Critical success factors for technology-based startups

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Abstract: Technology-based startups (TBSs) significantly contribute to the generation of jobs and economic development; therefore, the success of these companies should be guaranteed. However, despite their importance, TBSs have a high failure rate worldwide. The objective of this study is to identify CSFs for TBSs based on the analysis of the information systems theory, as well as theories on human, social, and organisational behaviour. This descriptive empirical study performed a simple correspondence analysis of the perceptions of 125 CEOs of TBSs located in Peru using student's t-test. The following effects were identified: technological surveillance → knowledge absorptive capacity, knowledge absorptive capacity → perceived performance of a product and/or service, knowledge absorptive capacity → dynamic capability, knowledge absorptive capacity → innovative and entrepreneurial culture, the perceived performance of a product and/or service → customer satisfaction, and the quality of a product and/or service → customer satisfaction. The results of the simple correspondence analysis showed that all identified relationships were valid using student's t-test at a 95% confidence level, with a high or very high effect, except for the impact of knowledge absorptive capacity on the innovative and entrepreneurial culture. This study identified ten CSFs for TBSs.

Keywords: technology-based startup; TBS; critical success factors; CSFs; IT startup; new technology-based firm; entrepreneurship.

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1 Introduction

Many readers associate Peru with its history and the Incas (Dana, 1988). The end of the 1980s Peru was submerged in economic crisis (Nishimura and Tristán, 2011). In the 1990s, as a result of a stable economy, companies formed by one person grow in Peru (Chaston and Scott, 2012). In addition, from the new century onwards, a large number of young people with a business vision emerged with the aim of creating new business initiatives. According to the Central Reserve Bank of Peru the 60% of production is done informally, 40% of the labour force work is self-employed in informal micro-enterprises (Dana and Mallet, 2014). According to the Global Entrpreneurship Monitor Report (2017) Peru ranked first in the entrepreneurial spirit index in Latin America (Serida et al., 2017), and in 2019 Peru was the fifth country with the most entrepreneurs worldwide.

In many countries, there are increasing number of innovative businesses being created, in particular new technology-based companies (startups) (Hormiga et al., 2010). Krejci et al. (2015) have shown that technology-based startups (TBSs) are new, including temporary companies whose business model is based on technology and innovation, and that these companies have a high potential for growth and scalability. TBSs have been recognised by governments worldwide for their contribution to economic stability and growth (Wei-Wen, 2009) and are considered the primary contributors to job creation (Sulayman et al., 2014) and technological innovation. Some leading technology companies, including Apple, Cisco, eBay, Qualcomm, and Intel, were startups reliant on external funding during their formative years (Spiegel et al., 2015).

The impact of TBSs on the global economy is significant (Van Gelderen et al., 2005). However, these companies have a high failure rate worldwide (Colombo and Grilli, 2005; McAdam and McAdam, 2008). Ejermo and Xiao (2014) reported that from 1990 to 2000, only 21% of TBSs in Sweden survived for more than five years, and Hyder and Lussier (2016) found that more than 80% of startups in Pakistan failed in the first year of operation. Furthermore, most startups are small with limited resources and compete with large and experienced companies (Schneider et al., 2007).

Prohorovs et al. (2018) reported that TBSs have received a lot of attention in entrepreneurship literature in the last two decades. Reynolds and Miller (1992) were the first to study critical success factors (CSFs) for TBSs. This research has continued, including in 2017 when Santisteban and Mauricio described 21 elements that are critical for entrepreneurial success. However, the failure rate of these companies is high, suggesting the presence of other CSFs.

This study identified ten CSFs for TBSs: technological surveillance, knowledge absorptive capacity, the perceived performance of a product and/or service, the quality of a product and/or service, customer satisfaction, staged financing, the support of a business incubator, innovation and entrepreneurship ecosystem, the dynamic capability of the entrepreneurial team, and innovative and entrepreneurial culture. Five of these factors were supported by the theories of absorptive capacity, expectation confirmation, dynamic capability, and the success model of information systems proposed by Delone and McLean.

The impact of CSFs was assessed by analysing the perception of entrepreneurs from 125 TBSs. The results of the simple correspondence analysis (SCA) indicated that the effect of all factors was either high or very high. Through a graph that shows which factors are related to success, i.e., the closer two data points are to each other, the closer their relationship is to each other, and the stronger is their influence.

This article has seven sections. Section 2 investigates the literature on TBSs, the characteristics of business success, and known CSFs for businesses. Section 3 describes other CSFs for TBSs and 12 hypotheses. Section 4 addresses the research methodology used to corroborate the relevance of these factors and hypotheses. Sections 5 and 6 present the results and discussion, respectively, and Section 7 concludes.

2 Literature review

This section presents a literature review on CSFs for startups.

2.1 Startup

There are different definitions of a startup (Table 1), and there is no consensus on its definition. Because in the literature there are several studies that attempt to define a startup and it is concluded that there is no standard definition. However, there is agreement that startups are small and characterised by innovation, rapid growth, scalability, and high risk. Therefore:

> "A startup is a small, dynamic, flexible, high-risk company that has a reproducible and scalable business model and provides innovative products and/or services."

In addition, TBSs were defined as *companies that provide innovative IT-based products and/or services*.

