An Engineering Management Approach to Develop a Practical Capital Funding Model for Technology Start-ups

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Dedication

The author wishes to dedicate this research to her son and best friend: Joseph Strohmier. She is most appreciative of his enthusiasm, encouragement, love, and support.

In addition, the author wishes to express her gratitude to her husband, Dr. Douglass Berry, II, for his instrumental support and constant reminder "*Are you done writing?"*.

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Abstract of Praxis

An Engineering Management Approach to Develop a Practical Capital Funding Model for Technology Start-ups

Capital funding models for start-ups are rare, yet they are needed to enable engineers to calculate their capital funding amount needed to complete their equity crowdfunding forms, loan application, or pursue other sources of funding. Funding decisions are frequently performed on an ad-hoc basis with minimal instructions, and with no clearly established methods. In this Praxis, I obtained and analyzed the financial data of fifteen technology start-ups and examined a proposed new practical model to estimate capital funding. The new model enables engineers to calculate their start-up capital funding and it was compared to the Allen's model and to the Gruber's model. This model identifies seven factors obtained from the financial statements to be used in the capital funding calculation: research and development, sales and marketing, general and administrative (income statement accounts) additional paid-in capital, accumulated deficit, accounts payable, and cash and cash equivalent (balance sheet accounts). This proposed practical capital funding model assists engineers and technologists in their process of obtaining capital funding by calculating the capital funding amount needed to complete various funding request forms and enables engineers to answer the question raised by investors and bankers, how much money are you asking.

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List of Acronyms

1 (S)RMR (Standardized) Root Mean Square Residual

2 AVE (CFA only) Average Value Explained

3 CFA Confirmatory Factor Analysis

4 CFI Comparative Fit Index

5 CPA Certified Public Accountant

6 EDGER Electronic Data Gathering, Analysis, and Retrieval

7 EFA Exploratory Factor Analysis

8 FAST Federal and State Technology

9 GDP Gross Domestic Product

10 GFI Goodness of Fit

11 JOBS Jumpstart Our Business Start-ups

12 MDS Multidimensional Scaling

13 NFI Normed Fit Index

14 PCA Principle Component Analysis

15 RMSEA Root Mean Square Error of Approximation

16 RSQ Squared Correlation Coefficient

17 SBA Small Business Administration

18 SBIR Small Business Innovation Research

19 SEC Security and Exchange Committee

20 SPSS Statistical Package for the Social Sciences

21 STTR Small Business Technology Transfer

22	VC	Venture Capital

Chapter 1 - Introduction

Entrepreneurship is a journey that takes the engineer into a new spectrum full of challenges, setbacks, and rewards. It can be hard at times, and not everyone can take on this journey. Once an idea consumes the thoughts of an engineer, he or she may explore the idea, work on it, and make it a reality. In contrast, the engineer may end up not pursuing the idea they once had. The technology and entrepreneurship journals reveal that one in thousands of ideas become a product or service (Schaufeld, 2015).

Taking all start-ups into account, engineering and technology companies are the most likely to fail, with only a 37% success rate after only four years. The industries with the highest success rates are the finance, insurance, and real estate industries, in which 58% of these businesses were still operating after four years (Reid, 2017).

This prompted the questions: Why does the business of technologists and engineers fail in comparison to other professions? Moreover, why do so few of these businesses succeed? Several studies convey that engineers lack management skills, struggle to manage their financials, and believe a good product or service will sell itself.

As a research area, funding management of start-up businesses, in the engineering and technology field is challenging and under-researched. Research data is minimal and published studies are mostly descriptive and lacking substance.

This research uses an engineering management approach to develop a new capital funding model to help current and future engineering and technology entrepreneurs calculate their capital funding needs and be able to complete the Security and Exchange Commission (SEC) Form C for equity crowdfunding, investors and venture capitalists' capital investment presentations, banks and others' applications for capital funding.

The common question raised by bankers and investors is, how much money are you asking? An engineering and technology entrepreneur will usually face unique challenges in answering this question. Estimating the appropriate level of funding is a challenging endeavor. Robust financial information drives the methods and techniques for established companies, while start-ups usually lack this sort of information.

In order to overcome this challenge, this Praxis will focus on developing a capital funding model, which will provide engineers with a practical model to calculate their capital funding amount.

1.1 Problem Description

The Information Technology industry accounts for $1.14 trillion of U.S. value-added Gross Domestic Product (GDP) and 10.5 million jobs with direct and indirect impacts (Select USA, 2017). The number of jobs created directly by the software industry has increased 14.6% since 2014 (Select USA, 2017). There is more than 100,000 software, and IT services companies in the United States, and more than 99% are small and medium-sized firms under 500 employees (Select USA, 2017).

CBInsights completed a study of over a hundred failed start-ups and compiled the top twenty reasons for failures shown in Figure 1-1. The number one reason raised by 42% of the companies was no market and lack of customers for the product or services offered (CBInsights, 2017). The number two reason raised by 29% of the companies was running out of cash and lack of funding. The list continued to outline other reasons of failures such as know the right management team, outcompeted by the competition, pricing, and other similar reasons (CBInsights, 2017).

The Small Business Administration (SBA) states that small businesses use an array of financing options to fund their business ventures. Debt instruments include loans, trade credit, leases, lines of credit, credit cards, and bonds. Equity includes savings, shares, grants, founder's capital, and promissory notes (SBA, 2012).

This research will utilize an engineering management approach to develop a new capital funding model for the engineering and technology entrepreneurs using equity crowdfunding data.

Problem Statement: Technology start-ups failure can be due to lack of capital and causes an adverse impact on the engineers and their start-ups.

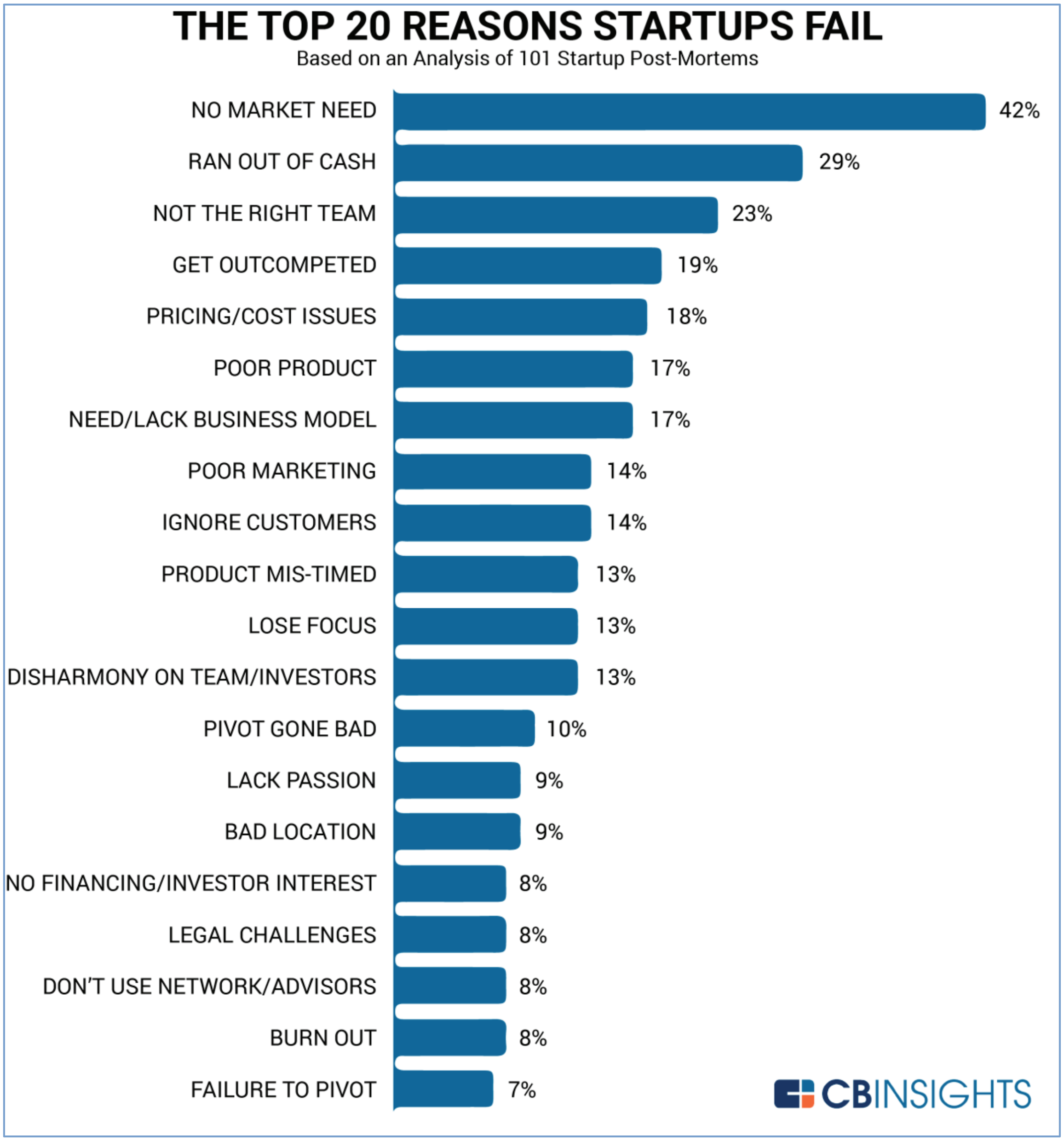

Figure 1-1 CB Insights Top 20 Reasons for Failures (CBInsights, 2017)

1.2 Research Objectives

The primary focus of this research is to provide an alternative model using engineering management approach to address the accuracy in current models. And to estimate a start-up's capital funding amount and to provide a discussion of available funding sources for engineering and technology start-ups.

Hypothesis: If technology start-ups have reliable capital funding model, then they will be able to more accurately calculate their requests for capital funding.

Thesis: A practical capital funding model is needed to assist engineers in calculating their start-up funding amount for soliciting capital.

1.3 Research Questions

The following research questions will be addressed in the literature review, the methodology, and the results sections: What are the available funding sources? What are the challenges faced by start-ups? What are the risks associated with a lack of funding? Why is it important to calculate funding capital? How can the engineer calculate capital funding? What are the other alternative methods to estimate capital funding?

1.4 Solution Approach and Significance

The traditional methods of intuition and rule of thumb are no longer sufficient for the capital funding process. It is especially challenging in the early stages, as technology start-ups usually lack data and detailed guidance. The rapid changes in the funding market continue to be a challenge for engineers and investors alike. Methods to bring technology to market that worked in the past are no longer relevant today. (Schaufeld, 2015) With the global and connected world, the entrepreneur can reach investors outside their zip code, state or country.

The critical role of capital funding in the innovation process of a technology start-up motivates the use of engineering management approach to develop a model to better estimate capital funding for technology start-ups. This proposed model supports the entrepreneur in estimating the amount of funds to be requested from various fund sources, and it enables the engineer to start their capital funding process.

1.5 Organizations of Chapters

The Praxis is organized by chapters. Chapter 2: Literature Review, provides an overview of the challenges and risks facing engineers in their start-ups, discusses current innovation models and capital funding tools, discuss various engineering management methods in building models using exploratory factor analysis, and outlines the different funding sources for technology start-ups. Chapter 3: Methodology, explains the set of procedures used in the Praxis research. Chapter 4: Results and Discussion, describes the outcome of statistical analysis and presents the new Capital Funding model, as well as providing a validation of the proposed model with the Allen's model and the Gruber's model. Lastly, Chapter 5: Limitations. Conclusion and Future Research, presents the application of the new capital funding model and addresses the limitations of the model.

Chapter 2 - Literature Review

One of the most challenging tasks for the start-up entrepreneur is to calculate the amount of appropriate funding required to support the start of a new venture. If a new product or service is unique, the calculation becomes increasingly more difficult because there is no precedent (Allen, 2016).

Determining the appropriate amount of funding and the source of funding can be challenging and overwhelming. The current published lectures and models are usually vague and mostly lack the how-to and the guidance needed. This paper will discuss the traditional and non-traditional funding sources, including the newly introduced equity crowdfunding as a source of funds. Furthermore, this Praxis will use engineering management techniques to better estimate the amount of funding needed in equity crowdfunding.

2.1 Understanding Technology Start-ups

Technology companies' lifecycle typically follows a normal distribution curve as shown in Figure 2-1. The start-up phase, the growth and maturity phase, and the sell-out, or close-out phase (Schaufeld, 2015). The start-up phase is further divided into three stages, and they are the idea stage, the pre-start-up stage, and the start-up stage. 1) In the idea stage, engineers will discuss ideas and will look at how to convert those ideas into a solution. In this phase, discussions concerning minimal investment need and about the what will occur. Once engineers decide it is a good idea that is worth pursuing, they will draft a business plan and will form a new entity. 2) The pre-start-up stage activities include the drafting of the business plan, mapping the timeline for the development of the idea into a product or service, and focusing on how to get from an idea to a product. 3) Next is the start-up stage, where the engineer completes the development of the prototype and pursues the market. In this phase, the engineers will be faced with funding challenges and will likely be pursuing external funding (Leach and Melicher, 2018).

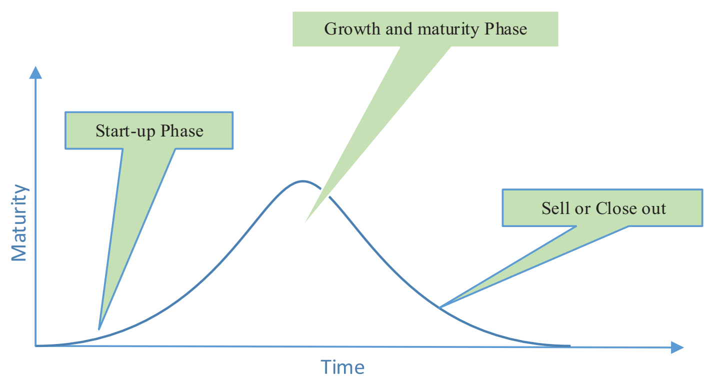

Figure 2-1: Start-up Maturity Normal Distribution

2.2 Technology Start-ups Risks

Technology start-ups and start-ups in general, encounter a numerous amount of risks. Start-ups are inherently risky as they lack resources that accomplished companies have developed. The main common categories of risks are financial risks, market risks, technological risks, and compliance risks. Financial risks include: lack of capital, lack of operating capital, cost control risks, and lack of funds to support the daily operations of the company. Market risks include inaccurate pricing of product or service, lack of consumer needs, a saturated market with other similar products, customer loyalty and likability to competitors, technology product costs, and pricing. Technological risks include hacking of the know-how, patents data, or customer's data (Allen, 2010). Compliance with current federal, state, and local laws and regulations and industry-specific compliance represent significant risks for all start-ups (Allen, 2010). This research will focus on the financial risks inherent in the start-up phase in technology companies.

