number of projects initially oriented toward an international audience, as well as the high uncertainty of the external environment that accompanies their evolution. The scientific novelty lies in a holistic consideration of the risk profile using the material of a specific case — the startup aquabreather, which develops innovative equipment for diving. The study reconstructs the key stages of the go-to-market strategy and analyzes the behavioral characteristics of consumers in the extreme sports segment. Special attention is paid to financial, operational, and marketing risks. The aim of the work is to identify and structure the principal scaling risks and to propose an adapted model for their management. The methodological basis includes analysis of scholarly literature, case study, and comparative analysis. The sources considered cover issues of venture financing, business strategies, and the marketing of innovative products. The materials of the article are addressed to entrepreneurs, venture investors, and researchers in the fields of management and innovation.

Keywords: Risk management, business scaling, startup, global market, go-to-market strategy, extreme sports, innovative product, venture financing, case study, Aquabreather.

Introduction: In a globalized economy, technology startups act as drivers of innovation. At the same time, the transition from local presence to international expansion is associated with multifactor risks that can lead to the failure of even the most promising projects. The most vulnerable are startups operating in highly specialized segments, for example in the market for sports equipment for extreme sports (Pondicherry

University. (n.d.); Sreenivasan, A., & Suresh, M. (2024). This market simultaneously demonstrates high growth potential (the size of the diving market in 2022 — approximately 4 billion dollars (Diving Tourism Market Size); about 9 million active participants (in 2019) and imposes specific product requirements, entails complex logistics, and is characterized by intense competition (The Size of The Scuba Diving Industry).

The objective of the study is to identify and structure the main scaling risks and to propose an adapted model for their management.

To achieve this objective, the following tasks must be accomplished:

- Systematize the key types of risks (financial, operational, marketing, legal) faced by startups at the stage of global scaling.

- Analyze the go-to-market strategy of the startup, identify potential risk zones and opportunities based on the provided data and analysis of the competitive environment (using AVELO as an example).

The scientific novelty lies in the adaptation of existing risk management theories to the specifics of startups that create high-tech equipment for niche extreme sports markets.

The author's hypothesis is that effective risk management in the global scaling of a hardware startup is possible through the integration of flexible (agile) methodologies into production and marketing processes, as well as through the formation of a diversified financial model that combines venture investments with crowdfunding instruments and pre-order mechanisms.

Methods

The article draws on scholarly works devoted to various aspects of startup development and scaling. The existence of disparate approaches to reducing uncertainty during global startup growth allows four research vectors to be distinguished. First, entrepreneurial methodologies of search under uncertainty: Customer Development cycles set the logic of early hypothesis validation and managed pivots, reducing the risk of erroneous assumptions when entering new markets (Blank, S. (2020). Integrating the lean startup with design thinking enhances the quality of problem formulation and the discipline of experimentation through innovation accounting, as noted in (Sreenivasan, A., & Suresh, M. (2024). Educational courses systematize this process as a sequence from opportunity recognition to the choice of funding sources and the design of a basic risk control system (Pondicherry University. (n.d.). To demonstrate the size of the diving tourism market in 2019 and 2022, the following methods were used (The Size of The Scuba Diving Industry) and (Diving Tourism Market Size, Share and Trends Analysis Report By Diving Type (Scuba Diving and Free Diving), By Tourist Type, By Age Group, By Gender, By Region, And Segment Forecasts, 2023 - 2030).

