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Research paper



Prediction Modeling of Software Startup Success By PLS-SEM Approach

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Abstract

With the fact that the tendency of startup business fail, it is necessary to understand factor influencing the startup success. It is understood that the lack of knowledge of how to start business creates uncertainty. The uncertainty may increase the likelihood of startup failure, which leads to economic loss. This paper aims to develop a predictive model of startup success in identifying factors and variables influencing startup success. This study also explores ways to compile and validate predefined startup prediction models in the startup business environment. Furthermore, the significance of factors and variables have also been identified to predict software startup success. The results showed that there were 18 significant factors influencing software startup success. These include the characteristics of the founders, quality of the startup organizations, support of resources, environmental conditions, performance of value creation processes, and effectiveness of competitive strategies. The result also showed that six variables contributed significantly (74.8%) in the prediction of software startup success.

Keywords: *prediction modeling; startup; software startup; startup success; structural equation model; pls-sem approach*

1. Introduction

The study conducted by [1] stated that Gross Domestic Product (GDP) per capita value tends to decrease based on the Global Innovation Index (GII) ranking sequence. This indicates that the higher level of innovation of a country is indicated by achieving a higher ranking in GII; thus, the per capita income of the country also tends to increase.

Development of entrepreneurship nowadays has driven by the emergence of consumers in the internet and cellular markets that leads to the burst of the dot-com bubble. The wide use of the internet and cellular devices drives the development of software that increases the number of startups. Ease of access to the potential market and the low cost of service distribution attract the modern entrepreneurs. Research [2] stated that inspired by the success of startup business, the number of software business grows rapidly. The software startup is the organization of software developers that focuses on developing high and innovative technologies, with little or no-operation history, which aims to expand the business aggressively in the highly measurable market.

The life cycle of a startup starts with creating and fixing the conception of an idea into a product that leads to the first sale. This timeframe is characterized by the need to gather small executive teams with the necessary skills to start building products. The stabilization phase starts from the first sale and lasts until the product is stable enough to be used by new customers without causing over-head cost for product development. The growth phase begins with a stable product development process until it reaches the determined market share size and growth rate. Finally, a startup evolves into a mature organization, where product development becomes powerful and can be a proven process for new product discoveries.

A startup is usually a temporary situation, where the maturity of work experience and market domain knowledge lies at the basis of current workplace analysis, thereby reducing extreme uncertainty. Although there are successful startups, however, most startups fail within the first two years of operation. Thus, more research is required to investigate and help beginners to meet their challenges and guide their decisions to avoid choices that lead to business failure [3].

Uncertainty on the results of startup products on the market has led to new investors and entrepreneurs to examine what made a startup fail, and more importantly, what made a startup successful. Studies concerning these issues are limited, as well as published research by companies that have the resources to collect such data. High uncertainties increase the likelihood of relatively high startup failure. This is in line with what research by [4] state, where approximately 90% of all startup businesses fail.

This paper addresses several aforementioned issue including:

a. Lack of knowledge creates uncertainty about the results of startup products in the market.
b. High uncertainties increase the likelihood of a relatively high startup failure. The failure results in economic losses, which are significantly greater after launching a product, as opposed to in the early phase of startup innovation.

The study focuses on developing a prediction model of startup success in identifying factors and variables influencing startup success. The specific objectives of the study were as follows:

a. To examine factors influencing a startup success, particularly focusing on the factors that can be analyzed based on environmental and financial support.

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b. To create a model based on the concept of startup success in the innovation to observe the change in the relationship model related to the process of achieving startup success.

Refer to research [5] state that with small samples and with complex models that contain formative indicators, PLS-SEM is the preferred approach, and because the goal of this research was to maximize the R2 value of the endogenous constructs, PLS-SEM was deemed an appropriate method to assess the measurement model and test the hypothesized relationships in the full structural model. The predicted success model of a startup was comprised of variables and indicators that had been tested in SEM-PLS.

Influential factors and variables of startup success model were expected to bridge between science and entrepreneurship especially in the field of software innovation to reduce the distance, limitations, and fundamental issues related to the development of software innovation.

2. A literature Review

2.1. Human capital theory

A study [6] state that human capital is a term that describes the hierarchy of skills and knowledge. This theory of study [7] postulates that entrepreneurs with higher input levels should produce superior output. Furthermore, research [8] findings postulate that the theory of human capital supports the view that public welfare is not just a function of capital accumulation, resources, and labor but more influenced by individual knowledge and skills.