2.3 Technology Start-up Challenges

Entrepreneurs face challenges throughout the entrepreneurial process. Most start-ups will face the following challenges:

- Human capital challenges include the identifying, hiring, retaining, and developing talents (Wellins, 2017).
- Working capital challenges include the estimating, applying, acquiring, and managing capital (Windaus, 2015).
- Ideas transformation challenges include the adoption of the right business model and the ability to evolve, change and grow with the business. There is no one size fits all business plan. The entrepreneur needs to develop a business plan that will work for their start-up (Schaufeld, 2015).
- Market challenges include learning the market, identifying customers, study the competition, benchmarking, acquiring customers and perform (Allen, 2010).
- Laws and regulations challenges include payroll compliance, tax compliance, industry-specific regulations, state and local laws and regulations.
- Administrative challenges include locating the appropriate office space, obtaining

the applicable insurance, obtaining the required licenses, obtaining applicable financial systems, and track expenses and separate business expense from personal expenses (Kuratko, 2017).

- Technology start-ups' products or services usually face tough competition that may include major corporations worldwide. Major corporations usually have financial sources to develop, build and market their products. Major corporations usually have technical expertise in their research and development, and human resources (Freedman, 2007).
- Start-ups will need to pursue and procure funding from multiple sources (Leach and Melicher, 2018).
- Start-ups cannot guarantee that they will be able to raise enough funds in one offering in crowdfunding. Therefore, they may pursue multiple sources for funds or multiple rounds of crowdfunding (Fallon, 2015).
- If the start-up is not able to raise or obtain sufficient capital throughout their life, they may not be able to execute their business plan, continue operations or they will be forced to cease operations (Fallon, 2015).
- Start-ups usually do not have the infrastructure to allow them to have controls over their financial reporting (Allen, 2010).
- Start-ups historical operating results may not be accurate indicators of their future performance and usually urge the investors not to rely on such results to predict the future start-up performance (Allen, 2016).
- Start-ups face challenges in their ability to manage working capital and in their inability to adjust certain fixed costs and expenses (Windaus, 2015).

- The US and worldwide economies will impact a start-up's performance and its revenue generation. Demands on start-up products or services tend to be tied to economic and business cycles. Increases in the unemployment rate or an extended downturn in the economy could cause the revenue to decline (Freedman, 2007).
- Rapid technology changes, new products and services, and evolving business processes present a challenge for the technology entrepreneur and their start-ups (Schilling, 2017).
- Failure to obtaining and retaining customers could have an adverse impact on the start-up's revenue (Schilling, 2017).

A study by Leach and Melicher conveyed that 40% of business failures cited by business owners were excessive debt, insufficient capital funding, lack of management experience, and unsatisfactory profits (Leach and Melicher, 2018).

The engineering and technology entrepreneur usually faces difficulty answering the following financing start-up questions (Kuratko, 2017):

a. What is the development cost of the product or service?
b. What is the cost of setting up operations?
c. What is the cost of obtaining capital?
d. What are the sources of the fund should the start-ups target?
e. How to estimate cash flow?
f. What will be the return on investment (ROI)?
g. When and how will the investors receive their money back?

In this Praxis, I will focus on the financial aspects of the engineering and technology start-ups.

2.4 Entrepreneurship Models

There are several models and frameworks addressing technology start-up finance. However, they are mostly lacking substance and lack the quantitative method to guide the entrepreneur in calculating capital requests. The following section discusses the models that have substance, and it briefly addresses the funding issue in engineering and technology start-ups.

2.4.1 Allen's Model

Allen's model for calculating start-up cash requirements is driven from the cash flow statement. However, there is a risk because this is an estimate based on a series of estimates. There is also a good possibility that the cash flow statement is not entirely accurate. Therefore, Allen adds a safety margin to mitigate this risk (Allen, 2016).

According to Allen, the cash flow statement is the most important financial statement for the entrepreneur because it portrays the cash position of the company at a specific point in time. It shows the engineering entrepreneur the inflow and the outflow of cash. The cash flow statement also shows when the company is expected to produce a positive cash flow based on sales of its products and services. Cash is the lifeblood of any business, and the entrepreneur needs to be constantly aware of the cash position of their venture (Allen, 2016).

According to Allen, the engineer will need to estimate revenues, expenses, start-up costs from their industry, market, and customer, as well as their knowledge. Figure 2-2 illustrates the steps needed for calculating start-up capital requirements. Allen's start-up capital needs are separated into types of capital resources that will be required: 1) capital expenditures, 2) working capital, and 3) safety margin (Allen, 2016).

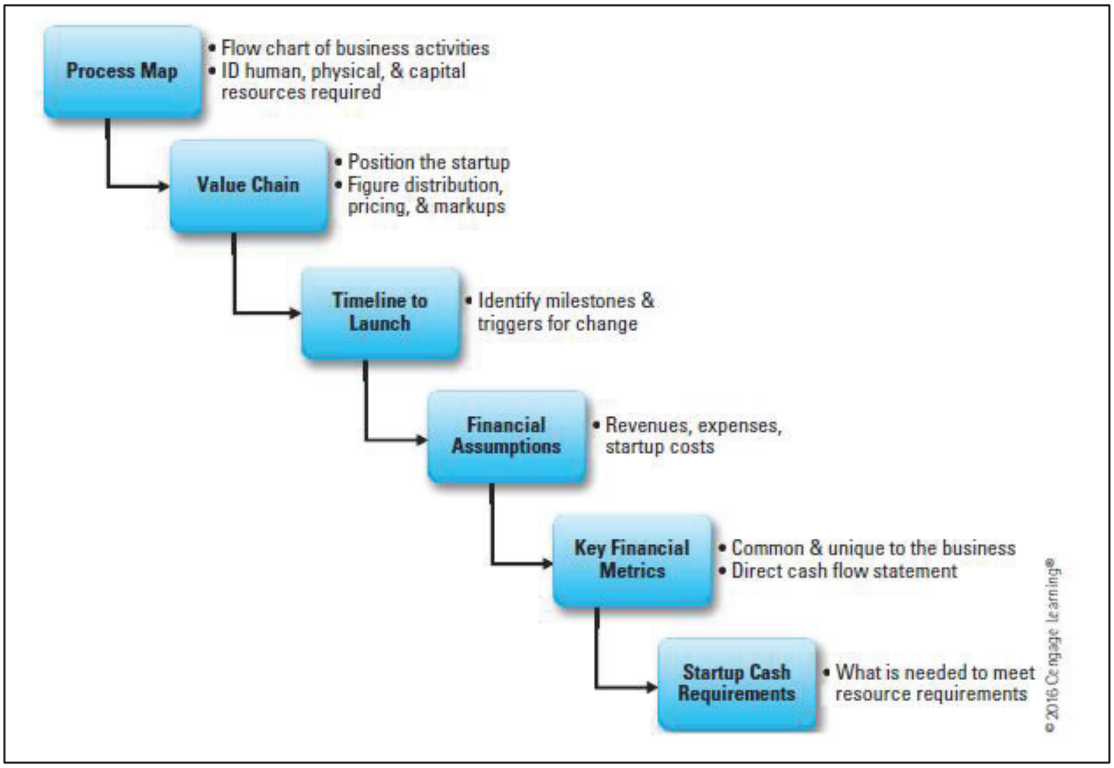

Figure 2-2: Allen's Steps for Calculating Start-up Capital Requirements (Allen, 2016)

Allen's model shown in Figure 2-2 recommends the engineer to construct a business process mapping that addresses the four main resource categories which are the human category, the intellectual category, the financial category, and physical category. In order to determine the resources needed, the entrepreneur should know how their start-up works and create a process map to illustrates how their information will flow through their start-up. This process mapping entails listing needs based on activities, employees and contractors, supplies and equipment, location and office space (Allen, 2016).

Allen's value chain step determines the start-up margins, customers, and the pricing for its products or service. A start-up in the service industry delivers its products directly to customers, while a developing or manufacturing product startup follows a different process and timeline as shown in Figure 2-3 (Allen, 2016).

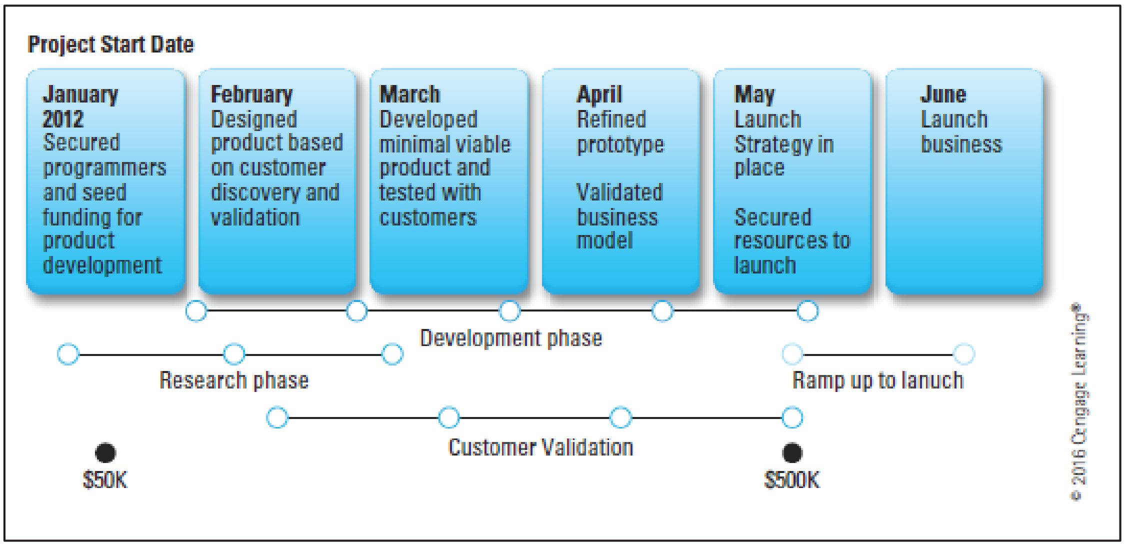

Figure 2-3 Flow of Information in Manufacturing Products (Allen, 2016).

Allen's timeline is for launching a hypothetical product, and it is presented to illustrate the different phases and the potential cost associated with it. For example, in January, the start-up will hire programmers to develop the product and will secure seed funding, approximately $50K to fund the research phase. In the development phase and customer validation phase of the product, the start-up will start looking for $500k to complete the development and launch the product.

There are several knowns, and unknown risks associated with any start-up and the engineer needs to identify as many potential risks as possible. Engineers identify risks, categorize those risks and rank them to create a mitigation plan to reduce or eliminate the impact of those risks.

The following Allen's diagram depicts how the flow of information in a service business, needing to identify resources, also needed to calculate capital:

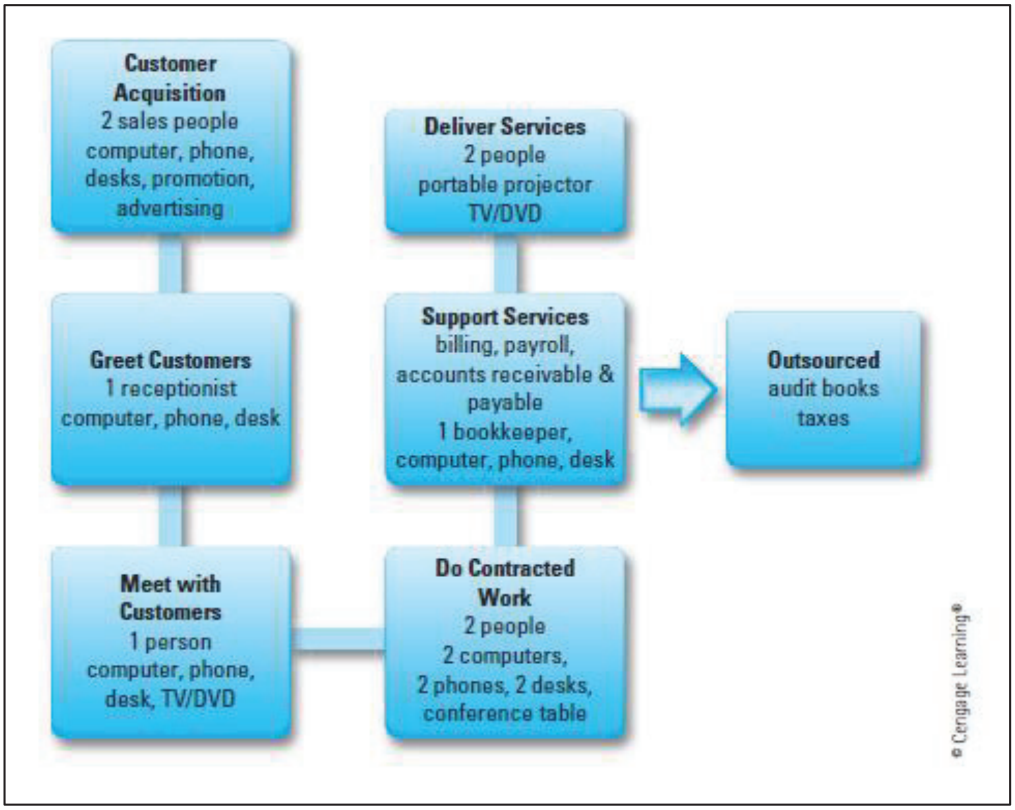

Figure 2-4: Flow of Information in Service Business (Allen, 2016)

Figure 2-4 illustrates the start-up needs of working capital and capital expenditures as it flows from the acquisition to the delivery of the service. The flow in the service business starts with customer acquisition, where the service start-up needs two sales people, and needs two phones, two computers, two desks for those two sales people who will develop a promotion plan and will obtain advertising that will create the cost of sales and marketing. The next step shows a receptionist who will greet customers. Besides the headcount of employees added one person and phone, computer and desk for that receptionist. Next, a start-up person will meet with the customer, that person will need a computer, phone, desk and perhaps TV/DVD to present to the customer the services rendered by the start-up. If the customer likes the service, the start-up will create a contract with the customer for those services. In this step, the start-up will need to have two people to perform the service. Those two people will need two computers, two phones, two desks, and a conference table. Then a support services function is needed which includes billing payroll, and it will need one bookkeeper that will need a phone, a computer, and a desk. Upon delivery of the service, the start-up will need two people with a project to present to the customer their services (Allen, 2016).