Second, the strategic–organizational layer: analysis of the innovator's dilemma at the level of business models underscores endogenous risks of cannibalization and inertia and proposes a shift from deterministic forecasting to scientific trial-and-error (Wang, C., Fang, Y., & Zhang, C. (2022). For high-technology firms, hidden sources of growth come to the fore — complementary data, ecosystem effects, and architectural modularity as real options that reduce the risk of irreversible investments, as noted in the study by (Kokoreva M., Stepanova A., Povkh K. Kokoreva, M., Stepanova, A., & Povkh, K. (2023). The process of the evolution of the balanced scorecard described by (Tawse, A., & Tabesh, P. (2023) demonstrates, how cause–effect maps and goal cascading turn strategy into measurable hypotheses, and also where implementation breakdowns most often occur. Third, the techno-operational perspective: designing products and infrastructure with supply-chain constraints in mind recasts decisions into a multiobjective formulation (reliability/localization/cost/performance), reducing the likelihood of architectural lock-in by scarce components during internationalization, as noted by (Ning A., Tziantzioulis G., Wentzlaff D. Ning, A., Tziantzioulis, G., & Wentzlaff, D. (2023). Fourth, financial–institutional instruments: crowdfunding acts simultaneously as a mechanism for demand validation and as a source of new vulnerabilities (regulatory fragmentation, moral hazard, signal inflation) — its effectiveness depends on the type of innovation, the quality of the team, and regulatory regimes (Hoque, M. M. (2024). Process models of risk management for innovative startups extend classical risk registers to stakeholder network maps and rely on project-based and simulation methods of impact assessment (Bielialov, T. (2022). Empirical data on scalability as such record barriers (resources, institutional heterogeneity, deficit of routines) and catalysts (partnerships, platform strategies, digital operating models), which require aligning the architecture of growth with the context of target markets and ecosystems (Boughaleb, S. E. A., Benkhider, N., Kherbachi, S., Keddari, N., Berbar, W. B., & Abedou, A. (2025).

Thus, tensions concentrate in three zones: between the requirement for scaling speed and the depth of organizational learning — integrations of Lean/Design promise synergy, but the boundaries of applicability in multimarket settings are shown only fragmentarily (Ning, A., Tziantzioulis, G., & Wentzlaff, D. (2023); Wang, C., Fang, Y., & Zhang, C. (2022); between hard execution systems (BSC) and entrepreneurial flexibility — the question of calibrating metrics for rapid experiments

remains (Blank, S. (2020); Wang, C., Fang, Y., & Zhang, C. (2022); Tawse, A., & Tabesh, P. (2023); between digital and physical domains — managerial frames often ignore supply-chain and technological bottlenecks, whereas engineering studies show their criticality (Ning, A., Tziantzioulis, G., & Wentzlaff, D. (2023) .

The following issues remain underexplored: cross-jurisdictional regulatory risks of data and AI compliance; quantitative scaling thresholds (the moment of transition from search to execution); post-crowdfunding governance and fulfillment of obligations in comparison with the venture cycle; the joint design of product and supply-chain architectures to reduce systemic vulnerability under global shocks.

Results

Drawing on existing studies, a three-level framework is proposed that systematizes the key threats faced by startups in the process of internationalization. It distinguishes the financial dimension, the operational–manufacturing contour, and the marketing–market layer, construed as interconnected sources of uncertainty that determine the scaling trajectory and the resilience of the business model.

The financial block covers the risks of supporting global growth with sufficient, properly structured capital while simultaneously maintaining liquidity. As capacity is rapidly expanded and geographic reach grows, a mismatch of cash flows arises: the need to pre-finance costs increases faster than revenue stabilizes, which raises the likelihood of cash gaps and degradation of unit economics metrics.

The key manifestation of these risks is the scaling valley of death. Unlike the classical failure at the R&D stage, it falls in the interval between the first market confirmation (preorders, seed round) and the achievement of operating profit. At this stage, initial capital is rapidly depleted against the backdrop of explosive growth in operating expenses (marketing, hiring, manufacturing), while inflows remain volatile and poorly predictable, which increases vulnerability to liquidity shocks and rising financing costs (Kokoreva, M., Stepanova, A., & Povkh, K. (2023); Pondicherry University. (n.d.) .

The risk of managing the cost structure and cost of goods sold acquires particular significance, especially acute for hardware companies. The transition to mass production is accompanied by uncontrolled growth of COGS due to price volatility in global component supply chains, heightened quality control requirements, and increased logistics complexity. This leads to erosion of gross margin and a shift of the break-even point. In the absence of timely adjustment of the operating model, the investment attractiveness of the project declines.