Table 1 Definitions of startup

Source	*Definitions*
Kakati (2003), Spyros and Nickolaos (2012)	Temporary organisations that use advanced technology to create innovative products and/or services.
Chorev and Anderson (2006), Thiranagama and Edirisinghe (2015)	Organisations at an early stage of development.
Gimmon and Levie (2010)	Dynamic and flexible companies that evolve along with the market.
Ries (2011), Chen et al. (2019)	Organisations that create new products and/or services in an environment of high uncertainty.
Blank and Dorf (2012)	Temporary organisations with a reproducible and scalable business model.
Festel et al. (2013), Sefiani and Bown (2013)	Technology-based small and medium companies with a high likelihood of success and that tend to lack the financial resources necessary to create a robust business model because of the company's limited experience and the small number of employees, requiring external funding to sustain growth.
CAF (2015)	Business initiatives operated by entrepreneurial teams that identify a business opportunity with high growth potential on a regional or global scale.
Hale (2019)	Company that is designed or created to try to grow very quickly.
Krejci et al. (2015), Prohorovs et al. (2018)	Emerging and temporary companies with potential for rapid growth and scalability and whose business model is based on innovation and technology.
OECD (2016)	Innovative companies that provide solutions to emerging problems or create new demands by developing new business models.
World Economic Forum (2018)	Emerging and intrinsically innovative technology companies.
Petru et al. (2019)	Scalable companies with low incremental costs and potential for significant growth in the short-term.
Garcia-Muiña and Navas-López (2007), Konsek-Ciechonska (2019)	Organisations that create new products or services in conditions of high uncertainty and search for business models that, once tested, can promote business growth

2.2 Business success

There are different definitions of what success is for startups, and no consensus exists in the literature (Table 2). For instance, entrepreneurs define success as the ability to generate new jobs and achieve personal fulfilment, whereas investors define success as the ability to make profit (Roa et al., 2018; Kim et al., 2018; Cabrera and Mauricio, 2017).

Table 2 Definitions of the success of startups

ID	*Definition*	*Source*
D1	Achieve the company's goals and objectives and have effective management.	Davidsson et al. (1994), Anh et al. (2012), Yoon-Jun (2010), Yoo et al. (2012), Hyder and Lussier (2016)
D2	High financial performance.	Morteza et al. (2013), Dornberger and Zeng (2009), Preisendorfer et al. (2012), Spiegel et al. (2015)
D3	Increase in sales and profits, and the increase have to be similar to or higher than the industry average.	Oakey (2003), Hormiga et al. (2010), Strehle et al. (2010)
D4	Businesses that allow free time and promote well-being.	Oakey (2003), Chirjevskis and Dvortsova (2012), Balboni et al. (2014)
D5	Success is defined by the number of jobs that the company has generated.	Maine et al. (2010), Banda and Lussier (2015)
D6	Market share and number of clients.	Van Gelderen et al. (2005), Kim and Heshmati (2010)
D7	Being purchased by another company or being listed on the stock market.	Colombo and Grilli (2010), Krejci et al. (2015), Hyder and Lussier (2016)
D8	Meet the demands of employees and customers.	Strehle et al. (2010), Pirolo and Presutti (2010)
D9	Develop high-quality products and/or services that help satisfy unmet needs and improve people's lives.	Hyder and Lussier (2016), Sulayman et al. (2014), Kim and Heshmati (2010), Yoo et al. (2012)

The conditions for achieving success are limited. For instance, the increase in sales cannot be determined if a TBS makes a single purchase of a product and/or service or the company is for sale. Job positions do not apply to IT companies that can operate with a few workers because processes and services are fully automated. Market participation does not apply to TBSs whose clients are large companies that use their services permanently, such as fintechs, which are acquired by large banks. However, success involves making profits, selling products and/or services, meeting the demands of customers, selling the company, or being listed on the stock market. Therefore:

> "Successful startups meet the demands of customers and organisations, have higher profits than other companies in the same industrial sector, are acquired by another company for a price higher than its value, and have a stock market value higher than its base value."

The proposed definitions of TBS satisfies those shown in Table 2, except for D5 and D6, because the possibility of being sold to a large company or having a stock market value higher than its base value satisfies D1 and D7, having profits higher than the industry average satisfies D2 and D3, meeting the demands of employees through business success satisfies D8, and meeting the demands of customers satisfies D4 and D9.

2.3 Identification of critical factors of success

In the present study, CSFs were considered elements that affected the success of startups (Abou-Moghli and Al-Kasasbeh, 2012). A large number of studies identified CSFs for TBSs A total of 1.013 potential studies were identified, and 21 factors were identified in

the state-of-the-art study by Santisteban and Mauricio (2017), who analysed 74 articles on this topic (Table A1). Positive and negative factors are shown as + and –, respectively.

3 New critical factors identified

This section details and supports new CSFs that positively influence the success of the TBSs.

3.1 CSFs

Seventy-seven theories related to information systems, as well as theories on human, social, and organisational behaviour, have been reviewed in relation to business success. The following CSFs were identified on the basis of these theories and other data sources:

- Technological surveillance (F1) is the systematic identification, analysis, dissemination, and exploration of technical information used for business survival and growth (Ko and An, 2019). Roa et al. (2018) have shown that technological surveillance allows innovative organisations to obtain information on other products and/or services or emerging technologies, thereby achieving sustainable success.
- Knowledge absorptive capacity (F2) is the ability of the business team to recognise, assimilate, and apply external knowledge to the organisation to add value to customers (Senivongse et al., 2019).
- Perceived performance (F3) is high performance in delivering a high-value product and/or service to the customer (Arefin et al., 2019). A high level of performance in meeting customer's expectations creates brand loyalty and promotes business growth.
- Quality (F4) is the set of inherent characteristics or properties of products and/or services, which meet the needs of customers and allow a company to achieve business success (Al-Fraihat et al., 2020).
- Customer satisfaction (F5) is currently the primary goal of small, medium, large, national, and internal companies (Bocken, 2015). It is key to business sustainability and growth (Luna-Perejon et al., 2019). However, companies vary in how successful they are in maintaining customer satisfaction, which looks different for each company.
- Staged financing (F6) is the set of financing instruments provided by different actors of the entrepreneurship and innovation ecosystem (local governments, angel investors, and private companies, among others) to assist companies in achieving sustainable growth and success during each stage of the TBS life cycle (Honorine and Emmanuelle, 2019).
- The support for a business incubator (F7) creates environments and conditions that facilitate the formation and success of new startups (Murray, 2019). The main benefits of business incubators are their ability to expedite the launch of innovative products and/or services in the market, provide access to risk capital and funding

agencies, as well as the advice, mentoring, and support of business experts during the first years of operation.