2.2. Entrepreneurial success components theory

In this theory, a study [9] develop a key component of startup success through qualitative methods (social typology of aspiring entrepreneurs). This theory views entrepreneurship as a social process because ideas and ambitions appear in social situations. This model is divided into four basic success components, which are ideas and markets, motivation and determination, resources, and abilities.

2.3. Innovation process theory

A study conducted by [10] provides a comprehensive view of the commercialization process of technological innovation by analyzing 23 secondary case studies in companies that have faced this challenge. The results of the study were empirically developed and validated using a qualitative secondary case study sample.

Meanwhile, research [11] state that the requirements to succeed in software innovation is the basic mechanism for employment and the creation of national wealth.

Research [12] explains that innovation is an activity that generates novelty or improvement on one of the following four things: the product or service, process, organization, and or market. Meanwhile, the ability to create innovation is the ability to produce products or services that have global competitiveness in one or more of four things as previously described. The innovation ability can come from a company or other organizations, such as educational institutions or government research companies.

2.4. Theories regarding factors influencing the startup success

Defining company success is not an easy task in many types of businesses, including in newly established or startup companies. Research [13,14] state that at the time of the study, there was no consensus on the definition or the best way to measure the success of a startup.

The studies that have been conducted to analyze the factors or important points underlying and influencing a startup to achieve its success including studies conducted by [4, 15, 16, 17, 18].

Research [15] conducted a systematic literature review of many studies investigating the commercialization performance of invention or innovation in many countries in recent years. The results identified six major factors that have significant effects on the commercialization performance of innovation, which are organizational resources, knowledge management, strategy orientation, organizational support, contextual factors, and collaboration.

Although some research has been done to find out the factors and variables that affect the success of a startup, there are still opportunities for improvement (OFI). Previous studies discussing variables that influence the startup success summarized in Table 1.

Table 1: List of previous studies discussing variables that influence the startup success

No	Author	Year	Assessed Factors	Approach	OFI
1	Roure	1987	individual, team, company, and environment	Exploratory and field study	The study was not tested empirically
2	Gardner et al.	2004	organization, market, environment and technology, strategy, process, regulation, culture, project management, benefit, and risk	Systematic literature review	The study was not followed by a qualitative study
3	Lau et al.	2012	Entrepreneur skill, willingness	Hierarchical regression analysis	The study focused on readiness to try qualitatively
4	Tung et al.	2013	The organization resources, knowledge management, strategy orientation, organization support, contextual factors, and collaboration	Systematic literature review	The study was not followed by a qualitative study
5	Sharma & Madan	2014	Willingness, business experience, intellectual ability, and work experience	Chi-square test	The study only used fresh graduates as respondents
6	Wohlfeil and Terzidis	2014	25 parameters influencing the success of technological innovation commercialization	An empiric and qualitative case study	The study was not specific to startup business
7	Seun & Kalsom	2015	Entrepreneurship, opportunity, personal characteristic, environment, quality, training	Deductive hypotheses	The study only used a single variable
8	Schillo et al	2016	Entrepreneurship readiness, regulation, norm, cognitive, conductive, startup intent	Double regression	The study did not analyze productivity
9	Silva et al	2016	Founder characteristic, startup characteristic, capital, and external factors	An empiric study	The study was only about Portugal

From the literature review, several variables that influence the success of a startup were used to compile a matrix to construct a model of startup success in a software startup.

3. Method

The study used a hypothetical-deductive approach. The development of a hypothetical model consisting of the structural model

and measurement model in the form of path diagrams was based on the justification of the theory using data analysis techniques of structural equation modeling using partial least squares (SEM-PLS). SEM was used because it allows testing of a series of relations simultaneously, and it can also explain the relationship between several variables that exist in the study. The equations in SEM described all relationships between constructs (dependent and independent variables) involved in the analysis. Constructs are factors that cannot be directly measured or factors that were represented by several variables. The general research design of this study is shown in Table 2.

Table 2: Technical details of the research

Location	Bandung Digital Valley (BDV) Indonesia
Methodology	Structured questionnaire
Sampling procedure	Simple random sampling
Study population	48 founders of startups of Bandung Digital Valley
Sample size	48 founders of startups of Bandung Digital Valley
Response rate	65.40%
Unanswered items	0%
Level of confidence	90%
Data collection period	December 2017 - January 2018

From the literature review, several variables influencing the success of a startup were used to compile a matrix to construct a model of startup success in a software startup.