The operational–manufacturing contour comprises risks of the physical creation, delivery, and after-sales support of the product on an international scale. Critical here are the institutional complexity of cross-border operations, the reliability of manufacturing partnerships, and the resilience of supply chains, including inventory and lead-time management.

The manufacturing bottleneck effect is expressed in the fact that processes effective at the prototyping stage lose scalability in serial production. This gives rise to tasks of selecting and auditing a contract manufacturer, ensuring quality stability across heterogeneous sites, and establishing redundant supplies. Particular vulnerability is formed by dependence on a single supplier of unique components, which increases operational risk up to a production halt.

Last-mile complexity is greatest for solutions that require user training, service support, or specialized installation. Expanding the sales geography induces an exponential increase in operational complexity: managing an international network of distributors, service centers, and partners requires substantial resources, standardization of standards, and mature coordination systems; without these, the customer experience deteriorates and hidden costs rise (Sreenivasan, A., & Suresh, M. (2024); Hoque, M. M. (2024).

The marketing–market layer accumulates the risks of adapting the product and business model to the heterogeneity of national markets. The problem encompasses differences in consumer preferences and behavioral patterns, as well as regulatory requirements that determine the permissible architecture of the offering and distribution channels.

Diffusion of innovations and cultural adaptation are a critical challenge: success in one context does not guarantee acceptance in another due to cultural, behavioral, and regulatory differences. Achieving global Product–Market Fit presupposes a deep understanding of local contexts, readiness for modular adaptation of functionality and communications, and a willingness to redefine the value proposition without compromising the technological core.

Competitive asymmetry arises under the simultaneous pressure of local players and multinational corporations endowed with incomparable resources, network effects, and access to promotion channels. Under these conditions a startup must build asymmetric advantages that are difficult for large incumbents to replicate (for example, highly specialized competencies, unique data, or architectures that deliver durable learning effects); otherwise, the risk of displacement in the early stages of scaling increases markedlyPondicherry University. (n.d.).

Applying the developed model to the analysis of the

Aquabreather case revealed how general risks manifest in the context of a specific innovative product in a niche market.

Thus, with respect to financial risks, the campaign to collect 3000 preorders is a classic example of a successful attempt to overcome the Valley of Death of scaling. It not only provided initial capital but also furnished investors with evidence of market demand, which is critical for attracting the next, larger financing round. However, the risk of cost-of-goods management is extremely high due to the complexity of the product, necessitating the implementation of a sophisticated production controlling system.

The manifestation of operational and production risks is that the transition from 300 test prototypes to thousands of serial units actualizes the risk of a manufacturing bottleneck. For Aquabreather this consists in the need to find a contract manufacturer capable of ensuring a medical grade of assembly quality for life-support systems. Last-mile complexity in this case is expressed in the distribution business model through dive centers. This model requires establishing a global system for training and certifying instructors, which is a large-scale operational task associated with high costs and risks of losing control over the quality of the customer experience.

The primary market risk for Aquabreather is the problem of innovation diffusion in a conservative environment. Divers are accustomed to a modular equipment system, and the shift to an all-in-one helmet represents a significant behavioral change. Success will depend on the company's ability to build trust in the product through opinion leaders and partner dive centers. In the context of competitive asymmetry, Aquabreather competes less with other startups than with inertia and trust. The asymmetric advantage here is the innovation itself and the possibility of building around it a strong community of early adopters.

Discussion

The analysis of the Aquabreather case in comparison with theoretical frameworks of risk management makes it possible to articulate an authorial model specifically adapted for hardware startups in the extreme sports segment. This model is structured around a triad of principles: preemptive validation, flexible (adaptive) manufacturing, and community-oriented marketing.