- The innovation and entrepreneurship ecosystem (F8) is the relationship between public and private entities and entrepreneurs, which facilitate the success of emerging technology-based companies (Corrales-Estrada, 2019). This ecosystem offers many advantages to innovative companies, including access to funding sources, trained personnel, and business networks.
- Dynamic capability (F9) is the ability of organisations to integrate and build internal and external competencies to quickly address changing market conditions (Arora et al., 2019) and systematically solve problems. Therefore, dynamic capability is a source of competitive advantage and business success (Arora et al., 2019).
- Innovative and entrepreneurial culture (F10) is the ability to identify opportunities and obtain resources that can transform opportunities into successful ventures (Roy et al., 2020). Corrales-Estrada (2019) shows that the culture of pioneering organisations includes aspects related to the workforce and working environment. The two elements necessary for the success of an organisation are creative employees and culture of innovation (Corrales-Estrada, 2019). The growth and success of companies depend on the talent pool and the ability to develop an innovative business culture in line with local demands.

The identified CSFs and definitions are summarised in Table 3.

3.2 Hypothesis

The relationships between CSFs and TBSs success were established and 12 hypotheses were formulated to meet the research objective (Figure 1).

Figure 1 Initial conceptual model

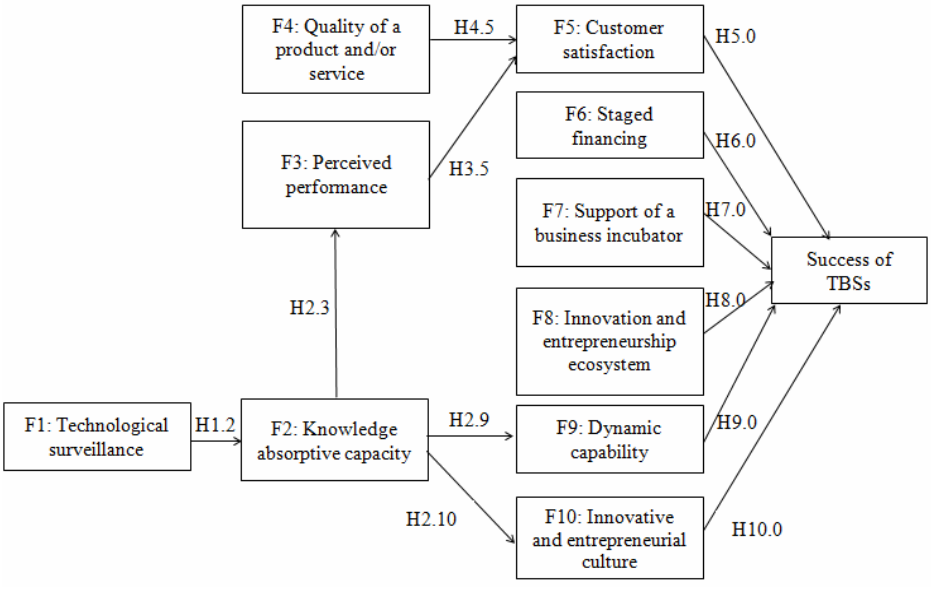


Table 3 New factors influencing the success of TBS

ID	*Factor*	*Definition*	*Justification*
F1	Technological surveillance	An organised and permanent way of obtaining external information on science and technology, analysing it, and turning it into knowledge for decision-making.	Ko and An (2019), Roa et al. (2018)
F2	Knowledge absorptive capacity	The ability of the entrepreneurial team to identify, assimilate, transform, and exploit knowledge.	Absorptive capacity theory (Senivongse et al., 2019)
F3	Perceived performance	The high performance of a product and/or service acquired by customers.	Expectation confirmation theory (Arefin et al., 2019)
F4	Quality of a product and/or service	The characteristics of a product or service that satisfy the needs of customers.	Delone and McLean IS success model (Al-Fraihat et al., 2020)
F5	Customer satisfaction	Meeting or exceeding customer expectations through a product and/or service.	Delone and McLean IS success model (Luna-Perejon et al., 2019)
F6	Staged financing	The development of adequate financing instruments throughout the life cycle of TBSs.	Honorine and Emmanuelle (2019)
F7	Support of a business incubator	Business incubators involved in training, support, and sustainable growth.	Murray (2019)
F8	Innovation and entrepreneurship ecosystem	The set of public and private institutions and people that support innovation and entrepreneurship.	Corrales-Estrada (2019)
F9	Dynamic capability of entrepreneurs	The potential of the entrepreneurial team to solve risk situations and/or problems.	Dynamic capabilities theory (Arora et al., 2019)
F10	Innovative and entrepreneurial culture	Generating original ideas to improve business success.	Roy et al. (2020), Corrales-Estrada (2019)

3.2.1 Technological surveillance (F1)

Technological surveillance is more relevant for organisations whose raison d'être is innovation, as is the case for TBSs. These companies should adopt an organised, selective, and permanent process of technological surveillance as a business model to identify scientific and/or technical innovations or new market threats. Therefore, the entrepreneurial team should exploit external knowledge (F2) to predict its potential market and create or improve products and/or services. Therefore, we conclude that:

Hypothesis H1.2 Technological surveillance improves knowledge absorption capacity.