4. Prediction modeling of software startup success

4.1. Develop a structural model

Dependent Variable

In this study, the dependent variable is a startup success. This is considered a successful startup, an organization in the first development stage with high levels of innovation, inherent risk and measurable business models that operate four years or more. The dependent variable is a binary variable that takes the value of one if it is a successful startup or zero if no successful startup.

Characteristic of founder

The founder is the foundation of startup, and the characteristics of the founder can determine the starting point of the startup culture and its interaction with the business environment. Experience, knowledge, age, and education have been recognized as relevant human capital characteristics that are considered important factors for organizational performance [19, 20] in [21]. Even though the relationship between human capital and success is acknowledged to have a positive relationship, the value seems to vary significantly between studies.

Human capital is positively correlated with the founder's ability to find and exploit business opportunities and develop better business plans and strategies. It helps the founders acquire resources such as financial and physical capital, which in the early stages help to reduce capital shortages [22].

Formal education is one of the most studied indicators related to human capital. This indicator correlates with the entrepreneurial ability to successfully find and take advantage of business opportunities, problem-solving, motivation, and confidence. Thus, it is recognized that entrepreneurs with parents who own a business have a positive relationship with the success of their company [23].

As has been explained above, there is a relationship between the characteristics of individual founders with resources, organization startup, environment, value creation process, competitive strategy and startup success.

H1: Characteristics of founder influence the startup success significantly.

Quality of the startup organization

Characteristics and nature of the organization are other categories that affect business success. Even though the positive effect of the size of the founding team on performance has been recognized, a larger team size does not guarantee better performance. However, the coordination and communication challenges in larger teams should also be considered [24, 25]. It is also important to mention that the attributes of human capital that contribute to business success can have other sources, such as staff other than founders or professional advisers. Businesses that cannot attract and retain qualified employees have a greater chance of failure [26].

The availability of professional advisors provides access to information networks that provide specific data and incentives to succeed. The act of seeking information can also reflect a more comprehensive plan and a higher level of managerial sophistication. For this reason, the availability of professional advisors contributes to business success [27]. Organizations are structured by human capital, but it is important to evaluate internal activities. Formal planning involves the determination of initial goals, the creation and evaluation of different scenarios and strategies, and implementation controls.

The importance of planning, recording, and financial control and their relationship to performance has long been discussed [25]. The availability of a specific business plan is a unique variable that presents a powerful explanation in all successful startup research, which shows a positive influence on business success. Businesses that release products or services that are premature or too old have a greater chance of failure than firms that release products/services that are in the growth stage [26].

As has been explained above, there is a relationship between the startup organization with the competitive strategy to be taken and the success of the startup. Therefore, the following hypothesis is proposed in this study.

H2: The quality of the startup organization affects the startup success significantly.

Support of resources

Resources can be defined as financial, physical, human, and organizational assets that companies use to develop, produce, and deliver products or services to their customers [28]. Resources are the source or supply from which the benefits (output) are produced. Entrepreneurial resources, on the other hand, are defined as a person's tendency to behave creatively, act with foresight, use intuition, and be alert to new opportunities. Entrepreneurial resources are tangible and intangible assets that companies use to exploit competitive imperfections in the marketplace [29]. Entrepreneurial resources include the resources and capabilities of the entrepreneurs themselves [30].

The startup process will work well for the value creation of products that are already part of the overall strategic planning process [31].

If no resources are given, new product ideas in the early stages are often difficult to gain knowledge of markets, customers, and competitors so that they can survive in stage two. Resources, people, and money are channelled into the project for initial market and technical assessment. It is clear that there is a link between resources and competitive strategy and startup success since the initial phase. Therefore, the following hypothesis is proposed in this study.

H3: The support of resources has a significant influence on the startup success.

Environmental conditions

Research [9] in [28] developed a key component of successful startup through qualitative methods (social typology of aspiring entrepreneurs). This theory sees entrepreneurship as a social process because ideas and ambitions appear in social situations. This theory argues that although we may not conclude that entrepreneurs can be developed, they can still be helped to create a successful and sustainable business.

Moreover, many studies (Chowdhury, 1997, Prahlad, 2004, Mintoo, 2006) in [32] have revealed the relationship of entrepreneurial

success to environmental factors, such as the political environment, governance, infrastructure, technology, and others. For example, in [33], startups can choose a more favourable environment [34], manipulate their environment by working with other successful organizations [35] and creating an environment with new norms, values, and models. Several studies have found a great variant in the ability of startups to gain access to stable resources and relationships, which in turn led to differences in early performances of these beginners [37, 38].