In this scenario, the start-up needs seven people, seven computers, seven phones, seven desks, one conference table, one projector, and business and financial software to be installed on their computers. The start-up will also need to outsource their payroll, and taxes service (Allen, 2016).

The start-up financial metrics step discusses the common metrics start-ups use. Examples include the sales forecast, employee and contractor's headcount metric, fixed and variable expenses metric, and the breakeven cash flow. There are specific purpose matrices that the start-up may be able to use such as qualified leads and the customer acquisition costs. In the process to calculate the start-up capital funding, the engineer will need to develop financial assumptions. The engineer will assume how much revenue they will generate in their start-up based on their assumption of the sales of their product or service. The engineer may assume the demand for their products or service by utilizing similar products or service sales history (Allen, 2016).

The engineer will set their prices based on a cost-plus-profit margin. However, that may be too high, and the engineer may resort to a price match to similar products. Alternatively, the engineer may use the competitor pricing as a base for their pricing and assume that the increase in sales will reduce the fixed cost and arrive at the capital needed to develop the product or service (Allen, 2016).

To arrive at Allen's capital requirements, the engineer will add the capital expenditures plus working capital plus a safety margin. Safety margin which is a contingency amount usually represents two to three months of operating expenses based on the probability that the entrepreneur's estimates might be off (Allen, 2016).

$$\textit{Allen Capital Funding} = C + WC + SF \qquad (2.1)$$

Where C denotes capital expenditures, WC denotes working capital, and SF denotes safety margin (Allen, 2016).

2.4.2 Gruber's Model

Gruber offered tips on how to pursue those various types of funding and offered a simple method of determining start-up funding. He was suggesting using the number of employees and multiply that by $15,000 and 18 months (Gruber, 2014). The Gruber method will allow companies to have enough funds to cover its costs for the eighteen-month period. It is important to note that the formula focused only on labor cost and it ignored all other costs (Gruber, 2014).

$$\textit{Funding needs} = N * \$15{,}000 * 18 \qquad (2.2)$$

Where *N* denotes the start-up number of employees (Gruber, 2014).

Gruber's formula is widely used due to the ease of calculation, however, it does not work for those businesses that have a limited number of employees or no employees. It also can be misleading as the basis for the formula is fifteen thousand dollars as the cost of employment per person. While it may work in high cost of living regions, it may not work in areas where the cost of living is much lower. Gruber's model is based on the simple headcount of employees and does not require historical or financial data. The Gruber's model is focused only on labor cost and it ignored all other costs (Gruber, 2014).

The Gruber's framework discussed ways to obtain the capital funding and illustrated several sources to pursue funding such as bootstrapping, family and friends, angel investors, venture capital, crowdfunding and equity-based crowdfunding.

2.4.3 Schaufeld Commercialization Model

The Schaufeld model focused on addressing the economic risks, and it consists of five steps: 1) Sources of Ideas, 2) Opportunity Recognition, 3) Feasibility Analysis, 4) Going to Market Methods, and 5) Project Plan (Schaufeld, 2015). It lacked the how to calculate capital funding for start-ups.

In the third component of the model, he discusses the financial capital needs and its implications on the start-up. The feasibility analysis assists in the decisions of go-no go, abandon, or hold. According to Schaufeld (2015) there are six broad categories of the elements embraced during feasibility analysis and they can be categorized as follows (Schaufeld, 2015):

- Economic Considerations.
- Technical Considerations.
- Operational Considerations.
- Risks Considerations.
- Legal Considerations.
- Strategic Considerations.

Economic considerations usually rise to the top in feasibility studies. Cost estimates are developed using cost models, for example, bills of materials and workflow models, as well as service labor standards and material cost (Schaufeld, 2015).

The model discusses risk management and the practice of risk mitigation. There are financial risks in cash planning and budget. Those risks may result in cash deficits that cause significant exposure to failure. The results of a feasibility analysis should convey a path forward, and it should identify any conditions of uncertainty (Schaufeld, 2015).

The Schaufeld commercialization model addressed economic risks and its feasibility analysis focused on Return on Investment (ROI) and Internal Rate of Return (IRR). It ignored the funding decision support process and funding strategy for a technology start-up.

2.4.4 Leach and Melicher Venture Life Cycle Model

The Venture Life Cycle Model Figure 2-5 illustrates the following five stages in the life-cycle of a successful venture: 1) Development Stage, 2) Start-up Stage, 3) Survival Stage, 4) Rapid-Growth Stage, and 5) Early-Maturity Stage (Leach & Melicher, 2018).

Leach and Melicher discussed short-term financial planning which involved the projection of monthly financial statements for one year or less. However, the model lacked how to calculate capital funding.

Leach and Melicher stressed that access to adequate cash drives the set-up path of any start-ups, however, inadequate cash may limit the venture's ability to grow. Availability of cash considered to be the main reason of anguish in engineering and technology start-ups (Leach and Melicher, 2018).

The process of preparing estimated financial statements for a short-term, usually three to six months, helps the entrepreneur to account for other sources of funding capital needed to support their operations during the projected year. Leach and Melicher discussed the venture's operating cycle and its cash conversion cycle and their importance in managing cash flow (Leach and Melicher, 2018).

A cash budget is a financial tool showing the inflows and outflows of the venture's cash balance over a specific period. The cash budget, for the most part, reverses the impact of accrual basis of accounting and follows simple actual cash basis. In laymen terms, the actual cash in and the actual cash out gets recorded for the cash budget (Leach and Melicher, 2018).

In general, early-stage ventures raise debt capital from individuals and venture lenders. Once they become profitable and are rapidly growing, they conceivably raise debt capital from other traditional financial institutions. The founding venture entrepreneurial team may include angel investors along with venture capitalists as the primary sources of early-stage equity capital (Leach and Melicher, 2018).

The types of financing that typically coincide with each stage of a successful venture's life cycle are (Leach and Melicher, 2018):

- Development Stage – Seed Financing.
- Start-up Stage – Start-up Financing.
- Survival Stage – First-Round Financing.
- Rapid Growth Stage – Second-Round, Mezzanine, and Liquidity-Stage Financing.
- Maturity Stage – Obtaining bank loans, issuing bonds and issuing stocks.

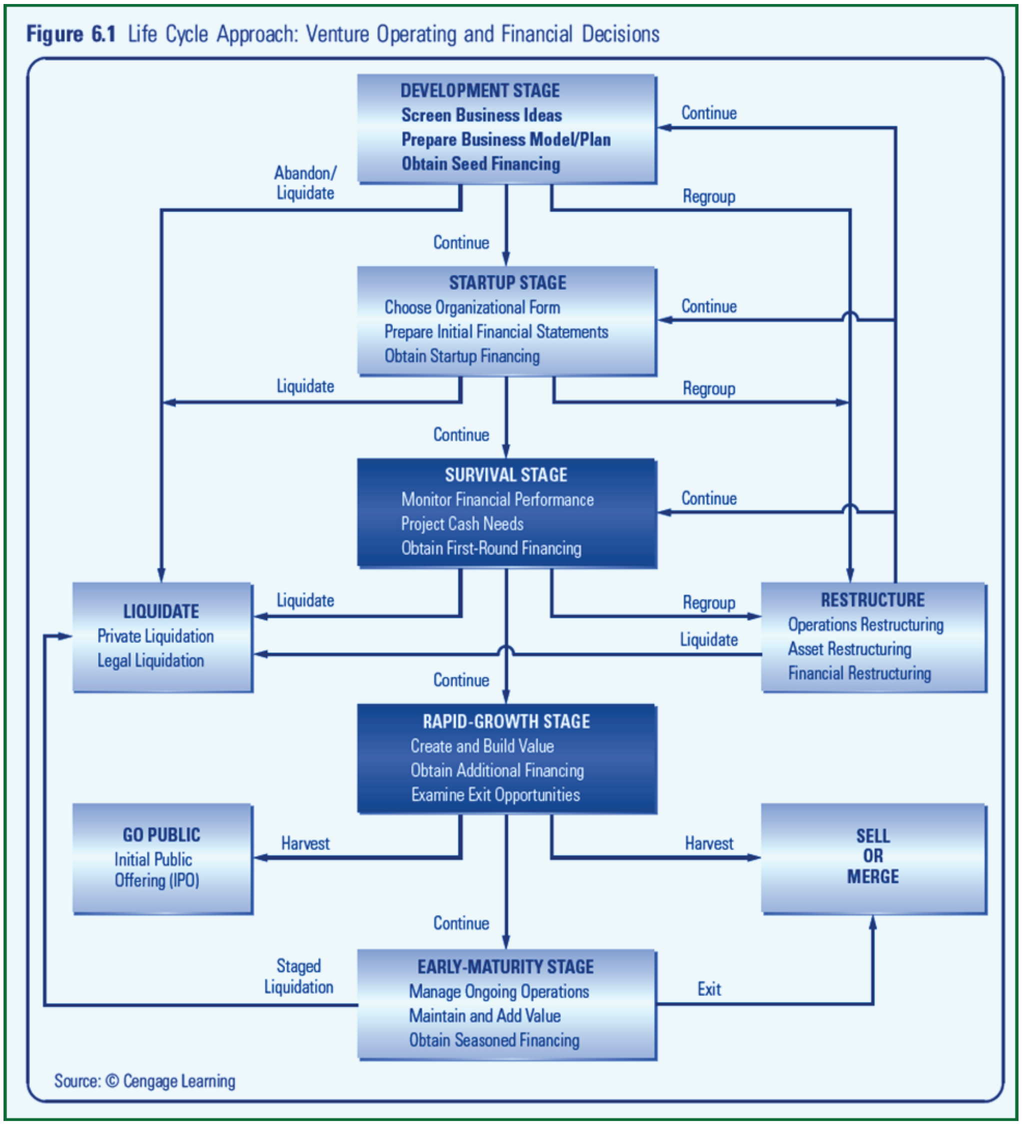

Figure 2-5: Venture Life Cycle approach (Leach and Melicher, 2018)

The Venture lifecycle approach discusses the significant sources of funding associated with each step in the venture lifecycle is as follows:

- Development Stage – The entrepreneur, utilize assets of their own, assets of their family, and financial assistance from friends (Leach and Melicher, 2018).

- Start-up Stage – The entrepreneur will continue to utilize the funding provided in the development stage into the Start-up-Stage. In this stage, the entrepreneur prepares financial statements, and obtains start-up funding by approaching angel investors, and venture capitalists for working capital (Leach and Melicher, 2018).
- Survival Stage – The entrepreneur monitors their financial statements and projects their financial needs. They obtain the first round of funding from venture capitalists, suppliers, customers, government assistance programs, and commercial banks (Leach and Melicher, 2018).
- Rapid-Growth Stage – The entrepreneur, continues to monitor their financial statements and projects their financial needs. They obtain additional funding to assist with their business operations. In this stage, funding may be obtained from their suppliers, customers, commercial banks, and investment bankers (Leach and Melicher, 2018).
- Early-Maturity Stage – The entrepreneur manages their business operations, and has the financial history to allow him or her to seek funding from commercial banks and investment bankers (Leach and Melicher, 2018).

2.4.5 Schilling Technological Innovation Model

Schilling's quantitative methods focused on financial ratios and profitability index, where it can be easily achieved for larger ventures, while the start-up usually does not have this wealth of financial data to perform Shilling's analysis (Schilling, 2017). In the first few stages of start-up and growth, entrepreneurs usually obtain the funding they need for their business from their friends, family, and personal debt (Schilling, 2017).

Start-ups may be able to successfully obtain initial funding through government agencies programs, such as the Small Business Innovation Program (SBIR). However, if the venture idea is promising and the management team has the experience and the track record of success, then the entrepreneur may pursue capital funding from angel investors and venture capitalists (Schilling, 2017).

2.4.6 Financial Models Summary

This financial models discussion provided an overview of the various capital models available. It is determined that the Allen's model is considered to be the industry standard. Furthermore, the Gruber's model suggests that it is the go-to model for entrepreneurs due to its ease of use. Both models use linear equation. This Praxis proposes a practical capital funding model that would be compared to the Allen's and the Gruber's models.

2.5 EFA Based Models

Principal Component Analysis (PCA) aims at reducing the dimensions in a data set where original variables are replaced with Principal Components, which explain the variability in the data. While Exploratory Factor Analysis (EFA) is a method for grouping multiple variables that tend to change together. The method assumes that the dependent variables in a study come from a mixture of several latent variables, where each latent variable follows a unique Gaussian distribution with some noise. By grouping the independent variables based on their correlation, we can detect these latent variables that were not part of the measurements (Raykov and Marcoulides, 2008). Therefore, EFA is the appropriate statistic method for the focus of this research. This subsection discusses other industry models that used Exploratory Factor Analysis as their method of selecting factors to build their models.

2.5.1 Cellular Automaton Modeling of Land Use Change

A study using EFA based modeling by Feng and Tong (2017) was conducted to define the optimal driving factors to simulate land use change based on Cellular Automaton (CA). Three combinations of five non-correlated driving factors were derived from eight candidate factors. Exploratory Factor Analysis with regression was used to search and statistically build the CA model. The researcher validated the model using landscape metrics, overall accuracy (simulation percent error) and spatial autocorrelation (Feng and Tong, 2017).

