Gateway to Market: Configurating Startups and Industry 4.0

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Abstract

According to researchers and reports in the field, approximately 90% of startups do not thrive, but this is not attributed to a single factor. Irrelevant or unviable ideas, complex and inadequate business models, as well as the need for sufficient human, financial, physical, and technological resources - in other words, failure is the result of a combination of factors. To better understand these challenges, the study relies on configurational theory, the startup lifecycle, focusing on technology-based startups in the Industry 4.0 to examine combinations of factors that lead to startup success. 120 technology-based startups operating with Industry 4.0 technologies in a globally recognized innovation ecosystem located in the Southern region of Brazil were studied. Using fuzzy-set Qualitative Comparative Analysis (fsQCA), eight distinct configurations were identified that can lead startups to the market.

Keywords: Startups; Industry 4.0; Critical Success Factors; Configurational Theory.

1 Introduction

In historical context, startups were traditionally associated with young and innovative entrepreneurs in Silicon Valley, such as Apple, Google, and Microsoft, which began in modest settings and became globally prominent companies. With the rise of Industry 4.0 (I4.0) technologies, such as the Internet of Things (IoT), big data analytics (BDA), cloud computing (CC), artificial intelligence (AI), Blockchain, fundamental I4.0 technologies, automation, robotics, virtual reality (VR), 3D printing (AM), and front-end I4.0 technologies, a new wave of startups emerged, adopting these emerging technologies to create innovative solutions with exponential growth potential. This trend impacts both developed and developing countries, offering opportunities to drive economic growth [1].

In the Brazilian context, startups are on the rise, with notable innovations in sectors such as finance, healthcare, education, and agribusiness. The startup ecosystem in Brazil is thriving due to a favorable environment for entrepreneurship, including government initiatives and venture capital investments [2]. However, despite their positive contributions, startups face significant challenges, including high mortality rates, with some not surviving even a year after their inception [3][4].

These challenges include a lack of understanding of the market and customers [5] resource wastage [6], and the development of products or services that do not meet market demands [7]. Startups focused on I4.0 technologies play a significant role in promoting innovation, especially in developing nations, by modernizing organizational structures in line with I4.0 principles [7] [8][9]. However, these startups still face obstacles in launching their solutions into the market, prompting the question: What is/are the configuration(s) of critical success factors that can lead I4.0 technology-based startups to the market? This question underscores the importance of understanding the critical factors that determine their market entry.

To address this issue, a study employed a configurational theoretical approach [10][11], focusing on identifying combinations of critical factors that lead I4.0 startups to the market. The study applied Fuzzy-Set Qualitative Comparative Analysis (fsQCA) [24] to analyze complex patterns of critical factors, identifying eight distinct configurations that lead these I4.0 startups to the market. This allows for a better understanding of the activities involved in each critical factor and the necessary conditions for technology startups in I4.0 to reach the market.

2 Theoretical Foundation

2.1 I4.0 Technologies and startups

I4.0, involving the integration of digitization and operational process monitoring, offers opportunities for startups applying I4.0 technologies [6]. These technologies encompass IoT, BDA, CC, AI, and blockchain, as well as robotics, simulation, AM, and VR [9][12][13]. Startups can become technological providers, playing a crucial role in the adoption of these technologies across other sectors. However, startups face challenges such as high costs and technological complexity when adopting I4.0 technologies. To overcome these challenges, they can turn to strategic partnerships, incubators and accelerators, academic collaborations, and solutions leveraging I4.0 technologies [14][15]. The increasing integration of I4.0 technologies will have a significant impact on society, and startups need to develop competencies to adapt to rapid changes and focus on sustainable and ethical solutions in response to market and environmental demands.

2.2 Critical Factors

In the current dynamic market conditions, startups seek innovation through I4.0 technologies, positioning themselves as "technological providers" to enter competitive markets [6][14]. However, many of these startups face challenges leading to failure. This study selected critical factors based on their relevance in research on the success and failure of startups, highlighting their significance in the literature, see Table 1. Resources are considered crucial [15], especially for startups with limited resources. Dynamic capabilities such as detection, learning, and adaptation [16] are emphasized to enable startups to adjust quickly to market changes. Collaboration plays a vital role, given the dependence on other actors and external networks to drive development and reduce risks [17]. Resilience is crucial to cope with uncertainties and challenges [17]. The perspective of social cognitive theory aids in perceiving opportunities and risks, decision-making, and learning from experiences, guiding startups to the market [6]. Mentoring accelerates development and avoids common errors [18] Knowledge management balances innovation and efficiency [19]. Private, governmental, and university support, when combined, contribute to the success of startups in different phases of their lifecycle, following the concept of the triple helix [20].