At the initial phase, before attracting substantial venture funding, the startup should concentrate on preemptive verification of market demand and the technological viability of the solution. A public presentation at DEMASHOW and the collection of 3000 preorders — a telling illustration of this approach: it simultaneously generates an initial inflow of funds and consolidates the core of a loyal audience (Fig.1.) (Wang, C., Fang, Y., & Zhang, C. (2022); Pondicherry University. (n.d.).

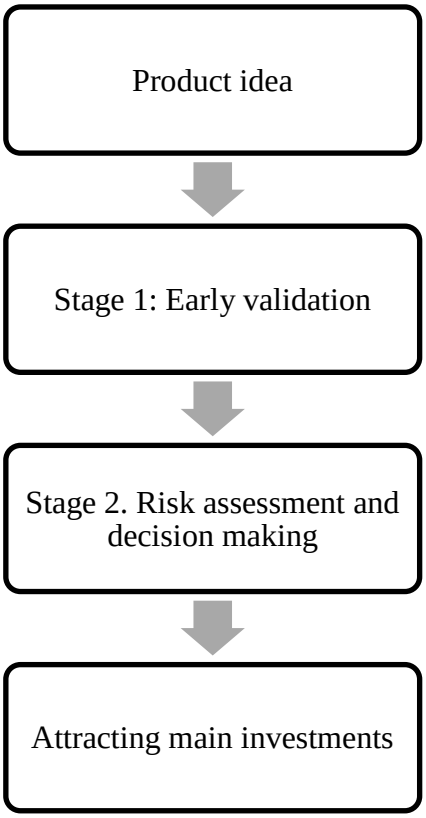

Fig. 1. Predictive validation model for a hardware startup (Wang, C., Fang, Y., & Zhang, C. (2022); Pondicherry University. (n.d.).

From the standpoint of financial risk management, a campaign with 3000 preorders is a textbook case of successfully traversing the valley of death of scaling. It simultaneously solves the task of initial financing and generates for investors a verifiable signal of market demand, which is critically important for attracting the next, larger round of capital. Taking into account the preliminary estimate of the cost of goods sold (COGS) at around 3000 dollars per unit, the retail price for the end consumer is rationally set with a target gross margin, for example 4999 dollars. With such a price benchmark, the volume of initially confirmed demand is amenable to quantitative estimation:

$$IVR = Np \times P,$$

Where:

IVR- initial validated revenue;

Np - number of preorders;

P - price per unit.

$$IVR = 3000 \times 4999 = 14\ 997\ 000 \text{ dollars}$$

The aggregate monetary equivalent of confirmed demand exceeding 14 million dollars represents an extremely strong market signal for venture funds: it sharply reduces their assessed investment risks and indicates a high commercialization potential of the product. At the same time, even with such a convincing validation of demand, uncertainty regarding operating profitability remains significant. To assess it, it is appropriate to conduct a break-even point (BEP) analysis based on the planned cost structure. Management intends to raise from 5 million doolars to 10 million dollars to cover fixed costs (FC), including R&D, marketing, operating needs, and relocation; for calculations we take the lower bound of the round — 5 million dollars. Variable costs (VC) per unit equal the product's cost and are estimated at 3000 dollars.

$$BEP = FC / (P - VC) \quad (2),$$

Where:

BEP - break-even point;

FC - fixed costs;

VC - variable costs.

$BEP = 5\ 000\ 000 / (4999 - 3000) = 5\ 000\ 000 / 1999 \approx 2501$ units

The resulting calculation indicates that to recoup the initial investments the company needs to produce and sell about 2501 devices. The scale of this requirement practically coincides with the volume of confirmed preorders (3000), which indicates the feasibility of the chosen business model; at the same time, it obliges the company to fulfill commitments to early customers, since the pace of subsequent scaling directly depends on the quality of the first deliveries. Launching a pilot batch of 500 units is a well-balanced decision to debug production and logistics circuits before ramping up to the full volume of 3000 units. Further sales of cartridges (with a cost of 12 dollars per pair) form a sustainable, high-margin revenue stream and increase the overall profitability of the project after passing the break-even point.