Feng and Tong (2017) primarily classified the land use patterns from land data images and detected the land use change out of which they created the driving factors of change from vector maps, in the period from 2000 to 2015. The methodology utilized the systematic sampling in order to determine samples for model training from maps that visually presented the factors which effect the change of land use. On the basis of the samples, they used an exploratory regression aimed at evaluating all the possible combinations of the input variables in order to best explain the dependent variable. This analysis determines the weight of the factors through a logistic regression which retrieves the rules for the land transition. The model aimed at stimulating the change in land use and included factors such as neighborhood effects, special constraints, and stochastic factors (Feng and Tong, 2017).

The model was validated by assessing stimulation error, landscape metrics, and spatial autocorrelation. The influencing factors were selected using ArcGIS 10.2, the remote sensing classification was done through ENVI 5.4, while the exploratory regression was applied using Spatial Statistics Toolbox. The researchers conducted logistic regression through GLM in R-Gui 3.3, and the CA model was created using the SmartSEM modeling framework from Feng (Feng, 2016).

The classification of land use created patterns consisting of urban, non-urban and excluded categories which consisted of water bodies, wetlands and ecologically significant areas which represented the spatial constraints in CA modeling. Remote sensing images classification with ENVI 5.2 allowed for the calculation of the probability that the pixel given belongs to the determined type of land use. The overall accuracy of 97.8 and 96.5% indicated that the classified created significant patterns for CA modeling (Feng and Tong, 2017).

In order to model the usage in urban land usage, factors such as distance, neighborhood, constraints and stochastic factors were included. These factors were reported as maps and served as input for CA modeling. The land slope was not considered as their maps were overall flat. Moreover, percent error was used for validation (Feng and Tong, 2017).

Similar to CA modeling, the capital funding model needs to identify financial factors for engineering and technology start-ups. Therefore, exploratory factor analysis will be used in this Praxis.

2.5.2 Multiple Linear Regression Model for the Prediction of Carcass Weight in Akkeci Kids

Keskin, Daskiran, and Kor (2007) analyzed the relationship between carcass weight and body measurements utilizing the factor and multiple linear regression analyses. The sample population counted 82 participants of male Akkeci kids (Turkish goats) who were raised in semi-intensive conditions and measured for the factors of slaughter weight, withers height, body length, chest depth, chest width, chest circumference, leg circumference, leg width, leg length and rump width. After which the animals were slaughtered, and the carcass weights were recorded. The researchers then conducted the Kolmogorov-Smirnov normality test for all the variables tested, and the variables resulted in a normal distribution (Keskin, Daskiran, and Kor, 2007).

Furthermore, the factor analysis performed on variables examined ranked their relative significance and described the patterns of interrelationship with regards to the variable measured, that is, carcass weight. The factor analysis expressed as a matrix

$$Z= \sum (\lambda F+\varepsilon) \qquad (2.3)$$

Whereby Z denotes the pxl vector of variables, λ represents a pxm matrix of factor loadings, F denotes mxl vector of factors and ε stands for pxl vector of error residual factors (Keskin, Daskiran, and Kor, 2007).

The researchers then standardized the variables due to the differences in the various units used in the factor analysis and used the correlation matrix of variables to arrive at the eigenvalues. The VARIMAX rotation was utilized for facilitation of interpretation of factor loadings, and the factor coefficients derived the factor scores for selected factors. An eigenvalue higher than one was a benchmark for choosing the factors which were included in multiple regression analysis (Keskin, Daskiran, and Kor, 2007).

In order to predict the dependent variable (carcass weight), the score values of variables selected were treated as independent variables. The regression equation showed to be:

$$CaW = a + b_1\, FS_1 + b_2\, FS_2 + b_3\, FS_3 + e \qquad (2.4)$$

Where *CaW* denotes carcass weights recorded, *a* depicts the regression constant, *b* values are regression coefficients of factor scores *(FS),* while *e* accounts for the error term (Keskin, Daskiran, and Kor, 2007).

The t-statistics was applied to test the regression coefficients, while the coefficient of determination served as the indicator for the quality of regression. The software used for data analysis were MINITAB and SPSS. The authors found that the factors derived were able to account for 83.9% of the variation explained (Keskin, Daskiran, and Kor, 2007).

Similar to this research, the use of exploratory factor analysis and ranking the factors using uniqueness is applicable to identify and rank financial factors based on uniqueness, and the use of confirmatory factor analysis to identify the best fit model among all other models.

2.5.3 Exploratory and Confirmatory Factor Analysis - Human Resources Management Policies and Practices Scale

The study conducted by Demo, Neiva, Nunes, and Rozzett (2012) had the goal to validate the HR Management policies and practices scale through the two-factor analyses, exploratory and confirmatory, utilizing the maximum likelihood method. Through mostly quantitative study design, the researchers included qualitative analysis for scale development Demo, Neiva, Nunes, and Rozzett (2012).

Interviews were conducted in order to define the critical incidents which subsidized the explanation of scale items, and the responses were analyzed with categorical thematic content analysis. Furthermore, the theoretical analysis of items was conducted through a semantic analysis, which focused on 27 participants' sample which was different from the 30 participants in the initial sample (Demo, Neiva, Nunes, and Rozzett, 2012).

The sample was determined from the lowest to the highest stratum of the target population in order to secure the broadest item understanding. The subjects were afterward divided into groups of 5-6 and asked to elaborate on the items in their terms, which left no doubt in the item understanding. Lastly, the judges' analysis checked the item consistency (Demo, Neiva, Nunes, and Rozzett, 2012).

The questionnaire was created after the initial qualitative scale development steps, and the 50 items generated were randomized for bias avoidance. A sample population of 632 subjects represented a relevant number of participants for the study. The assumptions for multivariate analysis was then assessed by Myers (1990) and Menard (2002) procedures and was found to be precise with no error registration or average and standard deviation discrepancy (Demo, Neiva, Nunes and Rozzett, 2012).

The researchers did not find multicollinearity or singularity (tolerance values>0.2) and variance inflation factor resulted in values lower than 5.0. The outliers, normality, and linearity were analyzed which screened out participants using the Mahalanobis distance criterion (D2=66.76; p<0.001). The Listwise deletion method excluded the percentage of missing data (<5%). The exploratory factor analysis (EFA) selected 304 participants randomly from the sample and was guided by the Hair et al. (2009) Criterion for adequate sample size, determined 5-10 participants for each item instrument (Demo, Neiva, Nunes, and Rozzett, 2012).

For psychometric validation primarily EFA was used, after which the sampling adequacy test was conducted for factorability based on Kaiser-Meyer-Olkin reference, which resulted in correlation matric and matrix determinant. Furthermore, the eigenvalues explained variance percentage of each factor, parallel analysis, and scree plot graphic was tested for the determination of the factors which were to be extracted (Demo, Neiva, Nunes, and Rozzett, 2012).

Following, the principal axis factoring (PAF) was conducted using Promax rotation as the researchers expected the correlation in the factors which explain behavioral phenomena (Demo, Neiva, Nunes, and Rozzett, 2012).

The authors then validated the structure through an exploratory study with an independent sample of the remaining 328 participants and determined that the structure was stable. The total sample was then utilized for the confirmatory factor validation. In order to determine the factor structure, AMOS 18 evaluated the fit through the indexes of NC (normalized chi-square or chi-square value divided by the model's degrees of freedom = CMIN/DF), CFI (Comparative Fit Index) and RMSEA (Root Mean Square Error of Approximation). The internal reliability was tested with composite reliability which, represented a more reliable measure over Cronbach's alpha for structural equation modeling as it is based on loadings (Demo, Neiva, Nunes, and Rozzett, 2012).

The research results provided a seven-factor model with high reliability, a good fit for variance explanation. Construct validity was tested through convergent and discriminant analyses, while the factors have proven consistent with the existing reviewed literature and succeeded in explaining 58% of the variance. The study provided instruments for the assessment of employees who desire to improve their wellbeing and organizational outcomes (Demo, Neiva, Nunes, and Rozzett, 2012).

Similar to this research, this Praxis will use exploratory factor analysis and confirmatory factor analysis.

2.5.4 Exploratory and Confirmatory Factor Analysis for Workplace Innovation

Workplace innovation provides opportunities for development and improvement of products, process, and service which further leads to improvement in the performance of the organization. The study examined the factor structure of workplace innovation through factor analysis where exploratory factor analysis explained 69.1% of construct variance, while the confirmatory factor analysis determined two-factor structure to be a validated model. The researchers have recognized the vast opportunities in data set replication for public management studies (Wipulanusat, Panuwatwanich, and Stewart 2017).

This large data comes from government research in industrialized economies, where employees are surveyed about human resources management, and workplace.

One such example is the Australian Public Service Commission, which measures employees' perception of whether the characteristics of a successful organization exist in their departments. The original survey aimed at gathering data from Commonwealth department employees through online channels, and therefore represents a significant sample population, for the study conducted by Wipulanusat et al. (2017). For the researchers, the sample population data is taken as secondary data, while they recognized the limitation in the form of pre-determined respondent selection. Nevertheless, the sample is representative and significant for the study conducted. Wipulanusat et al. (2017) studied the perspective of engineers as key informants, whereby their target population were engineers, classified as Engineering and Technical Family in the existing sample population (Wipulanusat, Panuwatwanich, and Stewart 2017).

The sample size was 3,570, whereby the missing values were excluded, and the relevant observation set was of the size 3,125. The gender of the sample was mostly males with 86%, while there were 14% of females, and 49% were aged between 45 and 59 and had over five years of service (Wipulanusat, Panuwatwanich, and Stewart 2017).

The researchers tested differences in personal attitudes concerning the demographic groups of age, gender and education levels, through the mean difference and the different effect size. Concluding that there existed no significant differences in means or the effect size, as well as in personal attitudes concerning different demographic groups. They based their survey items classification on the workplace innovation theory and determined seven survey items which were measured on a 5-

point Likert scale (strongly disagree to strongly agree). The data was cleaned, and systematic error decreased by screening the missing values and outliers, while the distribution of variables measured was examined. The researchers additionally assessed the validity of the workplace innovation scale through the factor analysis, both exploratory and confirmatory. The exploratory factor analysis supported the creation of a controllable set of dimensions, which decreased a large number of items into sets (Wipulanusat, Panuwatwanich, and Stewart 2017).

This also supported the calculation of the number of items that construct each model. Confirmatory factor analysis created the basis for future model assessment and for the further check of the models' fitness level, convergent validity, discriminant validity and unidimensionality. Ultimately, the research confirmed the two factors which characterize workplace are individual creativity and team innovation (Wipulanusat, Panuwatwanich, and Stewart 2017).

In this article the author used EFA, and CFA, and used RMSEA index and RMSEA p-value to determine the better fit model. Therefore, in this Praxis, the use of EFA, CFA, and RMSEA will be used to determine the proper fit model.

2.5.6 Exploratory Factor Analysis Summary

In this section, the author explored the various use of EFA in other researches and concluded that to be able to use EFA, an understanding and review of the data variability is needed. Once the data is assessed, a parallel analysis needs to be performed to suggest the number of factors needed to build the EFA with regression in the statistics programming software.

Upon completing the EFA testing, a confirmatory factor analysis program should be built to test the validity of the EFA factor models and select the model with applicable RMSEA.

2.6 Multidimensional Scaling

The authors used factor analysis and Multidimensional Scaling (MDS) through their methodology. Both analyses were applied to the data as treatments of the statistics in order to arrive at the conclusions about their data. In factor analysis, it is assumed that measured variables are linear with underlying variables and its logic suggests the correspondence between these variables occurs through a causal variable system which results in correlated measured variables (Almalaq, 2016). The measured variable system does not always result in correlated causal variables and the limited conditions, which the analysis establishes, are available in order to assess the causal system concerning variables correlation (Almalaq, 2016).

This methodology implies that the inferences and uncertainties of the statistics are effecting the factor analysis. Factor analysis as a technique aims at reaching a common objective which is to represent the variable set with respect to hypothetical variables, focusing as well on the interrelationship between variables. Once the relationship between the variables is established, factor analysis aids in determining whether the correlations exist due to other variables associated with the one that was measured. In cases when the underlying variable is unknown, the researcher using factor analysis can ascertain this variable for comparison (Almalaq, 2016).

Additionally, factor analysis is utilized to confirm or reject a hypothesis. This is known as confirmatory factor analysis. There can exist cases where the relationship between variables obtained is not clear. The researchers can utilize half of the variables for exploratory strategies, and another half can be used to test the hypotheses derived from the exploration analysis (Almalaq, 2016).

Factor score coefficients for a variable are derived from multiplication of the variables factor loadings by the inverse of that factor's eigenvalue (Almalaq, 2016).

Multidimensional scaling suits standard data analysis and aims at organizing objects in space with a specific amount of dimensions for reproducing the observed distances in data and dissimilarities. This enables the explanation of distances or dissimilarities between results, with respect to the underlying dimension (Almalaq, 2016).

By using the multidimensional scaling, the researchers create a two-dimensional map. The distances between the points do not change with the map's rotation, and the axes can be oriented according to the subjective viewpoints and decisions that the researchers decide fit the most context. By rearranging points in space in an efficient manner, it allows for the point to be the best estimate. The arrival at observed distances can be achieved by moving around objects in the defined space, which is set by the number of dimensions. This supports testing of the accuracy with which the points distances can be reproduced when a new configuration is used.

The MSD that the researchers used was Kruskal and Wish's ALSCAL. They used the concept of stress to measure the quality of fit, and the Phi (raw stress value) was defined as

$$Phi = \sum\left[d_{ij} - f\left(\delta_{ij}\right)\right]^2 \qquad (2.5)$$

The d_{ij} represents the distances based on the numbers of dimensions, while δ_{ij} represents the observed distances. The $f\ (\delta_{ij})$ represents a non-metric transformation monotone of the observed distances and is reproducing the common rank-ordering of data input observations during the analysis.

The authors further point out that Shepard diagram is a tool which works effectively to measure the quality of fit and can be arrived to by plotting the distances for a specific number of dimensions against the observed input data, resulting in a scatter plot which is usually with a negative slope. This negatively sloped line shows the D-hat values, where the outcome is the $f\ (\delta_{ij})$ which is the monotone transformation for input data (Almalaq, 2016).

In conclusion, a multidimensional scaling program should be built to further confirm the model selection by reviewing the stress outcome and by determining the scaling factor to be used for the model calculation of capital funding based on the RSQ value.