Table 1. Critical Factors.

Critical factors	Justification
Resources	Resources are fundamental for startups, providing the foundation for the development and implementation of strategies.
Dynamic Capabilities: Sensing, Seizing, Transforming	Dynamic capabilities enable adaptation and response to rapidly changing business environments, which are essential for startups.
Collaboration in Open Innovation	Collaboration in open innovation accelerates product development and reduces risks through external networks.
Resilience	Resilience is crucial for startups to face challenges and adversities in uncertain environments.
SCT	The social cognitive perspective affects how entrepreneurs acquire knowledge and are self-efficacious to develop their business.
Mentoring	Mentoring accelerates the development of startups through guidance and reducing the learning curve.
Knowledge Management: Exploration and Exploitation	Knowledge management balances innovation with operational efficiency, which is crucial for the growth of startups.
Support of Private, Government, University agents	Support from private, governmental, and academic entities provides resources, knowledge, and legitimacy.

The critical factors identified in this study offer an essential configurational perspective for understanding the development of startups that adopt I4.0 technologies. By analyzing these factors and their interactions, it is possible to discern configurations to penetrate the market. This methodology establishes a framework, reducing the risk of overlooking crucial aspects in the development of such startups.

The incorporation of I4.0 technologies by startups creates a fertile field of opportunities but also poses significant challenges for market entry. The strategy of carefully configuring critical factors is crucial in this context. [21] emphasize the importance of qualitative analysis of results, assigning a score relative to the proximity of the desired outcome (successful market entry or failure). A strategic and effective implementation of these critical factors can empower startups to develop sustainable and scalable business models, overcoming challenges and securing a place in the competitive market.

2.3 Hypotheses development and critical factors influencing startups' go to market

The entry of startups into the market, especially those incorporating I4.0 technologies, is a phenomenon influenced by a range of critical factors. These factors include everything from material and human resources to the ability to quickly adapt to a constantly evolving technological and market environment. Understanding these critical factors is vital for startups aspiring not only to enter but also to excel in the competitive and technologically advanced market.

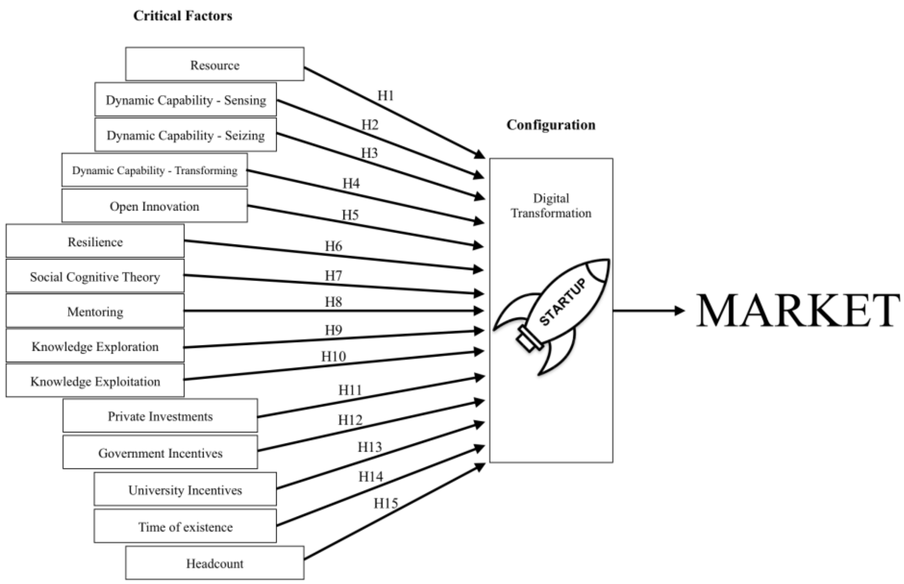

Fig. 1. Go-to-Market (GTM) Model: Critical Factors and Hypotheses for Configuring I4.0 Technology-Based Startups

The **resource** [15], encompassing financial capital, human talent, technological assets, and organizational capabilities, is fundamental for the development of startups. In the context of I4.0, these resources are even more crucial due to the rapid pace of innovation and technological complexity. **H1**: Resources are a critical determinant for the successful entry of startups into the market. The resource posits that the acquisition, management, and utilization of resources significantly impact a startup's market penetration success.