3.2.2 Knowledge absorption capacity (F2)

Knowledge absorptive capacity directly and indirectly affects the value of a product and/or service, improves processes, increases production capacity, reduces costs, and

improves technology and innovation, and consequently increases the value of a product and/or service. This added value benefits customers (F3). Therefore, we conclude that:

Hypothesis H2.3 Knowledge absorption capacity improves perceived performance.

Furthermore, the ability to absorb external knowledge allows organisations to develop new skills to cope with complex situations, increasing the chance of business survival and growth (Lasch et al., 2007). Sulayman et al. (2014) described dynamic capability as the potential of a company to generate new knowledge (F9) based on the continuous creation, improvement, and expansion of local knowledge. Therefore, we conclude that:

Hypothesis H2.9 Absorption capability improves dynamic capability.

Chirjevskis and Dvortsova (2012) have shown that knowledge absorptive capacity is a learning process oriented towards innovation. [Colombo et al. (2004) demonstrated that this capacity was converted to specific business strategies, and their strengthening sought to maximise intellectual assets and improve organisational culture (F10).] Therefore, we conclude that:

Hypothesis H2.10 Knowledge absorption capacity improves the innovative and entrepreneurial culture.

3.2.3 Perceived performance (F3)

The high value of a product and/or service improves customer satisfaction, stimulating repeated purchases and appreciation of the value of TBSs (F5), increasing the interest of other customers in purchasing the product and/or service, and ultimately increasing sales. Therefore, we conclude that:

Hypothesis H3.5 Perceived performance improves customer satisfaction.

3.2.4 Quality of the product and/or service (F4)

TBSs cannot achieve success without guaranteeing the high quality of products and/or services. Therefore, providing quality products and/or services is crucial to satisfy customer needs. Strehle et al. (2010) and Hormiga et al. (2011) have shown that customers appreciate products and/or services that are of high-quality and meet or exceed their expectations (F5). Therefore, we conclude that:

Hypothesis H4.5 The quality of a product and/or service improves customer satisfaction.

3.2.5 Customer satisfaction (F5)

The theory of Delone and McLean's IS success model postulates that the higher customer satisfaction, the greater the probability of acceptance of the organisation; in addition, the higher customer satisfaction, the greater the acceptance of the products and/or services provided by TBSs, i.e., product sales increase. Therefore, we conclude that:

Hypothesis H5.0 Customer satisfaction improves the success of TBSs.

3.2.6 Staged financing (F6)

Funding organisations with innovative business models are fundamental for the long-term survival and growth of businesses (Honorine and Emmanuelle, 2019). Given that startups have innovative business models, we can affirm that:

Hypothesis H6.0 Staged financing improves the success of TBSs.

3.2.7 Support of a business incubator (F7)

The support of a business incubator increases the likelihood of success of companies with reproducible and scalable models (Murray, 2019). Considering that startups have a reproducible and scalable business model, we conclude that:

Hypothesis H7.0 The support of a business incubator improves the success of TBSs.

3.2.8 Innovation and entrepreneurship ecosystem (F8)

The innovation and entrepreneurship ecosystem generates the financial conditions necessary for business growth and development and is critical for the success of TBSs (Corrales-Estrada, 2019). Therefore, the better the ecosystem, the higher the probability of forming successful ventures. Based on this argument, we can affirm that:

Hypothesis H8.0 The innovation and entrepreneurship ecosystem increases the success of TBSs.

3.2.9 Dynamic capability (F9)

TBSs are flexible and adaptable to changes and, therefore, are susceptible to risky situations (Sulayman et al., 2014) that impact business success. Dynamic capability, i.e., reacting quickly and effectively to different situations, mitigates these risks. Therefore, we conclude that:

Hypothesis H9.0 Dynamic capability improves the success of TBSs.

3.2.10 Innovative and entrepreneurial culture (F10)

TBSs generate disruptive ideas and foster a culture of innovation, and all team members develop and adopt creative behaviours. Fini et al. (2009) have shown that resourceful organisations do not achieve success without having an innovative culture that allows for the development of new products and/or services. Therefore, given that startups are creative, we conclude that:

Hypothesis H10.0 Innovative and entrepreneurial culture increases the success of TBSs.

The 12 proposed hypotheses are shown in Table 4. Each prediction is shown as Hx.y, in which ‘CSFx affects CSFy’ and ‘CSFx affects success S0’.

The effects of ten CSFs on TBSs success are shown in Figure 1. Factors F5–F10 directly affects entrepreneurial success, whereas factors F1–F4 indirectly affect success.

Table 4 Hypothesis matrix: factor vs. factor and success

Factors	*Factors*					*Success*
	F2	*F3*	*F5*	*F9*	*F10*	
F1	H1.2					
F2		H2.3		H2.9	H2.10	
F3			H3.5			
F4			H4.5			
F5						H5.0
F6						H6.0
F7						H7.0
F8						H8.0
F9						H9.0
F10						H10.0

4 Methodology

This section describes the process of data collection and analysis of results.

4.1 Data collection

A questionnaire was used for data collection. An online survey in Spanish was developed using Google Forms (Survey Google Form, 2018) based on the proposed model. The survey was applied to the CEOs of TBSs of six generations supported by non-reimbursable funds of the National Innovation Programme for Competitiveness and Productivity (Innóvate Perú, 2018) of the Ministry of Production of Peru from May 2018 to July 2019. The objective of the survey was to determine the perception CEOs have about CSFs for TBSs. In addition, the survey considered the effect of CSFs in each stage of business development, which is the subject of another study.