2.7 Sources of Capital Funding

There are several forms of capital funding available to engineers and to the technology entrepreneur for each stage of their venture. Each start-up may use different sources of funds based on the amount of capital needed and the current phase of the start-up (Kuratko, 2017).

The owner's money is often used in the earliest stages of the start-up. Investors will view this stage of the start-up as an unproven business, which entails high risk. Entrepreneurs may not be able to raise or receive funds until they have a prototype, proof of concept, and interested customers that start establishing a credible record (Kuratko, 2017).

Family and friends will most likely provide cash and assets once the entrepreneur has demonstrated a serious dedication, focus, and growth potential to their start-up. With this backing and a well-established roadmap, angel investors who are looking for a high risk and high reward promising business may also join the start-up by providing funds (Kuratko, 2017).

Seed capital usually boosts the start-up by providing significant cash to move the business towards a noticeable market presence. Once the start-up has evidence for growth and a proven track record, venture capitalists will then approach the entrepreneur and fund the start-up for a share in equity (Kuratko, 2017).

Throughout the growth process of a start-up, they will secure a market share and have a well-established product and service. This growth allows for access to the traditional funding sources such as bank loans. It also allows the pursuit of venture capital funding. There are various ways in which a start-up can pursue capital. The most significant and monumental capital raising method is to pursue an Initial Public Offering (IPO). This method can potentially raise capital into the millions of dollars depending on the amount of shareholder investment. This will also cause a significant increase in the start-up's business status in their respective field (Kuratko, 2017).

In the following subsections discuss the available sources of funds for engineering and technology start-ups.

2.7.1 Small Business Administration Funding Sources

Engineering and technology start-ups may pursue several SBA loan programs, where the bank is the lending partner and SBA is the guarantor. The engineer may choose the program that better suits their financial situation. The lending requirements for any given SBA loan may vary from bank to bank, depending on specific bank policies. SBA does not lend the money to the entrepreneur, banks do. However, the SBA is serving as a co-signer, and the SBA guarantees the portion of the loan, which helps the banks offering more flexible loans to the entrepreneur (Bank of America, 2018).

Applying for an SBA loan requires the entrepreneur to provide paperwork to both the bank and the SBA. In addition to the documentation, the SBA requirements typically include the following items: 1) an SBA loan application, 2) a business plan, 3) a personal financial statement, 4) three years of business financial statements, 5) three years of federal business tax returns, 6) a one-year cash flow projection, 7) information about all owners, 8) an explanation of how a loan will help the business, and 9) a copy of the business lease or proposed terms, and other documentation (Bank of America, 2018).

The SBA loans include the SBA 7(a) loan program, which is structured to provide up to five million dollars, and it is specifically designed for capital expenditures like buying equipment (SBA 7a, 2017). The SBA also partnered with a privately-owned investment company to offer debt, equity, or a combination of both that ranges from $250,000 to $10,000,000 (SBIC, 2017).

Engineers and technologists may participate in the FAST program. FAST is a grant that is offered for innovation and commercialization of new technology by engineering and technology small business. The grant amount ranges between $125,000 and 200,000 (FAST, 2017).

An engineering and technology start-up may pursue the Small Business Innovation Research (SBIR) grant program administrated to fund their scientific and technological innovation. The program is competitive, and engineers should pursue it if they were not successful in obtaining other funding options. The process of responding to the grant request of the proposal is lengthy, and the scope may not suit the engineering and technology start-up. The program starts with an award up to $100,000 and it increases to up to $1,000,000 in the second round (SBIR, 2017).

Lastly, the SBA offers Small Business Technology Transfer (STTR) grants that are similar to the SBIR with a grant amount of up to $150,000 in the first round and up to $1,000,000 in the second round (STTR, 2017).

2.7.2 Equity Crowdfunding

Engineering and technology start-ups can raise funds under Title 3 of the Jumpstart Our Business Start-ups (JOBS) Act. This rule was created in 2012 and went into effect in 2016. It allows the start-up to seek public money through the online crowdfunding platform. This change in the law opened the doors for engineers to be able to access another spectrum of funding that was not available before 2016. Equity crowdfunding is a sale of a portion of the start-up equity shares to the public. However, it limits the internet-based security offerings to $1,070,000 per twelve months.

The George Washington University Entrepreneurship Center presentation showed that one in four companies are successful in obtaining crowdfunding money (Gyro, 2017). There are several reasons for the 35% success rate in equity crowdfunding, however the main reason is that the JOBS act requires the company to keep the amount raised only if it meets the minimum amount of funding disclosed in the SEC Form C (Gyro, 2017). This research incorporates crowdfunding data as a new source of external funding.

2.7.3 Angel Investors

Angel investors are wealthy individuals with various backgrounds, and they could be lawyers, doctors, engineers, executives, trust fund recipients, real-estate moguls, business owners, or seasoned entrepreneurs. Angel investors are willing to invest in start-ups in return for equity. To become an angel investor, the individual needs to meet specific requirements published by the SEC (Investor Bulletin, 2013).

Engineering and technology start-ups seeking angel investor funding, should prepare an angel investor presentation and include the start-up mission and goals, owners and management team profiles, product or service overview, start-up timeline, start-up financial statements, amount of capital needed, and how it will be utilized.

The focus of this research is developing a practical capital funding model for calculating the amount of capital needed to initiate the capital funding process in engineering and technology start-ups.

2.7.4 Venture Capital

Venture capital is an established firm with several investors, employees, and professionals for funding start-ups in exchange for equity (SBA, 2018). Venture capitals are usually regional firms that target specific industries where its investors have knowledge and experience. Before they enter into the investment deal, the Venture capital firm usually agrees with the entrepreneur on their exit strategy before they form the investment deal. Most of the venture capital will participate in the start-up board of directors (SBA, 2018).

2.7.5 Traditional Loans

In order to incur and maintain all equity and control of a start-up, the entrepreneur may consider a traditional business loan from a bank. The following is Bank of America's list of items required from the entrepreneur to process a business loan:

- Loan application.
- Business plan.
- Funding amount.
- Revenue projection.
- Audited financial statements.
- Company Article of organization.
- Certificate of existence.
- Certificate of good standing.
- Company tax returns.

- Company credit history.
- Management team resumes.
- Owners credit history.
- Owners tax returns.
- Net worth.
- Proof of assets.
- Collateral.
- Personal guarantor

In addition to these requirements, banks may also have additional ways to analyze a start-up. According to the Bank of America website, banks look at the following five C's to help determine the creditworthiness of the business that's asking for financing (Bank of America, 2018).

Capacity: Does the business have the financial capacity to support debt and expenses? Typically, a business needs to have $1.25 of income to support every $1 of debt service. The extra $0.25 provides a cushion for the business to absorb unexpected expenses or a downturn in the economy (Bank of America, 2018).

Capital: Does the business own capital assets such as cash and equipment; is there enough to help support the financing you want? Entrepreneurs may have invested capital in your business; how much? (Bank of America, 2018).

Collateral: Accounts receivable, inventory, cash, equipment and commercial real estate are all forms of collateral that banks leverage to secure loans. In addition to looking at the value of collateral, the bank will consider any existing debt the start-up may still owe on that collateral (Bank of America, 2018).

Conditions: The state of the economy, trends in the industry and pending legislation relative to the business are all conditions that are considered by banks. These types of factors - often out of entrepreneur control - may affect the start-up ability to make payments (Bank of America, 2018).

Character: Work experience in the industry and personal credit history are all character traits banks will consider. Personal integrity and good standing and the integrity and standing of those closely tied to the success of the business are critically important (Bank of America, 2018).

In addition to this analysis, communication plays a vital role in a traditional institution such as a bank. The entrepreneur should communicate all opportunities as well as difficulties or roadblocks that interfere with the start-up's success with their bank representative. This will be beneficial in the partnership between the traditional institution and the entrepreneur (Bank of America, 2018).

2.7.6 Unsecured Business Loans and Lines of credit

An unsecured business line of credit can help bridge the gap between payables and receivables with no collateral required. An unsecured line of credit features revolving loan terms with annual renewal fees, no cash advance fees, and no interest charges until the entrepreneur uses the funds.

To qualify for a line of credit or simplified loan, the start-up has to have a minimum of two years in business under the existing ownership and a minimum of $100,000 in annual revenue (Bank of America, 2018).

Consequently, these unsecured business loans and line of credit comes with high risk. They have high interest rates. A start-up must be confident in its potential revenue and gains in order to stay ahead of the interest that will accumulate. If a start-up is not confident in its revenue potential, it should shy away from these loans. Dire consequences can result from having poor credit and can result in having a negative relationship with financial institutions and limit the opportunity to receive loans (Bank of America, 2018).

2.8 Capital Funding Strategy

Securing funding for technology start-ups is a time consuming and complicated process. The value proposition of the start-up is clear to the engineer, and it may not be as clear to the receiving end of that discussion. Engineers need a strategy for securing the right resources at the right time for their start-ups. There are different options and knowing the right source of funding is only half of the battle. The second half of the battle is having a good strategic plan for funding the business throughout its life.

Engineers should only raise what they need and should not wait until they need it. The common error the entrepreneur makes is raising as much as they can accumulate. It is also important to seek for capital with accurate information, given the fact that the sources of funds for start-ups is limited and highly competitive.

The engineer should understand the difference between debt funding and equity funding before they decide on which funding type to pursue. Equity funding is where the engineer will exchange money for ownership shares in their business. While debt funding includes traditional loans or grants to be paid back to the lender. This research is focused on equity funding.

2.9 Literature Review Summary and Gap Analysis

In summary, the literature reviewed provided an overview of the technology start-up life cycle, briefly discussed the risks and challenges faced by start-ups, and outlined the lack of capital as one of the top factors that contribute to the failure of the technology start-up.

The literature review discussed various entrepreneurship models and described the high level and lack of details on the how-to shown in those models. However, Allen's model and the Gruber provides a model to guide entrepreneur to calculate their capital funding. Allen's model relied on the cash flow statement, which includes capital expenditures as one of the main components of the model calculation, while start-ups may not have this amount available as they may be pursuing capital to purchase equipment and other capital expenditures. Additionally, Allen's model added a safety margin that is an estimated amount to compensate for the potential lack of information driven by the model. Gruber's model relied on the Graham's formula and used the number of employees as the basis for calculating capital funding. However, some technology start-ups may not have employees, which will lead to an inability to calculate the capital funding. Additionally, the Gruber's model is based on a preset dollar figures for each employee that may be applicable in Silicon Valley but may not be applicable in Washington D.C. due to the difference in cost of living and its implication on employee cost. Therefore, a need for a model to bridge those gaps and provide a practical method to calculate capital funding is needed and it is the subject of this Praxis.

The literature review discussed an engineering management approach and the use of exploratory factor analysis in other industries. It provided an overview of how other industries build models using exploratory factor analysis. It is usually used in conjunction with confirmatory factor analysis to select and fit the proposed model. Additionally, some studies discussed the use of multidimensional scaling using the Kruskal method in conjunction with exploratory factor analysis and confirmatory factor analysis, to further validate the selection of the better fit model.

The literature review concluded that an engineering management approach of performing descriptive analysis, exploratory factor analysis, confirmatory factor analysis, and multidimensional scaling applies to achieve this Praxis goal of developing a practical capital funding model. Additionally, performing validation analysis using the percent difference between the proposed practical capital funding model, Allen's model, and Gruber's model to the crowdfunding raised.

Chapter 3 - Methodology

A Praxis plan was developed to utilize data analysis and statistical methods to better estimate the capital funding requests by engineering and technology companies in comparison to the Allen's and Gruber's models.

3.1 Data Source

The author obtained data through searching the Security and Exchange Committee (SEC) Electronic Data Gathering, Analysis, and Retrieval system (EDGER) system for crowdfunding companies. The EDGER system is the interface between companies and the SEC. It allows companies to enter their data that is required by law to the SEC system. It also provides investors and corporations with the author searched over 100 companies by retrieving their filing forms and reading them. When the company meets the criteria outlined in Section 3.2, the author transferred its financial data into a master spreadsheet that is later used in this research.

The SEC requires any issuer, conducting a Regulation Crowdfunding offering, to electronically file its offering statement on the Form C EDGAR system and with the intermediary facilitating the crowdfunding offering (SEC, 2015).

Form C includes six different forms as follows: Form C, C-U, C-A, C-A/R, C-AR/A, and C-TR. Form C is the offering statement filed by the issuer to offer the shares in their company in exchange for cash. It includes information about the company, location, business plan, management team, the share offerings, financial statements, and the use of proceeds. It also includes information about the risks of investing in the company, the role of the broker-dealer listing the shares, and their fees. The dataset is extracted from the financial statements listed in Form C (SEC, 2015).

Form C-U is for progress reporting, where the start-up will report to the SEC, the amount of funding received to date or the expected to receive date based on obligations by the investors. This form data represents the actual amount of funding received by the start-up through their successful crowdfunding efforts. Since this data is reported to the SEC and it is submitted by the start-ups officers under penalty of misreporting financial information to federal agency, this data deemed reliable data and can be used for validation of the model, therefore, it will be used in this research to validate the accurateness of the capital funding estimate compared to the Allen's model and Gruber's model (SEC, 2015).

It should be noted that the start-up capital funding needs are usually different than the start-up received capital funding. The amount of capital received through crowdfunding has external factors that outside of the start-up control. For example, economic factors, political factors, availability of funds, and likability of the product and service will have an impact on the amount of money received by the start-up. The proposed capital funding model is a start to structure this process and provide a more reliable and accurate tool (SEC, 2015).

Form C-A is the amendment statement, where the start-up will file any amendment information such as changing the end date of the offering or adding a management team member (SEC, 2015).

Form C-AR is the annual report form filed by each issuer to report the total amount received in 12 months. The crowdfunding act stipulates that any recipient of equity crowdfunding should report to the SEC and file an annual report with all funds received and that funds should not exceed $1,070,000 in any 12 months' period. Form C-AR/A is the amendment filing for form C-AR with the SEC (SEC, 2015).

Form C-TR is the termination of the offering by the issuer. This form is filed when the start-up terminates their public offering for any reason.

Form D is the form completed by the start-up to report to the SEC the total amount of the funds received under Regulation D, in a combined offering. It includes information about the start-up, place of business, and industry group (SEC, 2015).