Dynamic capabilities, such as **sensing**, **seizing**, and **transforming** [16], are essential for startups in a market characterized by rapid changes and continuous innovations, especially in I4.0. **H2**: Sensing capability is a critical determinant for the successful entry of startups into the market. Sensing involves the ability to identify opportunities and threats. **H3**: Seizing capability is a critical determinant for the successful entry of startups into the market. Seizing refers to capturing identified opportunities. **H4**: Transformation capability is a critical determinant for the successful entry of startups into the market. Transformation pertains to adapting internal structures and processes in response to environmental changes.

Collaboration in **open innovation** is a means by which startups can overcome resource and knowledge challenges, access new markets, and foster innovation [17]. **H5**: Collaboration is a critical determinant for the successful entry of startups into the market. **Resilience** [17], defined by the ability to anticipate risks, adapt to changes, and turn challenges into opportunities, is crucial for startups in the dynamic environment of I4.0. **H6**: Resilience is a critical determinant for the successful entry of startups into the market. **SCT**, emphasizing a deep understanding of the market and the ability to adapt strategies [18], is vital for startups in I4.0. **H7**: The social cognitive perspective is a critical determinant for the successful entry of startups into the market. **Mentorship**, offering guidance and support [18], is especially valuable for startups in the ever-changing context of I4.0. **H8**: Mentorship is a critical determinant for the successful entry of startups into the market.

Knowledge management, involving both the **exploration** of new ideas and the efficient **exploitation** of existing knowledge [19], is crucial for startups in I4.0. **H9**: Exploration knowledge management is a critical determinant for the successful entry of startups into the market. **H10**: Exploitation knowledge management is a critical determinant for the successful entry of startups into the market.

Support from private, **governmental**, and **university** entities is a critical factor for startups, providing resources, knowledge, and networks [20]. **H11**: Private support is a critical determinant for the successful entry of startups into the market. **H12**: Governmental support is a critical determinant for the successful entry of startups into the market. **H13**: University support is a critical determinant for the successful entry of startups into the market.

Operational and structural variables, such as the **time of the startup** [22] and the **number of employees** [23], are important indicators of a startup's development stage and its ability to successfully enter the market. **H14**: The age of the startup is a critical determinant for its successful entry into the market. **H15**: The number of employees in the startup is a critical determinant for its successful entry into the market.

These hypotheses provide a comprehensive model (Figure 1) of the critical factors that, in various configurations, influence the success of technology-based startups in I4.0 in their market entry.

3 Methodology

This study employed a variety of methodologies to enhance the understanding of key factors affecting startup market entry, with a focus on those utilizing I4.0 technologies in Southern Brazil's ecosystem. A systematic literature review initially identified critical success factors, followed by a survey conducted using the *Qualtrics XM* platform across 120 startups from diverse sectors in Southern Brazil adopting I4.0 technologies. Findings revealed most startups had developed a product or Minimum Viable Product (MVP), yet over half encountered financial difficulties. Further analysis covered internal organization, competencies of founders and employees, information systems, and social resources.

Introduced configurational theory [10], positing that certain condition combinations are linked to desired outcomes through causality. This theory underlines purposiveness and causal complexity, suggesting outcomes can result from various factor combinations and the impact of specific factors varies based on their interactions with others. fsQCA is a methodological approach employed to examine complex causal relationships among variables. By integrating fuzzy set theory with qualitative comparative analysis (QCA), it effectively addresses the uncertainties and inaccuracies inherent in many phenomena. This study utilizes fsQCA to evaluate qualitative data, thereby identifying multiple pathways to successful market entry for startups leveraging I4.0 technologies.

The study's sample construction, as per [24], did not require random selection, allowing for flexible sample sizes. This flexibility facilitated detailed examination of large datasets or focused analysis on smaller samples, enhancing result robustness and addressing endogeneity concerns. Variable calibration (5%, 50%, 95% thresholds as per [11]) was crucial in assessing factors' market guidance relevance for startups. fsQCA calibration transformed raw data into a normalized scale, filtering out insignificant relationships and identifying significant configuration sets, thus illustrating the impactful combinations for startup in the market.

4 Results

Initially, the study characterized technology-based startups focused on I4.0 in the ecosystem of southern Brazil, with a sample of 120 startups. These startups provided data related to a series of critical factors in configurations of startups using I4.0 technologies that were identified from the truth table to penetrate the market. This technique allows for the identification of patterns of combinations of crucial variables for the success of these companies. The conservative solution covers all possible events within the dataset, not excluding any potentially relevant factors. The parsimonious solution takes a more reductionist approach, focusing on the most essential elements, while the intermediate solution balances the two previous approaches. In this study, the conservative solution was chosen due to its ability to incorporate all critical factors, ensuring a more comprehensive and detailed analysis.