Adner (2006) in [39] states that innovations are often not independent. On the contrary, it depends on the changing environment of the accompanying company for its success. This external change, which requires innovation from other actors, instils a firm focus on an interdependent innovation ecosystem. Beyond environmental contingencies, this study also examines vertical integration as a strategy to address ecosystem challenges.

As explained above, there is a relationship between the environment with the competitive strategy to be taken and the success of the startup. Therefore, the following hypothesis is proposed in this study.

H4: The environmental condition influences the startup success significantly.

The performance of a value creation process

The company's competitive advantage depends on its ability to create more value than its competitors (Porter, 1985; Brandenburger and Stuart, 1996) in [39]. Greater value creation, in turn, depends on the company's ability to innovate successfully. This study links this asymmetry in value creation to its impact on catch value and competitive advantage. Thus, it reveals how the structure and sequence of value creation affect the outcome of competition for the catch.

To successfully manage the relationship between corporate strategies and performance, the management team needs to identify specific factors that drive value creation, link the company's strategy to this base value driver, and identify measures that reflect the value of this driver (Ittner & Larcker, 2001, p .353) in [40]. As explained above, there is a relationship between the value creation with the competitive strategy to be taken and the success of the startup. Therefore, the following hypothesis is proposed in this study.

H5: The value creation affects the startup success significantly.

The effectiveness of a competitive strategy

The objective of a competitive strategy is that startup can defend itself from the power of its competitors or to influence the competitors for the startup's sake. According to [34], there are three generic strategies to outperform other companies in the industry, which are cost leadership, differentiation, and overall focus.

According to [41], the startup success variables are entrepreneurial qualities, resource-based capabilities, and competitive strategies. In addition, it is recommended to use some performance criteria to measure the success of a startup, not only a single measurement (such as ROI or market share).

The following hypothesis is proposed in this study

H6: The effectiveness of the competitive strategy has a significant influence on the startup success.

As can be seen in Figure 1, there was one exogenous latent variable, which is the founder (ξ) and six endogenous latent variables, namely:

a. organization (η1) represents of characteristics of the founders variable
b. resource (η2) represents of quality of the startup organization variable
c. environment (η3) represents of environmental conditions variable
d. value creation process (η4) represent of the performance of a value creation processes
e. competitive strategy (η5) represent of the effectiveness of a competitive strategies
f. the startup success (η6).

In addition to latent variables, the SEM also has a manifest variable, which is a variable that can be directly measured. The manifest variable is used as an indicator of the latent construct. The manifest variable is depicted with a grid to form a latent construct. It is manifested with questions to respondents by Likert scale. Respondents will be given a question with five categories of answers that are: strongly disagree, disagree, neutral, agree, and strongly agree (Ghozali, 2005: 11). The manifest variable that forms an exogenous latent construct is given the X symbol while the manifest variable that forms the endogenous latent construct is given the Y symbol. The model depictions accompanied by manifest variables is illustrated in Figure 1.

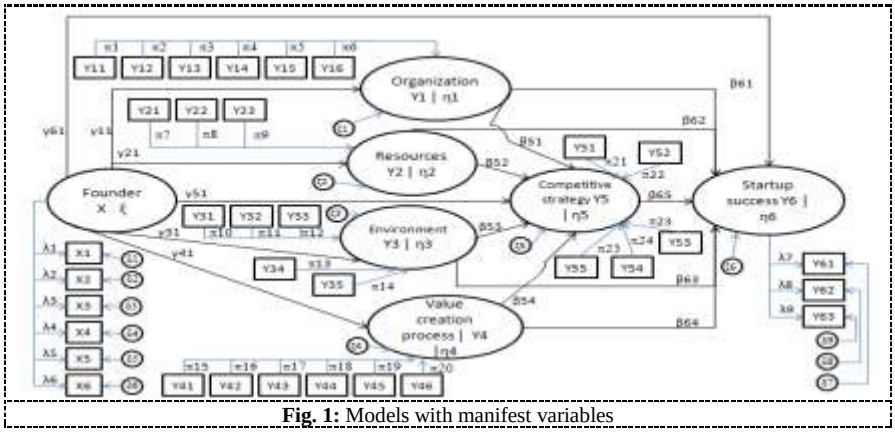

Fig. 1: Models with manifest variables

The symbols in Figure 1 are described in Table 3.