Form C and Form D includes information about the start-up revenue size where some start-ups can decline to disclose such information. The type of securities offered can be equity shares or debt securities or other types that are not applicable for technology companies. Form D will also say if the there is a sales compensation for the broker or dealer assisting the start-up in the offering and the amount of that commission or finder's fees. Form D provides information about the total offering amount, the amount sold and the remaining amount to be sold. The sold amount represents the amount of capital funding received by the start-up at that point in time (SEC, 2015).

3.2 Start-up Data Selection Criteria

A dataset was compiled from companies that filed form C with the SEC from May 2017 to June 2018 with the following criteria based on the understanding of technology start-ups literature review:

- Start-up provides an engineering or technology product or service.
- Start-up is in their first five years of their company life.

- Start-up has a separate legal entity from its owner and registered in its respective state within the United States of America.
- Start-up is in the development phase or early production of their product or service.
- Start-up provided a set of financial statement that produced by a Certified Public Accountant (CPA).
- Start-up is US-based company.
- Start-up utilizing an approved and registered broker-dealer firm or approved crowdfunding portal company for their capital funding efforts.

3.3 Start-up Crowdfunding Data Limitation and Usage

Crowdfunding rules require the technology start-up to raise all the funds they requested as a minimum to be able to receive those funds. It is an all or nothing rule.

The success of obtaining funding through crowdfunding is as low as only one in three companies will be able to receive funding through crowdfunding according to the GWU innovation center report (Gyro, 2017).

Start-ups are inherently riskier than established companies and technology start-ups usually have limited operating history and limited assets and resources. If the start-up did not generate revenues, it might render investors ability to evaluate their performance or their prospective future performance. The likelihood of the start-up as a viable business may lead investors to shy away, resulting in start-ups not being able to raise the capital they need.

Technology start-ups seeking crowdfunding face challenges and risks, including but not limited to the economic and political events and technological developments, such as data hacking, market likeability of the product or service, availability of cash, the competition of ideas of products or services by other start-ups, and market elements. Since measuring the direct impact of economic and market elements on a start-up requires large data and conducting surveys that are pure business in nature, this research focused on identifying other alternative method to calculate capital funding using an engineering approach.

3.4 Methodology Mapping

The following diagram represents the methodology map used in this research.

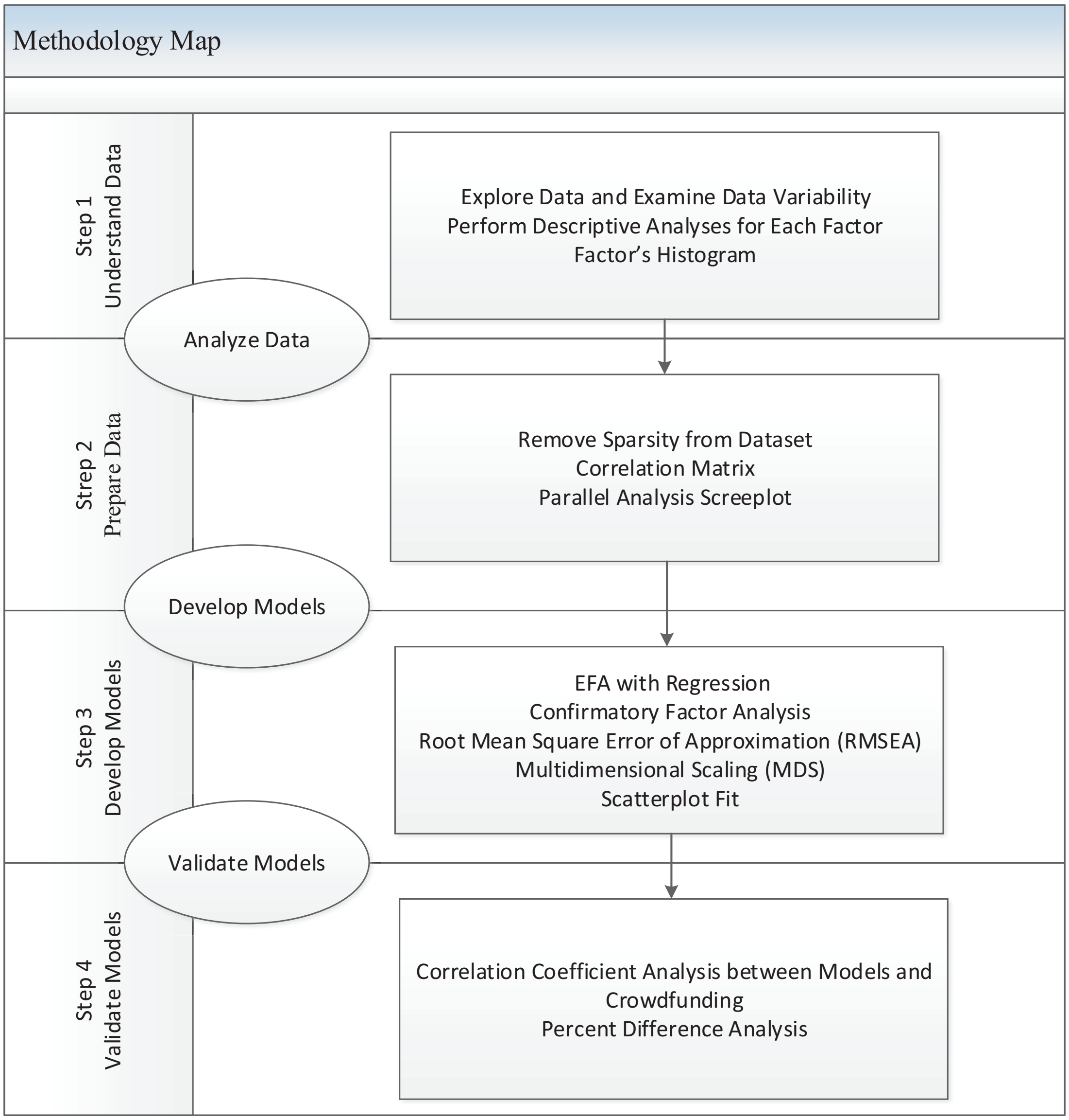

Figure 3-1: Methodology Map

Figure 3-1 was developed to summarize the methodology taken in this Praxis and described as follows:

1. Compiled financial data for engineering and technology start-ups from the SEC EDGER system.
2. Eliminated companies that did not produce financial statements, specifically balance

sheet and income statement, and are compiled, reviewed or audited by the certified public accountant.

3. Extracted the balance sheets and income statements data and compiled data into MS Excel for fifteen companies. Then prepare data for testing.
4. Performed descriptive analysis to understand the data using Statistical Package for the Social Sciences (SPSS) (IBM, 2017).
5. Utilized RStudio - R and SPSS to build and run the data and achieve results.
6. Performed Parallel Analysis to establish the number of factors needed to perform EFA with regression.
7. Perform EFA with regression.
8. Perform CFA and fit testing and select the better model based on Root Mean. Square Error of Approximation (RMSEA) index, p-value, and Chi squared.
9. Performed multidimensional scaling on the selected model factors and determine the scaling factor using dimension stress analysis.
10. Perform scatterplot for goodness of view the fit of the proposed model.
11. Created the following formula to calculate the proposed capital funding dollar amount:

$$\textit{Proposed Capital funding} = \sum_{i=1}^{n} (Xi \ast Li) \ * \ \surd(\sum\_(a(X\_ja - X\_ka)\hat{}2)) \qquad (3.1)$$

Where *Xi* denotes the factor dollar amount, *Li* denotes the factor uniqueness, *n* denotes the number of factors, *a* denotes the dimension in the multidimensional scaling matrix, *X_ja* denotes the factor location j (point) on dimension a, and *X_ka* denotes the factor location k on (point) on dimension a, which represents the distance *j-k* on dimension *a.*

12. Perform financial analysis for the proposed model and the currently used Allen's and

Gruber's models.

13. Perform correlation analysis for the proposed capital funding model, Allen's model, Gruber's model, and the crowdfunding received.
14. Perform dollar value comparison between models and funding received.
15. Perform Percent Difference to compare the capital funding model with Allen's model and with Gruber's model using the following formula.

$$\% Difference = [E\_1 - E\_2]/(1/2\ (E\_1 + E\_2)) \qquad (3.2)$$

Where *E_1* denotes model, *E_2* denotes actual crowdfunding amount received.

Chapter 4 - Results and Discussion

This chapter provides a discussion of the comprehensive statistical analysis performed and the results of the testing and examining the technology start-up financial data. Additionally, this chapter discusses the proposed practical capital funding model and provides a comparison of the proposed capital funding model and Allen's model and Gruber's model.

4.1 Factors Descriptive Analysis and Data Variability

Financial accounts of fifteen start-up companies have been compiled and produced a dataset of thirty-nine factors. Factors are numbered according to their appearance in the financial statements. A descriptive analysis of factors was conducted. This section of the Praxis provides a description and descriptive analysis of the nine most significant factors, while Appendix A includes the remainder financial statement's factors. Factor numbers represent the factor order number in the financial statements and do not represent an order of significance.

The descriptive analysis study assessed the variability of the data by examining factors' ranges and the spread of data.

Each factor below will present an explanation of the account, a table of the number of companies in a dataset, the range of the dollar amount in the data set showing the minimum, maximum, and mean. Those figures are used to assess the variability of the dataset.

4.1.1 Factor 1: Cash and Cash Equivalent

The cash and cash equivalent factor represents a balance sheet account that holds the cash usually held by the bank in a business account, and it may exceed the federally insured limit. The cash equivalent is a type of asset that can be liquidated fast, usually in less than three months. As an example, holding stocks can be sold for cash. Lenders like to see cash in the borrower's financial statements, and they may use the cash and cash equivalent account as collateral.

The cash account is used to report the balance at year end which is included in the data set. Using SPSS, the dataset mean of the cash account is $64,631.73, with a dataset dollar value range from $542 to of $201,582.

Table 4-1: Descriptive Statistics - Cash and Cash Equivalent

	N	Minimum	Maximum	Mean	Std. Deviation
Cash and cash equivalents	15	542	201582	64631.73	72473.13

The graph below shows the wide range of reported cash among companies in the dataset.

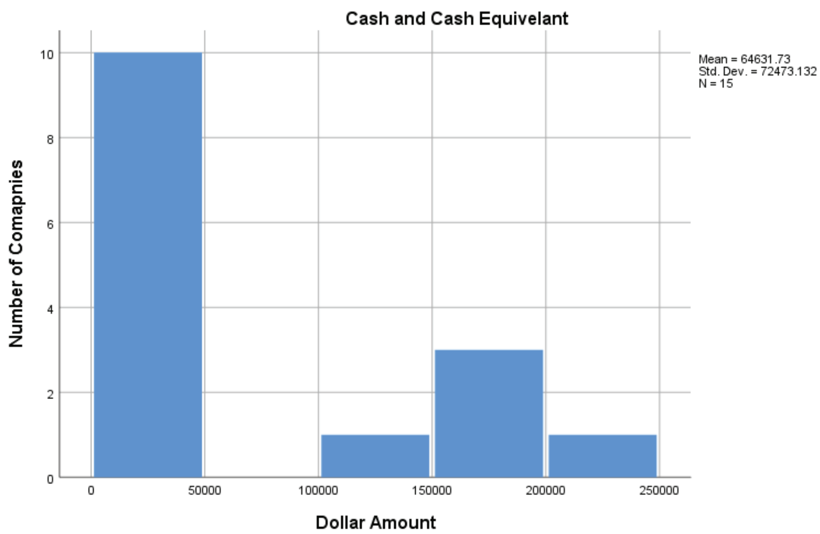

Figure 4-1: Cash and Cash Equivalents

4.1.2 Factor 12: Accounts Payable

In general, the accounts payable account is one of the most used accounts by a start-up. However, there are companies in a very early stage that will not use accounts payable. In this dataset, only two companies out of the fifteen companies did not report amounts in the accounts payable account. Accordingly, the accounts payable account is used to capture current liabilities that the company owes to others. The highest amount in the accounts payable dataset is $225,324 and the mean is $42,169.

Table 4-2: Descriptive Statistics - Accounts Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Accounts payable	15	0	225324	42169.00	64575.84

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their accounts payable.

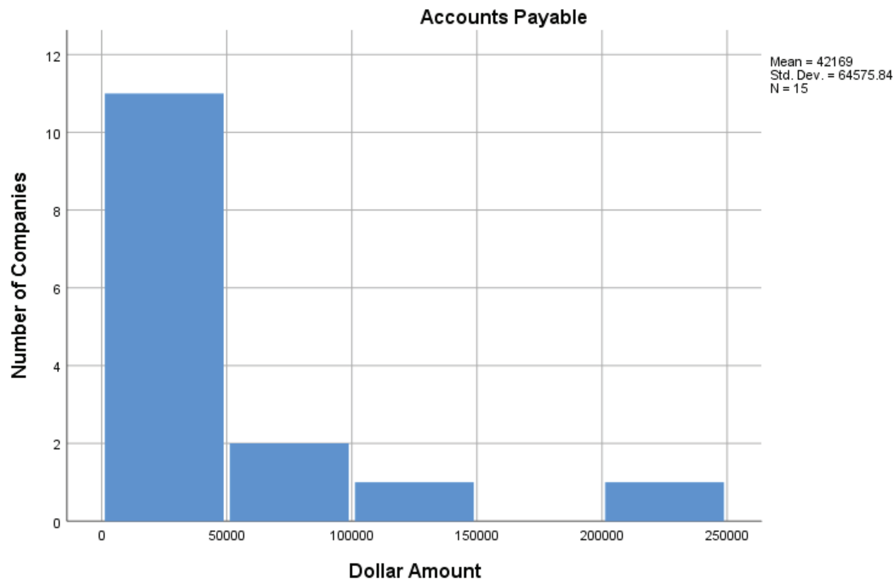

Figure 4-2: Accounts Payable

4.1.3 Factor 28: Additional Paid-in Capital

Additional paid-in capital (APIC) is also referenced as paid in capital. It is a balance sheet account that accounts for the aggregate amount of capital paid by owners and investors. When the entrepreneur requests additional capital to operate, most investors will want to buy out other investors' shares to gain a more significant percentage of the start-up. A larger percentage of equity provides more control over the business.