After verifying reliability, the fsQCA methodology was implemented, including data calibration, consistency checks, truth table construction, and generation of possible configurations. The subsequent analysis focused on the critical factors present, absent, and irrelevant in the eight identified configurations, providing a comprehensive and detailed understanding of the dynamics of these companies in the specific context of the technological ecosystem of southern Brazil.

Among the eight possible configurations identified by fsQCA, all of them emphasize the importance of Resources as a central condition. Each configuration was analyzed based on its raw score, unique score, and consistency, revealing how different combinations of critical factors influence startups in reaching the I4.0 market. These results underscore the complexity and interdependence of support networks that sustain the development of I4.0 startups, highlighting the importance of multiple stakeholders in strengthening this innovative ecosystem.

The eight configurations identified in this study highlight the importance of Resources as a central condition for the success of I4.0 startups in the market, varying in complexity and the relevance of other critical factors and control variables: Configuration 1: Emphasizes Resources as fundamental, including most other critical factors and the control variable of time of existence. The team size variable is negated, and university incentives are considered non-essential. It has a high raw score (0.096) and high consistency (0.928); Configuration 2: Highlights Resources with all critical factors and control variables present except for government incentives, which are non-essential. It has a raw score of 0.081 and consistency of 0.928; Configuration 3: Also prioritizes Resources, with all critical factors present. The team size variable is negated, and time of existence is non-essential. It has a raw score of 0.099 and consistency of 0.915; Configuration 4: Resources are crucial, with the negation of time of existence, team size, private investments, and university incentives. It has a raw score of 0.079 and consistency of 0.915; Configuration 5: Resources are central, negating the variables of time of existence, team size, open innovation, and university incentives. It has a raw score of 0.068 and consistency of 0.905; Configuration 6: Resources are essential, with the fewest critical factors present and negation of various variables, including dynamic capabilities and government incentives. It has a raw score of 0.061 and consistency of 0.901; Configuration 7: Focuses on Resources, negating the team size variable and exploration and exploitation of knowledge factors, and government incentives. It has a raw score of 0.065 and consistency of 0.906; Configuration 8: Concentrates on Resources, negating dynamic transformation capabilities, mentorship, and government and university incentives. It has a raw score of 0.055 and consistency of 0.906.

5 Conclusion

The research conducted offers a comprehensive examination of the startup ecosystem within southern Brazil, delineating a significant operational heterogeneity across various sectors, which integrate a plethora of technologies associated with I4.0 [25]. Despite encountering financial constraints and shortcomings in strategic planning and organizational routines, these enterprises demonstrate a robust capacity for innovation. The complexity and dynamism of their operational environment necessitate an adaptive and multifaceted strategy for successful market penetration.

Utilizing the fsQCA method, the study investigates eight distinct configurations that facilitate the success of startups based on I4.0 technologies. Each configuration embodies a unique amalgamation of critical factors, indicating multiple avenues to success. This underscores the significance of resource availability, dynamic capabilities (Sensing, Seizing, Transforming), open innovation, resilience, and mentorship as pivotal elements enabling these startups to establish, adapt, and prosper in the marketplace. Furthermore, collaboration with external stakeholders, including private investors, government entities, and academic institutions, proves vital in constructing essential support networks for the development and market consolidation of I4.0 startups.

The analysis of specific combinations of critical factors that lead to market success provides valuable insights for entrepreneurs and startup founders. Moreover, investors and policymakers can discern priority areas for support and intervention within this challenging and continually evolving technological ecosystem. The study enhances the understanding of technology-based startups aligned with I4.0, contributing to the burgeoning literature in this dynamic field of study.

The implementation of the fsQCA methodology marks a significant methodological contribution by revealing the intricate causal relationships among multiple critical factors in I4.0 technology startups. This approach introduces a novel perspective on understanding the configurations of critical factors that propel startups towards market success. Furthermore, it yields considerable implications for startup management theory, aiding entrepreneurs and managers in navigating this complex and dynamic environment. The study's limitations, centered on I4.0 technology startups in southern Brazil, highlight the necessity for future research to explore more diverse and expansive geographic contexts, examine additional influential factors such as leadership styles and technology maturity [26] [27] [28], and undertake longitudinal studies to better understand and generalize findings across various emerging markets. Managerial implications from our research suggest that the success of I4.0 technology startups critically depends on viewing digital technologies as core resources, developing adaptive competencies, and leveraging strategic leadership to effectively navigate complex and evolving markets.

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