The survey contains five sections. Section 1 provides general data on TBS managers (eight questions). Section 2 describes the general characteristics of a TBS (seven questions). Section 3 assesses the opinions on business success (two questions). Section 4 evaluates the relationship between CSFs and the success at each stage of business development (eight questions). Section 5 examines the relationship between CSFs and the success of a TBS (one question). Only Sections 1, 2, and 5 were covered in this study. The questions in Section 5 were evaluated using a five-point Likert scale to assess the degree of influence, as follows:

1 none

2 low

3 intermediate

4 high

5 very high.

After preparing the survey, a pilot test was conducted to validate the questions. The pilot test was carried out by 15 CEOs who verified whether the items were adequately related to the hypotheses. The wording of the questions was corrected to guarantee the use of appropriate language.

People were invited to participate in the Innóvate Perú survey by letter or e-mail. In addition, the survey was completed in-person by entrepreneurs from several TBSs during different business events in Lima, which were organised by several business incubators supported by Innóvate Peru. In total, 130 responses were obtained. Of these, five were discarded because of incomplete or inconsistent responses.

4.2 Results analysis

The following statistical analyses were performed:

1 data reliability (reliability and internal consistency using Cronbach's alpha)

2 descriptive analysis of the study population (demographics; mean, variance, mode, and distribution of responses)

3 SCA (a measurement of the relationship between a CSF and success of a TBS)

4 validation of results using student's t-test to verify the hypotheses.

5 Results

5.1 Data reliability

Cronbach's alpha was used to estimate data reliability. The validity of an instrument is the degree to which it measures what it was proposed to measure. The closer the alpha is to 1, the higher the internal consistency of the data. The validity of the instrument is acceptable if the alpha is higher than 0.70 (Streiner, 2003). Cronbach's alpha was equal to 0.91 using R software, confirming data reliability (Figure 2).

Figure 2 Reliability of survey data using R software

```
Reliability analysis
 raw_alpha std.alpha G6(smc) average_r S/N    ase mean   sd median_r
      0.91       0.9       1     0.051 9.3 0.0098  3.6 0.15    0.021
```

5.2 Descriptive analysis of the study population

Of the 125 TBSs, 79% of companies were run by men, 38% of participants were aged 25 to 34 years, 94% of participants had previously owned a business, and 48% of entrepreneurs had completed postgraduate studies. Most TBSs (56%) had four workers, and 84% operated in the city of Lima. The classification of the responses according to the business sector and financial support (seed capital or venture capital) is shown in Table 5. A total of 53% of startups worked in the area of education (Edtech, entrepreneurship that uses technology to improve teaching and learning) and health (Healthtech, a company

that resolves health challenges), and 94% of the respondents were supported with either seed capital or venture capital.

Table 5 Classification of respondents

Sector	*Financial support with seed capital or venture capital)*	*Frequency*	*(N = 125)*	*Percentage*
Edtech	Yes	38	41	33%
	No	3		
Fintech	Yes	18	19	15%
	No	1		
Foodtech	Yes	13	15	12%
	No	2		
Healthtech	Yes	24	25	20%
	No	1		
Insurtech	Yes	5	5	4%
	No	0		
Legaltech	Yes	6	6	5%
	No	0		
Retailtech	Yes	13	14	11%
	No	1		

The mean, variance, and mode of the responses on the perception of CSFs for TBSs are shown in Table A2. The average perception was greater than 3.7, indicating that the effect of CSFs was high.

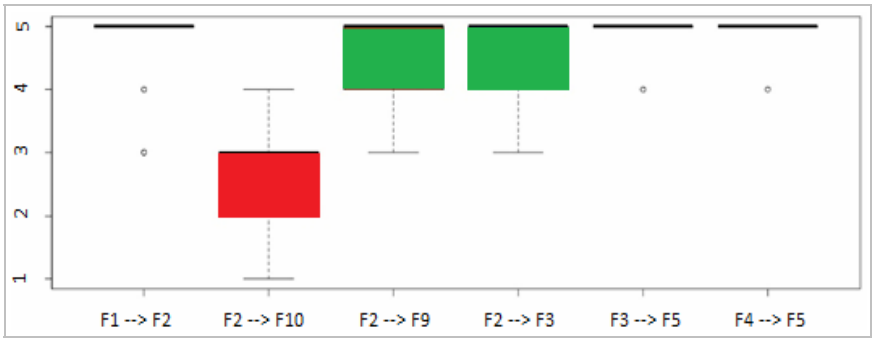
For the descriptive analysis of the population, boxplots were used for data distribution. The boxplot shows the opinions entrepreneurs have on the relationships between CSFs. The median scores of the relationships F1 → F2, F2 → F9, F2 → F3, F3 → F5 and F4 → F5 were 5, indicating that the effect was very high [Figure 3(a)]. However, the median score of the relationship F2 → F10 was 3, indicating that the effect was intermediate. Black lines represent values close to a level of influence. Therefore, the boxplot is flat. White dots correspond to outliers.

The boxplot in Figure 3(b) shows entrepreneurs' opinions on the effect of each CSF on success of a TBS. The median scores for F5, F7, F8, and F10 were 5, indicating a very strong impact. However, the median values for F6 and F9 were 4, demonstrating a strong influence.