Table 4-3: Descriptive Statistics - Additional Paid-in Capital

	N	Minimum	Maximum	Mean	Std. Deviation
Additional Paid-in capital	15	0	619601	141706.27	162647.14

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their additional paid-in capital.

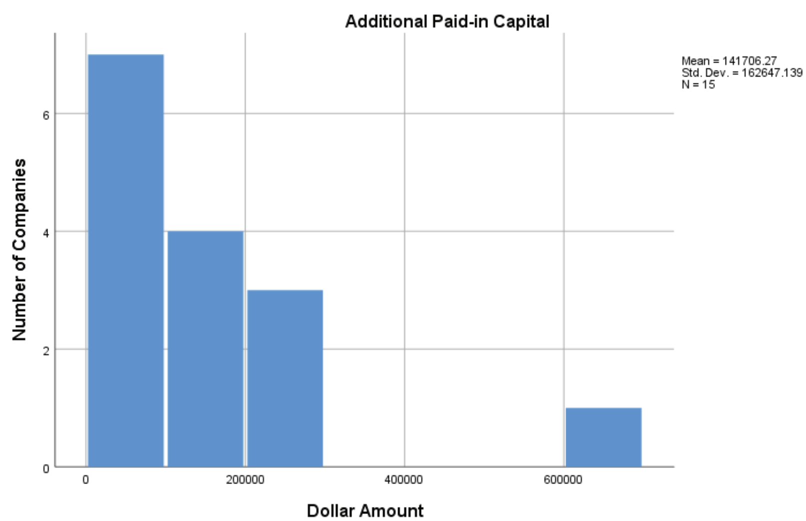

Figure 4-3: Additional Paid-in Capital

4.1.4 Factor 29: Accumulated Deficit

Accumulated deficit is a balance sheet account that represents the negative retained earnings which are the accumulation of the start-up losses and a sign of looming bankruptcy. The engineering and technology start-up needs to address those accumulated deficits preferably by revenue. However, some debts become mature before the start-up can generate the necessary revenue to pay them. The engineer needs to account for those losses and include the deficit as part of their requested capital to avoid a near-term bankruptcy.

Table 4-4: Descriptive Statistics - Accumulated Deficit

	N	Minimum	Maximum	Mean	Std. Deviation
Accumulated deficit	15	77039	4501365	619594.13	1156063.97

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their accumulated deficit.

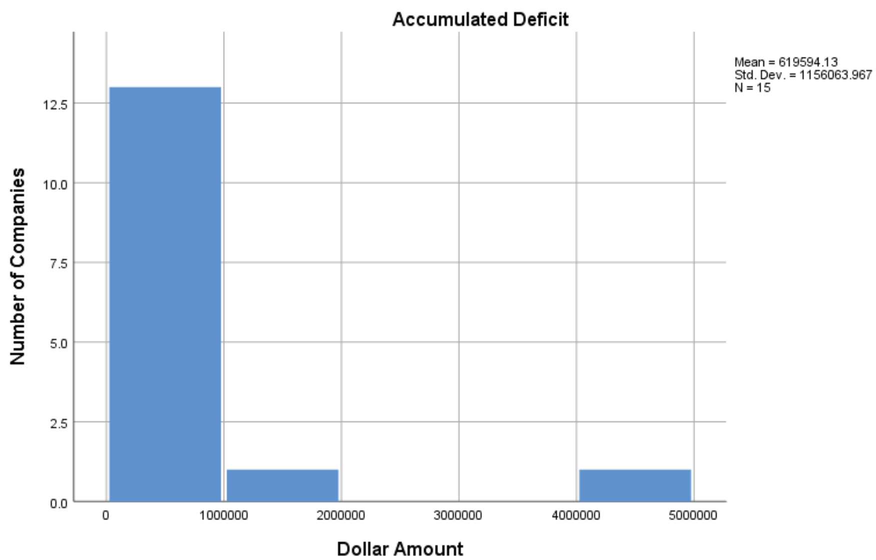

Figure 4-4: Accumulated Deficit

4.1.5 Factor 31: Revenue

Revenue by definition is the account where the start-up will post to it any income coming from sales of its products or services. It is the first account the investor will see in the income statement or the profit and loss statement. It is good to post revenue while the start-up seeks funds as it shows that the business can generate income. The spread among the start-ups is relatively large and the highest amount (upper bound) recorded is $2,682,151while the mean is $556,798. Those numbers are indications that the dataset start-ups have good revenue in general.

Table 4-5: Descriptive Statistics - Revenue

	N	Minimum	Maximum	Mean	Std. Deviation
Revenue	15	0	2682151	556798.20	941877.98

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their revenue.

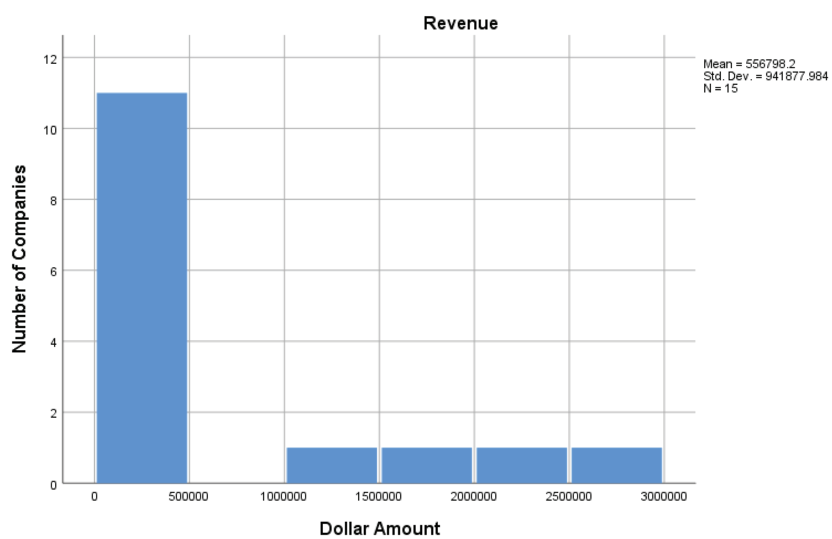

Figure 4-5: Revenue

4.1.6 Factor 32: Cost of Revenue

Any cost directly associated with the product development or the cost of labor directly associated with the product or service are tracked in the cost of revenue account. The spread of this account ranges from zero to $1,179,031, and the mean is $239,235.

Table 4-6: Descriptive Statistics - Cost of Revenue

	N	Minimum	Maximum	Mean	Std. Deviation
Cost of net revenues	15	0	1179031	239235.20	392690.93

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their cost of revenue.

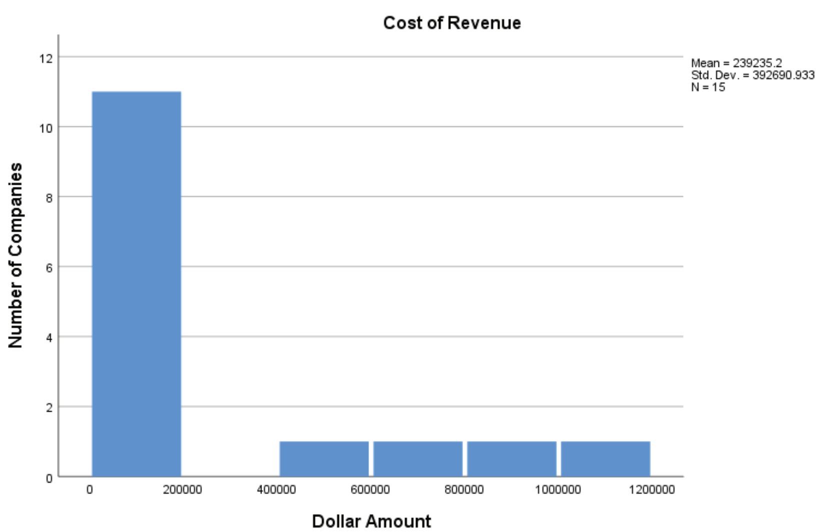

Figure 4-6: Cost of Revenue

4.1.7 Factor 33: General and Administrative

Start-ups track and record general and administrative costs related to operations in this account. Those costs cannot be associated directly with the production of the product or services. Examples of General and Administrative costs are rent, insurance, and utilities. The spread in this dataset ranges from $22,701 to $952,730, with the mean of $196,804.

Table 4-7: Descriptive Statistics - General and Administrative Cost

	N	Minimum	Maximum	Mean	Std. Deviation
General and administrative	15	22701	952730	196804.27	254672.39

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their general and administrative costs.

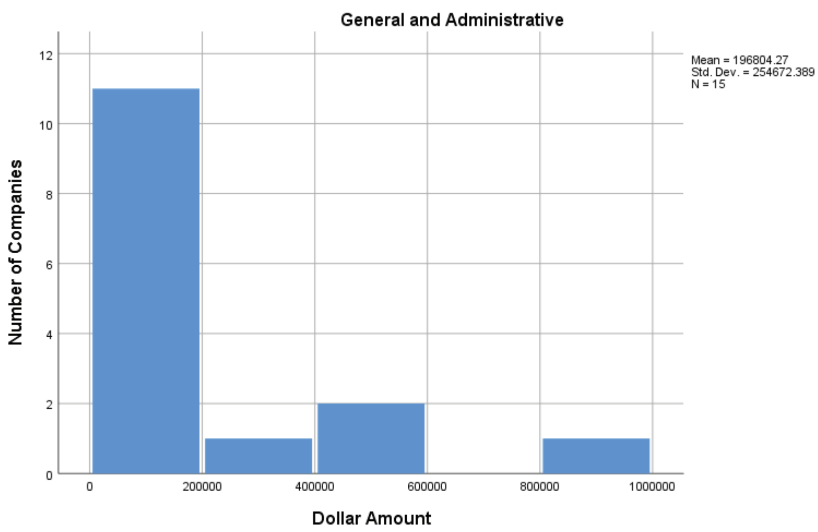

Figure 4-7: General and Administrative

4.1.8 Factor 35: Research and Development

Almost all engineering and technology start-ups perform research and development tasks. There are several costs associated with using innovation centers, building the necessary infrastructure and the workforce associated with the research and development tasks that the engineering and technology start-ups have to account for in order to search and develop their ideas.

Research and development is an income statement account and the costs associated with it are vital to the survival of the engineering and technology start-up. The highest amount reported in the dataset is $446,318, and the mean is $102,606.

Table 4-8: Descriptive Statistics - Research and Development

	N	Minimum	Maximum	Mean	Std. Deviation
Research and development	15	0	446318	102606.40	139100.68

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their research and development.

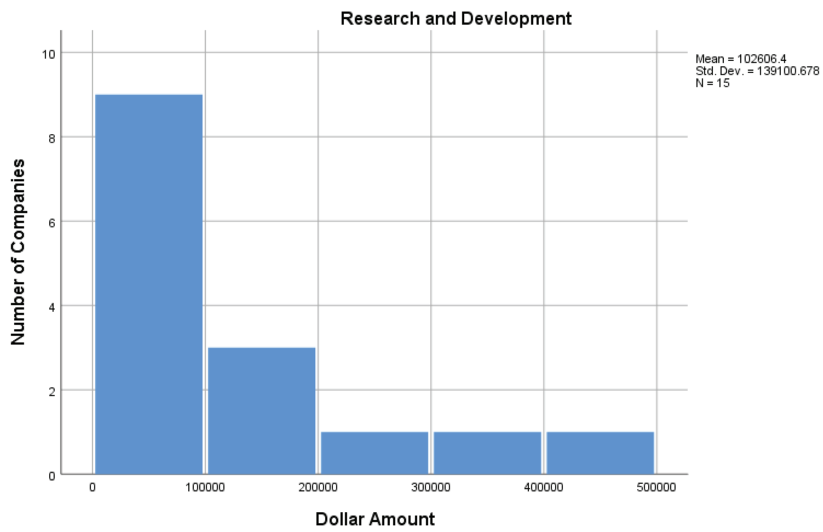

Figure 4-8: Research and Development

4.1.9 Factor 36: Sales and Marketing

Any engineering and technology start-up's product or service will need to be marketed for and sold to produce revenue for the start-up. Sales and marketing is an income statement account and is used to capture the cost associated with the selling and the marketing for the start-up product or service. Market research is an example of the cost, and it provides information about the industry, competition, and valuable insights into customer's wants and needs. This insight guides the development of the product or the service.

Sales and marketing costs could be outsourced or performed internally, and those costs may not be associated with the direct sale of start-up products or services. Start-up sales and marketing expenses include, but are not limited to, website development cost, website hosting cost, social media subscription, advertisements, show fees and cost, conferences fees and cost, publications, artwork, and promotional items.

The engineer entrepreneur should account for sales and marketing. Acquiring customers and selling the products and services are the primary goals to generate revenue and to survive as a business.

Table 4-9: Descriptive Statistics - Sales and Marketing

	N	Minimum	Maximum	Mean	Std. Deviation
Sales and marketing	15	1475	201442	70906.80	74448.09

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their sales and marketing.

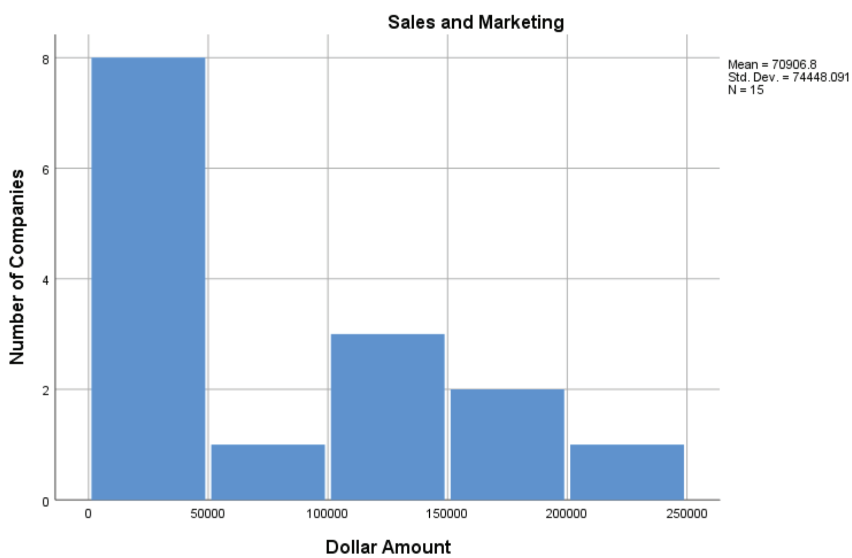

Figure 4-9: Sales and Marketing

4.1.10 Descriptive Analysis Conclusions

The descriptive analysis performed shows that the dataset has wide ranges, and each factor amounts are spread out. Therefore, it is determined that the dataset has good variability and applicable to perform the methodology of this Praxis.