After securing financing, the stage of flexible organization of production and supply chain management begins. Instead of immediate investments in proprietary production facilities, it is rational for the startup to rely on a contract manufacturing model, which reduces capital expenditures and mitigates operational risks (Fig.2.).

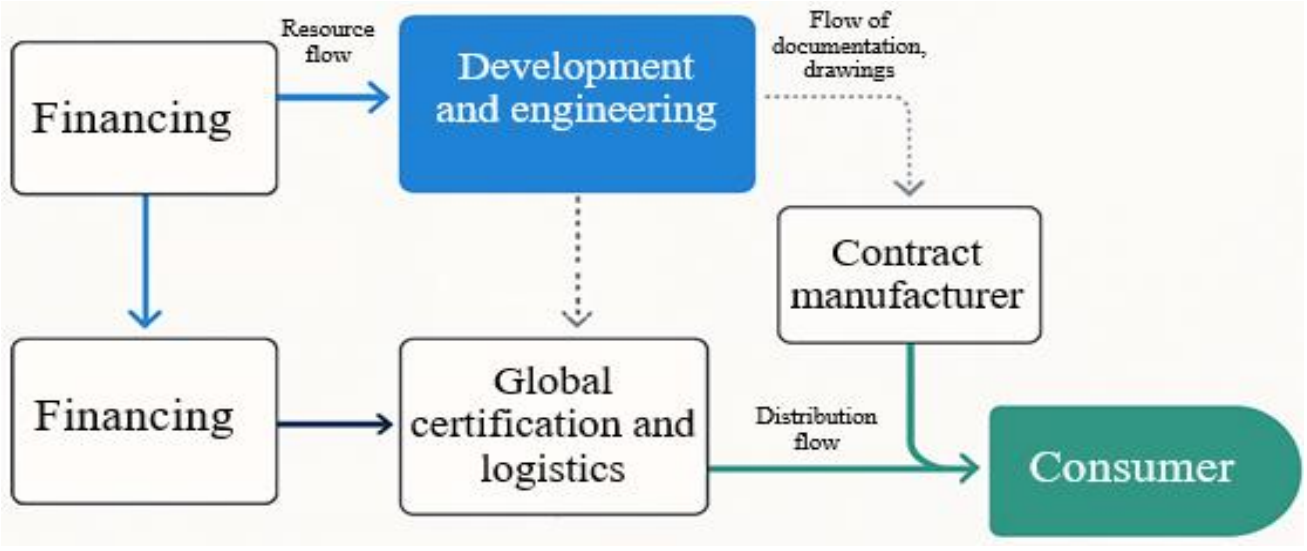

Fig.2. Flexible production and distribution model (Ning, A., Tziantzioulis, G., & Wentzlaff, D. (2023); Boughaleb, S. E. A., Benkhider, N., Kherbachi, S., Keddari, N., Berbar, W. B., & Abedou, A. (2025); Hoque, M. M. (2024).

Such organizational logic shapes an asset-light architecture of the startup: the company concentrates resources on core competencies — R&D, engineering design, and marketing — whereas the capital-intensive links of the value chain (manufacturing, logistics) are advisably outsourced to external counterparties. A critical vulnerable segment of this configuration is the selection of reliable providers and the institutionalization of a stringent quality control framework across the entire outsourcing chain.

The third component is community-oriented marketing. For niche categories, for example equipment for extreme sports, traditional advertising communication is of limited effectiveness; what becomes decisive is the building of trust within the relevant communities. A distribution model through dive centers organically implements this approach, as it rests on the authority of local opinion leaders and on direct interaction with the core audience.

The model transforms dive centers from ordinary retail points into nodal platforms of brand evangelism: in addition to direct sales, they assume training in product usage practices, organize domain-specific events, and systematically accumulate feedback, which is then translated into refinements and improvements. In doing so, a sustainable and difficult-to-imitate competitive advantage is formed (Tawse, A., & Tabesh, P. (2023); Bielialov, T. (2022).