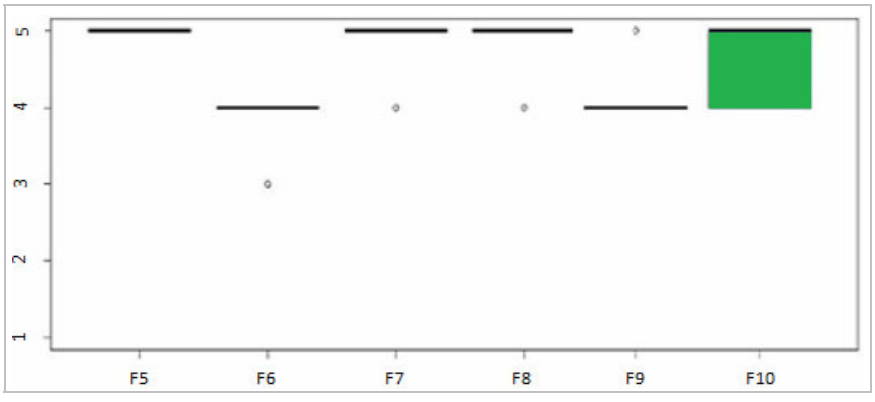
5.3 SCA

The objective of SCA is to determine the degree to which each CSF influences entrepreneurial success. The eigenvalues for SCA between each factor and success, as well as the variance and percentage of the variance of each component, are shown in Table 6. The first two components could explain approximately 97% of the data (82.4% + 14.5%). Therefore, components 1 and 2 (C1 and C2) were used to build a contingency table (Table 7).

Figure 3 Boxplot of the relationship between CSFs and the success of TBSs, (a) F1 → F2, F2 → F10, F2 → F9, F2 → F3, F3 → F5, F4 → F5 (b) F5, F6, F7, F8, F9 and F10 → success (see online version for colours)



(a)



(b)

Table 6 Eigenvalues of analysis of the CFSs that contribute to the success of TBS

Component	*1*	*2*	*3*	*4*	*5*
Value	0.088721	0.015659	0.003174	0.000152	1e–06000
Percentage (%)	82.4	14.5	2.9	0.1	0.0

Table 7 Contingency table of the CSFs that contribute to the success of TBS

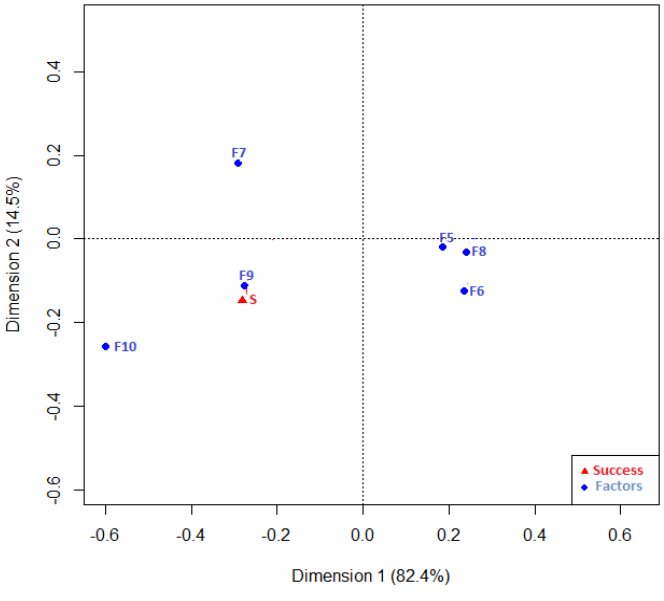
Factors	*F5*	*F6*	*F7*	*F8*	*F9*	*F10*
Mass	0.105756	0.007140	0.331102	0.002231	0.243641	0.310129
ChiDist	0.653062	0.525904	0.187348	0.837097	0.343751	0.245247
Inertia	0.045104	0.001975	0.011621	0.001563	0.028790	0.018653
Dim. 1	–2.014208	–0.928072	0.619762	0.786974	–0.978128	0.809318
Dim. 2	–2.055927	–0.891296	–0.156543	–0.985416	1.457746	–0.249399

A contingency table was created to graphically represent the effect of CSFs on success (Table 7) and shows the degree of contribution of each factor to C1 and C2, the relationship between each factor and C1 and C2, the total frequency of each data point

(mass), the value of the chi-square distribution (ChiDist), and the contingency value (inertia).

In the plot graph (Figure 4), the scores of the factors that affected success (value = 1) were ≥ 4, whereas the scores of the factors that exerted no effect (value = 0) were < 4. The graph shows which factors (blue points) are related to success (red triangle), i.e., the closer two data points are to each other, the closer their relationship is to each other, and the stronger is their influence.

Figure 4 SCA of the CSFs that contribute to the success of TBSs (see online version for colours)



With respect to the effect of different CSFs, the results showed that:

a F5, F6, and F8 had a weak impact

b F7 exerted a moderate effect

c F9 and F10 had a strong influence.

5.4 Student's t-test

In this section, the student's t-test (McMullen, 1939) was applied to verify the hypotheses proposed in Section 3. The null hypothesis (H_0) and the alternative hypothesis (H_a) were formulated so that H_a mathematically stated what we wanted to demonstrate, and H_0 stated the opposite; H_a was accepted if H_0 was rejected and vice versa. H_0 and H_a were defined according to the following decision rules:

- $H_0 = \mu < 3.7$ (entrepreneurs believe that the average level of influence of a factor on the success of a TBS was lower than 3.7).
- $H_a = \mu > 3.7$ (entrepreneurs believe that the average level of influence of a factor on the success of a TBS was higher than 3.7).