Table 3: Symbols in the manifest model

No	Symbol	Name	Explanation
1.	ξ	Xi	Exogenous latent variables or independent variables that are not influenced by other latent variables
2.	λ	Lambda	Coefficient showing the relationship of the exogenous latent variable to its indicators
3.	δ	Delta	Measurement errorof the exogenous variableindicator
4.	γ	Wy	Coefficient showing the direct relationship of the exogenous variable to the endogenous variable
5.	η	Eta	Endogenous latent variables or dependent variables and can also be transformed into independent variables in other equations
6.	ζ	Zeta	The latent variant variables not explained by the model
7.	π	Pi	Coefficient showing the relationship of the endogenous latent variable to its indicators
8.	β	Beta	Coefficients showing the direct relationship of endogenous variables to endogenous variables or model parameters

The structural equation of the relationships between the variables of Figure 2 can be written mathematically as shown in Table 4.

Table 4: The structural equation of the relationships between variables

	Eksogen		Endogen							Error
Eksogen	ξ		η1	η2	η 3	η4	η5	η6		
η1	γ_{11} ξ	+							+	ζ_1
η2	γ_{21} ξ	+							+	ζ_2
η3	γ_{31} ξ	+							+	ζ_3
η4	γ_{41} ξ	+							+	ζ_4
η5	γ_{51} ξ	+	β_{51} η1	β_{52} η2	β_{53} η3	β_{54} η4			+	ζ_5
η6	γ_{61} ξ	+	β_{61} η1	β_{62} η2	β_{63} η3	β_{64} η4	β_{65} η4		+	ζ_6

4.2. Analysis and results

The startup success was a multidimensional latent variable, and it was difficult to be observed directly. However, it was measured indirectly with a set of measurable indicators that served as proxies. To understand the startup success, a survey was conducted to ask the founder/startup members to build and enlarge their startup. In this survey, founders or startup members were asked to rate their experience on a scale that represents seven latent variables: Founder Characteristics (x), Organization Quality (y1), Resource Support (Resources/y2), Environmental Conditions (Environment/y3), Performance of value creation process (value creation/y4), Effectiveness of competitive strategy (Competitive strategy/y5), and Startup success/y6 success using 5-point Likert scale [(1) strongly disagree, 2) disagree, (3) neutral, (4) agree, (5) strongly agree].

Preparing the Data for SmartPLS

In the startup success model, the survey data was converted to Microsoft Excel and saved in .xlsx format, for subsequent conversion to .csv format. At the time of the experiment, this data set had a sample size of 48 with no missing value, invalid observation or outlier. To ensure SmartPLS could import the Excel data correctly, the indicators were named x1, y12, and so on, placed in the first line of the Excel spreadsheet, and no "string" value (for example, a word or one dot14) was used in another cell.

Running the Path-Modeling Estimation

After the indicators and latent variables were described in SmartPLS, path modelling procedures were conducted by opening the "Calculate" menu and selecting "PLS Algorithm". A pop-up window displayed the default settings. Since there was no missing value in the data set, we proceeded directly to the bottom of the pop-up window to configure "PLS - Settings Algorithm" with the following parameters:

a. Weighting scheme: Path Weighting Scheme
b. DataMatrix: Mean 0, Variance 1
c. Maximum Iteration: 300
d. Abort Criterion: 1.0E-5
e. Initial Weight: 1.0

Output of PLS-SEM

The last result of smartPLS after three steps of measurement is displayed in Figure 3.

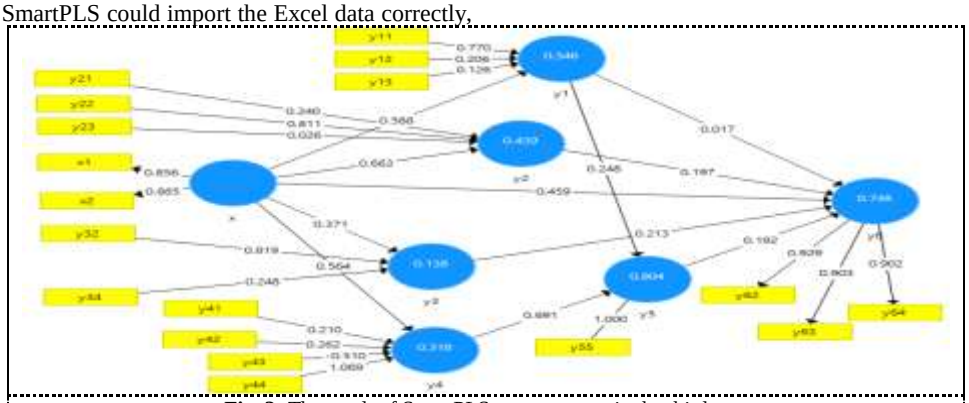

Fig. 3: The result of SmartPLS measurement in the third step

The third model PLS path modeling estimate is shown in Figure 3. Based on the diagram, the following preliminary observations are made:

(i) Explanation of the target endogenous variable

a. The coefficient of determination, R2, is 0.748 for the endogenous latent variable y6 (Startup success). This means that the five latent variables (Founder / x1, Organization / y1, Resource / y2, Environment / y3, Process value creation / y4, and Competitive strategy / y5) show 74.8% variance Startup success.
b. Founder / x1, Organization / y1, Resource / y2, Environment / y3, and Process value creation / y4 together account for 80.4% of the effect on variance Startup success.

(ii) Size and path coefficients on the inner path model

a. Inner model shows that the characteristics of founders / x1 of the competing strategy / y5 has the strongest influence on the Startup success / y6 (0.459), followed sequentially by Environment / y3 (0.213), Resource / y2 (0.197), Competitive strategy / y5 (0.192), and Organization startup / y1 (0.017).
b. The hypothetical pathway relationship between Founder Characteristics / x1 and Startup success is statistically significant.
c. The hypothetical pathway relationship between the startup Organization / y1 and the Startup success is statistically insignificant. This is because the standard path coefficient (0.017) is lower than 0.1.
d. The hypothetical pathway relationship between Resources / y2 and the Startup success is statistically significant.
e. While the hypothetical pathway relationship between Environment / y3, the Startup success / y4 and competitive strategy / y5 are statistically significant.
f. Thus it can be concluded that: The characteristics of the founder, Environment, Resources, and Competitive Strategies, are predictors of a strong Startup success, but the Organization does not predict Startup success directly.

This corresponds to the measurement of the path coefficient, as shown in Table 5.

Table 5: The output of path coefficient in SmartPLS

	Founder	Environment	Organization	Startup success	Value Creation process	Competitive strategy	Resources
Founder		0.371	0.588	0.549	0.564		0.633
Environemnt				0.213			
Organization				0.017		0.248	
Startup success							
Value Creation process						0.691	
Competitive strategy				0.192			
Resources				0.197			

As can be seen in Figure 3, the results of the inner model measurement or structural model determined the relationship between independent and dependent latent variables. There was a value that was lower than zero, which was eliminated at the third step of measurement.

(iii) Outer model weighting

To observe the correlation between the latent variable and the indicator on the outer model, we selected "Default Report" on the "Report" menu because we had a reflective model seen on the numbers shown in the "Outer Loadings" window. The results are shown in Table 6.

Table 6: Results of SmartPLS Outer Loadings

	Founder	Environme	Organiza	Startup Succes	Value Creation process	Competi tive strategy	Resources
x1	0.856						
x2	0.865						
y11			0.972				
y12			0.732				
y13			0.769				
y21							0.764
y22							0.981
y23							0.807
y32		0.983					
y34		0.788					
y41					0.726		
y42					0.795		
y43					0.781		
y44					0.971		
y55						1.000	
y62				0.929			
y63				0.903			
y64				0.902			

As seen in Table 6, there was no indicator in the outer loading that was less than 0.7 or red, which means that all indicators were valid. Therefore, the measurement was stopped at the third step.

The result show that characteristics of founder, support of resources, environmental condition, value creation, effectiveness of the competitive strategy influence the startup success significantly, but the quality of the startup organization not affects the startup success significantly.

5. Conclusion

The results show that the characteristics of the founders, resource support, environmental conditions, the performance of value creation processes, and the effectiveness of competitive strategies, had a significant influence on startup success.

Tests on predictive models with SmartPLS measurements show that six latent variables (founder characteristics, startup organization, resources, environmental conditions, value creation process performance and competitive strategy) contributed 74.8% to predicted startup success.

This study was conducted in Indonesia by the Indonesian people. The study contribute to to inspire other researchers, particularly Indonesian researchers, to continue this study as one effort to improve the success of startup and entrepreneurship by utilizing computer technology. Future research should consider utilizinginnovation pioneers such as investors, innovators, and customers to develop more commercial software innovation in the market..

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