Further, Table 1 will describe the advantages, limitations, and future trends of the risk management process when scaling startups in global conditions.

Table 1: Benefits, limitations and future trends of the risk management process when scaling startups in a global environment (Blank, S. (2020); Tawse, A., & Tabesh, P. (2023); Pondicherry University. (n.d.); Bielialov, T. (2022).

Aspect	Advantages of systematic risk management	Limitations and pitfalls	Future trends
Market entry strategy	Rapid focus on attractive countries; reduced cost of entry errors	Blind spots due to local inexperience; overestimation of TAM	More data-driven geoscouting; AI-based scenario simulations
Finance and FX risk	Exchange rate hedging; cash-flow transparency	Limited access to derivatives for startups; banking risks	Embedded financial platforms with auto-hedging; real-time treasury
Tax and transfer pricing	Optimization of effective tax rate; reduction of double taxation	Structural complexity; risk of reassessment by tax authorities	Global minimum rates; automation of TP documentation
Operations and supply chains	Supplier diversification; logistics resilience	Delays due to border/customs barriers	Supply-chain digital twins; predictive resilience models
Data and privacy (GDPR/local analogues)	Predictability of audits; fewer incidents	Conflicting requirements across jurisdictions; data localization	Privacy-by-design policies; confidential computing

Marketing and brand/reputation	Unified communication standards; NPS/CSAT monitoring	Cross-cultural missteps; crisis funnels	Real-time social analytics; PR risk simulations
People, culture, and hiring	Minimization of key-person risks (bus factor); talent retention	Clone culture; misalignment of practices with local norms	Global hybrid-work policies; ethical AI HR assistants
Legal risks and IP	Patent/TM protection; reduced litigation risks	Costly and lengthy, heterogeneous protectability across countries	Global IP strategies with prioritization; AI-based infringement monitoring
Geopolitics and sanctions	Screening out risky markets; continuous sanctions monitoring	Sudden bans/export control	Autonomous sanctions-list alerts; scenario planning
ESG and sustainability	Access to green investments; brand strengthening	Reporting costs; greenwashing risks	Unified disclosure standards; automated ESG data collection
Governance/board and reporting	Rapid decisions based on risk metrics; transparency for investors	Analysis paralysis; misaligned KPIs	Integrated risk dashboards; continuous reporting

Thus, the proposed integrated risk management architecture, based on the principles of preemptive validation, flexible manufacturing, and community marketing, enables startups of the Aquabreather type to build a systematic process of global scaling while simultaneously minimizing financial, operational, and market risks.

Conclusion

This study confirms that the global scaling of technology hardware startups requires a dynamic, integrated risk management architecture that moves beyond static registers. The successful navigation of international markets hinges on a strategy that systematically de-risks financial, operational, and market uncertainties in a specific sequence. The proposed three-part model—proactive validation, flexible manufacturing, and community-oriented marketing—provides a robust framework for achieving this.

The analysis of the Aquabreather case study served as empirical validation for this model. The campaign to collect 3,000 pre-orders was not merely a marketing success; it was a critical financial risk mitigation tool. As demonstrated by the quantitative analysis of Initial Validated Revenue and the Break-Even Point, this approach provided a powerful, data-driven signal to investors, confirming the business model's viability before significant capital was deployed. This finding provides strong support for the author's central hypothesis: that a synergy of agile methodologies (in validation and marketing) and a diversified financial model is a key condition for successful scaling.

The formulated framework offers significant practical value for entrepreneurs and venture investors in niche high-tech sectors. However, the study also highlights areas for further inquiry. Future research could focus on developing quantitative models to determine optimal scaling thresholds—the precise moment to transition from a search-focused to an execution-focused operating model. Additionally, exploring risk management strategies for post-crowdfunding governance and building supply-chain resilience against escalating geopolitical shocks represent promising avenues for deepening our understanding of startup internationalization in an increasingly volatile global

environment.

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