Student's t value and the degrees of freedom were calculated at a 95% confidence level. To accept or reject H_0, the probability of error (p-value) was calculated using the equation proposed by Monroy and Rivera (2012) [equation (1)]. The level of significance (α) was 5%. If the p-value was greater than α, H_0 was accepted and H_a was rejected. If the p-value was less than the level of significance (α), H_0 was rejected and H_a was accepted.

$$t = (\bar{X} - u) / (s / \sqrt{n}) \quad (1)$$

where $\bar{X}$ is the mean, μ is the mean specified in the null hypothesis, s is the standard deviation, n and is the sample size.

The t-test results of the correlation between six CSFs and the relationship between these factors and the success of TBS according to equation (1) are shown in Table 8. The correlations, t values, degrees of freedom (df), p-value, confidence interval, and estimated minimum and maximum mean values are shown in Table 8.

Table 8 Results of the student's t-test

Hypothesis	*t*	*df*	*p-value*	*Confidence*	*Estimated mean*		*Result*
				(%)	*Min*	*Max*	
H1.2	30.20	125	5,13E–62	95	4.8373	4.9548	Support
H2.3	11.35	125	6.84E–22	95	4.4887	4.6953	Support
H2.9	16.28	125	6.13E–34	95	4.6255	4.7985	Support
H2.10	–19.49	125	0.095	95	2.4578	2.7422	No support
H3.5	24.78	125	1.03E–50	95	4.7655	4.8985	Support
H4.5	26.30	125	7.59E–57	95	4.7842	4.9118	Support
H5.0	6.475	125	2.53E–10	95	4.9787	4.9906	Support
H6.0	13.58	125	7.65E–26	95	3.8516	3.9564	Support
H7.0	49.59	125	3.99E–63	95	4.9140	4.9899	Support
H8.0	61.25	125	1.71E–65	95	4.9367	4.9993	Support
H9.0	1.746	125	9.63E–05	95	3.9967	4.0512	Support
H10.0	18.59	125	5.72E–41	95	4.6576	4.8144	Support

The p-value was less than 0.05 for most hypotheses (H1.2, H2.3, H2.9, H3.5, H4.5, H5.0, H6.0, H7.0, H8.0, H9.0, H10.0), indicating that H_a was accepted. Therefore, we can affirm with 95% confidence that the average score was ≥ 3.7, demonstrating that the identified CSFs had a strong influence on entrepreneurial success (Table 8).

Hypothesis H2.10 was not supported ($p > 0.05$) at a 95% confidence level, indicating that knowledge absorptive capacity (F2) had a weak impact on the innovative and entrepreneurial culture (F10).

6 Discussion and future research

The results of the descriptive analysis of the study population showed that there was a high or very high influence between each CSFs and the success of TBSs, The median scores for F5, F7, F8, and F10 were 5, indicating a very strong impact (very high influence). However, the median values for F6 and F9 were 4, demonstrating a strong

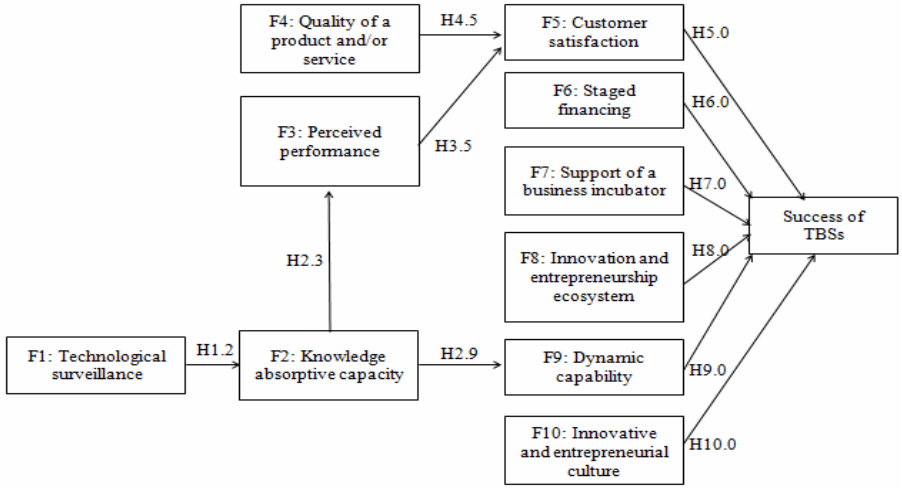
influence (high influence), i.e., indirect effects. For instance, technological surveillance (F1) indirectly impacted business success through knowledge absorptive capacity (F2) [Figure 3(a)], and user satisfaction (F5) directly affected success [Figure 3(b)].

Furthermore, the SCA results showed that all identified CSFs had a high to very high effect on success when considering approximately 97% of the data.

The results of student's t-test (Table 8) confirmed that 11 of the 12 hypotheses were valid because they were empirically tested and theoretically supported, whereas hypothesis H2.10 – knowledge absorptive capacity (F2) innovative and entrepreneurial culture (F10) – was rejected because the hypothesis test considered a strong effect to have an average score greater than $\mu = 3.7$. The resulting weak effect could be explained by the characteristics of TBSs in Peru, in which most of the surveyed TBSs focused on know-how and innovation but not on research since these businesses do not have a research culture, in contrast to spin-offs.

The final conceptual model contained ten factors and 11 relationships and, therefore, constituted a robust model because of its theoretical foundation (Figure 5).

Figure 5 Final conceptual model



6.1 Future studies

Factors F5–F10 should be analysed at each stage of development of a TBS (seed, early, growth, expansion, and exit) to identify the factors that promote growth, strategic business development and starge success, and mitigate the risk of failure.

7 Conclusions

The ten CSFs for TBSs are technological surveillance (F1), knowledge absorptive capacity (F2), perceived performance (F3), the quality of a product and/or service (F4), customer satisfaction (F5), staged financing (F6), the support of a business incubator (F7), innovation and entrepreneurship ecosystem (F8), dynamic capability (F9), and

innovative and entrepreneurial culture (F10). These factors were supported by several theories, including knowledge absorptive capacity, expectation confirmation, dynamic capability, and the success model of information systems. F5–F10 directly influenced business success, whereas F1–F4 indirectly influenced success.

An interpretation of the results leads to the following conclusion:

- Several studies identified CSFs for TBSs. However, there is no consensus on the definition of startup success. Therefore, success has been interpreted as increased sales, customer satisfaction, satisfying the demands of customers and organisations, having profits higher than the industry average, being purchased by another company for a price.
- The results of SCA of 125 TBSs in Peru showed that all relationships, except for H2.10, had either a high or very high effect on entrepreneurial success.
- Student's t-test results confirmed that 11 out of the 12 hypotheses were valid with a 95% confidence level. The final conceptual model contained ten factors and 11 relationships.

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Appendix

Table A1 CFSs that influence the success of TBSs

Factor		*Definition*	*Source*
1	Industry experience (+)	Company founders with industry experience have a reliable and extensive network of contacts that facilitate entrepreneurial development and growth.	Thiranagama and Edirisinghe (2015), Hyder and Lussier (2016), Pugliese et al. (2016), Rojas and Huergo (2016)
2	Business experience (+)	The business experience of company founders facilitates business development and prevents management errors.	Gartner and Liao (2012), Mueller et al. (2012), Bocken (2015), Pugliese et al. (2016)
3	Academic training (+)	Academic training in management courses by company founders improves business growth.	Hyder and Lussier (2016), Pugliese et al. (2016), Rojas and Huergo (2016)
4	Technological and business capabilities of the team (+)	Technical and managerial skills, abilities, and knowledge necessary to obtain a competitive advantage.	Yoon-Jun (2010), Groenewegen and De Langen (2012)
5	Experience in research and development (+)	Previous experience in research helps create innovative products.	Baum and Silverman (2004)
6	Experience in management (+)	The experience of entrepreneurs in managing the resources necessary to achieve success. It also describes the competencies (attitudes, skills, or abilities) required to meet objectives and goals.	Arruda et al. (2013), Cannone and Ughetto (2014), Thiranagama and Edirisinghe (2015), Hyder and Lussier (2016)

Source: Santisteban and Mauricio (2017)

Table A1 CFSs that influence the success of TBSs (continued)

Factor		*Definition*	*Source*
7	Entrepreneurial leadership (+)	The characteristics and skills of an entrepreneur to lead the organisation to meet its objectives.	Schneider et al. (2007), Wei-Wen (2009)
8	Gender of the entrepreneur (+)	The participation of men and women as company founders.	Friar and Meyer (2003)
9	The age of the entrepreneur (+)	This factor is relevant for creating a business, and the probability of establishing a business decreases as the entrepreneur's age increases.	Oakey (2003)
10	Motivation of the entrepreneur (+)	The company founder's motivation represents his commitment to a business project or plan	Ganotakis (2012), Greve and Salaff (2003)
11	Organisational size (+)	The number of employees. The larger is the size of the entrepreneurial team, the larger is the talent pool.	Joshi and Satyanarayana (2014), Cannone and Ughetto (2014), Thiranagama and Edirisinghe (2015), Rojas and Huergo (2016)
12	Organisational age (+)	Years of operation of the company from its inception.	Haltiwanger et al. (2012)
13	Product innovation (+)	The rate at which innovative products and/or services are introduced into the market.	Ardito et al. (2015)
14	Location (+)	The geographic location of a startup and the regional proximity to suppliers and customers facilitates business growth.	Hormiga et al. (2011)
15	Clustering (+)	Group of interrelated companies that work in the same industrial sector and collaborate strategically to share benefits.	Maine et al. (2010), Yoon-Jun (2010), Mueller et al. (2012)
16	Partner (+)	A person or company with which an agreement or alliance is maintained.	Sefiani and Bown (2013)
17	Government support (+)	The financial support of government through seed capital in the initial stage of business development, and support programs for TBSs.	Lasch et al. (2007), Anh et al. (2012), Arruda et al. (2013), Pugliese et al. (2016)
18	Venture capital (+)	Entrepreneurial capital that supports high-potential and high-risk TBSs in the growth phase.	Bertoni et al. (2011), Grilli and Murtinu (2014), Bocken (2015), Almakenzi et al. (2015)
19	Level of competition (+)	The level of competition between TBSs from the same industrial sector.	Song et al. (2008), Arruda et al. (2013)
20	Regional dynamism (-)	The high rate of change in the local environment.	Timmons and Spinelli (2004)
21	Science and technology policy (+)	Laws established by political authorities for the development of science and technology.	Scarborough and Zimmerer (2003)

Source: Santisteban and Mauricio (2017)

Table A2 Mean, variance and mode of the responses on CFSs that affect success of TBSs

Hypothesis	*Mean*	*Variance*	*Mode*
H1.2	4.90	0.33	5
H2.3	4.59	0.58	5
H2.9	4.71	0.49	5
H2.10	2.60	0.80	3
H3.5	4.83	0.38	5
H4.5	4.85	0.36	5
H5.0	4.98	0.14	5
H6.0	3.90	0.30	4
H7.0	4.95	0.21	5
H8.0	4.97	0.18	5
H9.0	4.02	0.15	3
H10.0	4.74	0.44	4