4.2 Model Development

4.2.2 Data Preparation

As a result of the study of data through descriptive analysis, it has been determined that some accounts need to be removed using the sparsity function. Utilizing RStudio – R programming language, and the threshold of 30%, the following steps and codes were used to remove those accounts.

```
remove_sparse <- function(x, threshold = 0.3){
  count = 0
  s = sum(x == 0)
  res = as.numeric(s/length(x))
  print(res)
  if(!is.na(res) && res >= threshold){ FALSE }else{  TRUE   } }
```

Calling the sparse function, is used to remove accounts that are too sparse. R will be calling to remove the sparse method on each row (account).

```
d = numeric(ncol(dat))
for(i in seq(1:ncol(dat))){
  d[i] = remove_sparse(dat[,i]) }
```

The following code is a conditional code to remove those rows that marked to be removed. If the current row (account) is marked as removed, then remove it from the data frame by only selecting rows for which sparse function gives true.

```
d2 <- ifelse(d == 1, TRUE, FALSE)
dat = dat[,d2]
d1 = dat
dat = apply(dat, 2, as.numeric)
```

The following sections will discuss the remaining factors and the development of various models.

4.2.3 Factorability Analysis

Factor analysis is used to identify the latent factors in the dataset. Exploratory Factor Analysis (EFA) is a statistical method used to uncover the underlying structure of a relatively large set of variables. EFA is a technique within factor analysis whose overarching goal is to identify the underlying relationships between measured variables. It is commonly used by researchers when developing a scale and serves to identify a set of latent constructs underlying a battery of measured variables. Moreover, it is used when the researcher has no prior hypothesis about factors or patterns of measured variables (Cleff, 2011).

There are several requirements for the dataset to be suitable for factor analysis. For example, dataset factorability, as the data needs to have some correlation among the factors. Accordingly, the following correlation matrix Table 4-10, anti-image correlation matrix Table 4-11 are used to analyze the data.

Table 4-10: Factors Correlation Analysis

Correlation Matrix									
Factors	Cash and cash equivalents	Accounts payable	Net revenues	Cost of net revenues	General and administrative	Research and development	Sales and marketing	Accumulated deficit	Additional paid-in capital
Cash and cash equivalents	1.000	0.510	0.496	0.425	0.637	0.204	0.540	0.478	-0.069
Accounts payable	0.510	1.000	0.875	0.745	0.512	0.018	0.561	0.735	0.511
Net revenues	0.496	0.875	1.000	0.948	0.802	0.026	0.501	0.707	0.490
Cost of net revenues	0.425	0.745	0.948	1.000	0.803	0.101	0.423	0.471	0.549
General and administrative	0.637	0.512	0.802	0.803	1.000	0.229	0.358	0.572	0.073
Research and development	0.204	0.018	0.026	0.101	0.229	1.000	0.188	0.047	-0.055
Sales and marketing	0.540	0.561	0.501	0.423	0.358	0.188	1.000	0.402	0.285
Accumulated deficit	0.478	0.735	0.707	0.471	0.572	0.047	0.402	1.000	0.115
Additional paid-in capital	-0.069	0.511	0.490	0.549	0.073	-0.055	0.285	0.115	1.000

The correlation matrix Table 4-10 illustrates the strength of correlation among any two factors within the nine factors. For example, cash and cash equivalent have 0.51 correlations with accounts payable. This means that both factors tend to increase together and that 0.51 is an indication of the moderate and positive correlation coefficient. Accounts payable has 0.875 correlations with a net revenue, which indicates that there is a strong and positive relationship. The angle line represents the correlation between the factor and itself, showing 1. Lastly, additional paid-in capital has a negative relationship with cash and cash equivalent that is represented by the negative correlation coefficient of negative 0.069.

Table 4-11: Anti Image Matrices

Factors	Cash and cash equivalents	Accounts payable	Net revenues	Cost of net revenues	General and administrative	Research and development	Sales and marketing	Accumulated deficit	Additional paid-in capital
Anti-image Covariance									
Cash and cash equivalents	0.148	-0.043	0.010	-0.012	-0.053	0.105	-0.135	-0.031	0.011
Accounts payable	-0.043	0.020	-0.005	0.006	0.021	-0.049	0.042	0.015	-0.001
Net revenues	0.010	-0.005	0.001	-0.002	-0.004	0.015	-0.014	-0.006	0.002
Cost of net revenues	-0.012	0.006	-0.002	0.004	0.004	-0.022	0.021	0.010	-0.010
General and administrative	-0.053	0.021	-0.004	0.004	0.030	-0.050	0.044	0.011	0.032
Research and development	0.105	-0.049	0.015	-0.022	-0.050	0.202	-0.161	-0.061	0.015
Sales and marketing	-0.135	0.042	-0.014	0.021	0.044	-0.161	0.322	0.058	-0.054
Accumulated deficit	-0.031	0.015	-0.006	0.010	0.011	-0.061	0.058	0.031	-0.017
Additional Paid-in capital	0.011	-0.001	0.002	-0.010	0.032	0.015	-0.054	-0.017	0.294
Anti-image Correlation									
Cash and cash equivalents	.358[a]	-0.805	0.675	-0.522	-0.796	0.605	-0.618	-0.459	0.050
Accounts payable	-0.805	.435[a]	-0.868	0.708	0.843	-0.771	0.525	0.603	-0.019
Net revenues	0.675	-0.868	.438[a]	-0.953	-0.647	0.877	-0.649	-0.904	0.109
Cost of net revenues	-0.522	0.708	-0.953	.436[a]	0.398	-0.817	0.618	0.952	-0.286
General and administrative	-0.796	0.843	-0.647	0.398	.472[a]	-0.636	0.445	0.344	0.339
Research and development	0.605	-0.771	0.877	-0.817	-0.636	.037[a]	-0.629	-0.769	0.060
Sales and marketing	-0.618	0.525	-0.649	0.618	0.445	-0.629	.373[a]	0.580	-0.174
Accumulated deficit	-0.459	0.603	-0.904	0.952	0.344	-0.769	0.580	.372[a]	-0.177
Additional Paid-in capital	0.050	-0.019	0.109	-0.286	0.339	0.060	-0.174	-0.177	.767[a]

Using IBM SPSS, an anti-image matrix was created to assess the variability of data. The anti-image matrix is comprised of two tables, anti-image covariance, and anti-image correlation. According to IBM, the anti-image correlation matrix contains the negatives of the partial correlation coefficients, and the anti-image covariance matrix contains the negatives of the partial covariance. In a good factor model, most of the off-diagonal elements will be small. The measure of sampling adequacy for a variable is displayed on the diagonal of the anti-image correlation matrix, which is reflected in Table 4-11 (IBM, 2017).

The above tables, Table 4-10 and Table 4-11, illustrate the dataset factorability, and it depicts correlated factors. Thereby, it is applicable to continue with the factor analysis.

4.2.4 Exploratory Factor Analysis

Using RStudio, R programming language, a parallel analysis was used to assist in determining the number of factors needed to run the exploratory factor analysis with regression.

Scree plot in Figure 4-10 shows the actual data, the simulated data, and the resampled data are close to the 2 component factors.

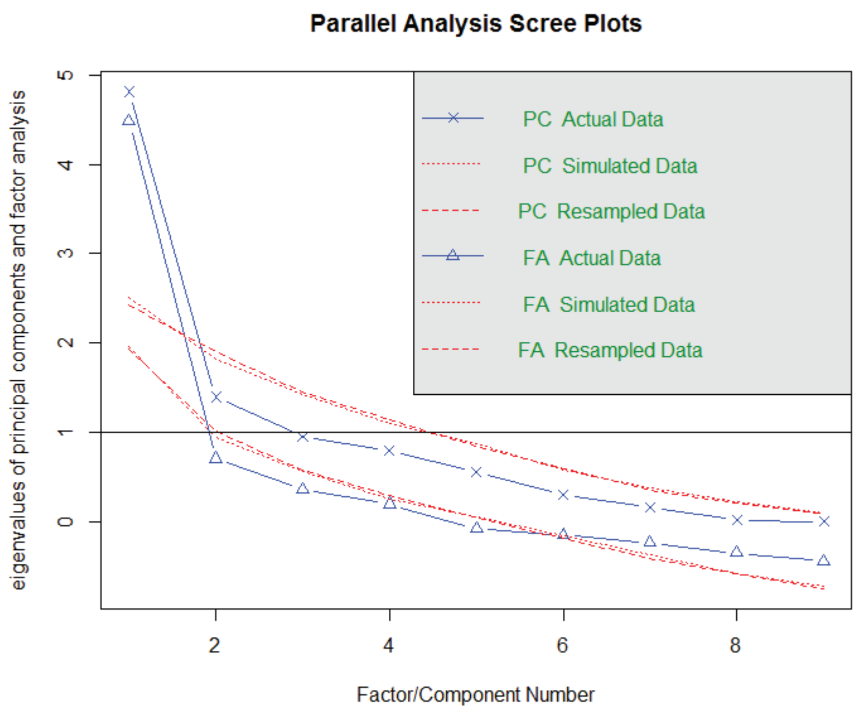

Figure 4-10: Parallel Analysis Scree Plot

The EFA component factor 1 loading is 3.798, while factor 2 loading is 1.492.

The proportion variance for component factor 1 is 0.422, while the factor 2 component variance is 0.166. The test of the hypothesis is that two factors are sufficient. The chi-square statistic is 41.18 on 19 degrees of freedom, and the p-value is 0.00228. The p-value is acceptable. Therefore, the loading of the component factor 1 and component factor 2, and the uniqueness of factors will be used to develop the capital funding models. Additionally, confirmatory factor analysis will be built to select and the better fit model.

Using RStudio - R and the factanal function (EFA <- factanal (data,factors =2, scores = "regression") the following models were created. Table 4-12 represents the factors' uniqueness and Table 4-19 represents the factors' loadings.

Uniqueness represents the proportion of the common variance of the variable not associated with the factors. As seen in Table 4-12, there are natural breakpoints in the table. For example, the research and development factor stands alone on top with 0.98 uniqueness value. The next three factors are clustered together between 0.68 and 0.72 uniqueness values indicating another breakpoint. Therefore, models were created at the various uniqueness data breakpoints. Tables 4-12 through Table 4-18 shows the development of six models using the factor uniqueness.

Table 4-12: EFA Factors Uniqueness

Factors	Uniqauness
Research.and.development	0.9815033
Sales.and.marketing	0.7289788
Cash.and.cash.equivalents.	0.7143617
Additional.paidin.capital	0.6798297
General.and.administrative	0.3373659
Accounts.payable.	0.1865301
Accumulated.deficit	0.0736289
Net.revenues	0.0050000
Cost.of.net.revenues	0.0050000

The first natural breakpoint in the uniqueness Table 4-12 is 0.981, and its factor will form model 1.

Table 4-13 Model 1

Model 1	Uniqueness
Research and development	0.9815033

Model 1 factor is research and development as shown in Table 4-13.

The following table represents model 2 based on the top 4 unique factors resulted from the EFA testing with regression.

Table 4-14: Model 2

Model2	Uniqueness
Research and development	0.9815033
Sales and marketing	0.7289788
Cash and cash equivalents	0.7143617
Additional Paid-in capital	0.6798297

As shown in Table 4-14 model 2 factors include research and development, sales and marketing, cash and cash equivalent, and additional paid-in capital.

The following table represents model 3, based on the top 5 unique factors resulted from the EFA testing with regression.

Table 4-15: Model 3

Model3	Uniqueness
Research and development	0.9815033
Sales and marketing	0.7289788
Cash and cash equivalents	0.7143617
Additional Paid-in capital	0.6798297
General and Administrative	0.3373659

As shown in Table 4-15 model 5 factors are research and development, sales and marketing, cash and cash equivalent, additional paid-in capital, and general and administrative.

The following table represents model 4, based on the top 6 factors in uniqueness resulted from the EFA testing with regression.

Table 4-16: Model 4

Model 4	Uniqueness
Research and development	0.9815033
Sales and marketing	0.7289788
Cash and cash equivalents	0.7143617
Additional Paid-in capital	0.6798297
General and Administrative	0.3373659
Accounts Payable	0.1865301

Model 4 factors as shown in Table 4-16 are research and development, sales and marketing, cash and cash equivalents, additional paid-in capital, general and administrative, and accounts payable.

The following table represents model 5, based on the top 7 factors in uniqueness resulted from the EFA testing with regression.

Table 4-17: Model 5

Model 5	Uniqueness
Research and development	0.9815033
Sales and marketing	0.7289788
Cash and cash equivalents	0.7143617
Additional Paid-in capital	0.6798297
General and Administrative	0.3373659
Accounts Payable	0.1865301
Accumulated deficit	0.0736289

Model 5 factors as shown in Table 4-17 are research and development, sales and marketing, cash and cash equivalent, additional paid-in capital, general and administrative, accounts payable, and accumulated deficit.

The following table represents model 6, based on the nine factors in the uniqueness table resulted from the EFA testing with regression.

Table 4-18: Model 6

Model 6	Uniqueness
Research and development	0.9815033
Sales and marketing	0.7289788
Cash and cash equivalents	0.7143617
Additional Paid-in capital	0.6798297
General and Administrative	0.3373659
Accounts Payable	0.1865301
Accumulated deficit	0.0736289
Net Revenue	0.0050000
Cost of Net Revenue	0.0050000

Model 6 as shown in Table 4-18 are research and development, sales and marketing, cash and cash equivalent, additional paid-in capital, general and administrative, accounts payable, accumulated deficit, net revenue, and cost of net revenue.

Factor loadings are the weight and correlation between each variable and the factor. The higher the load, the more relevant in defining the factor's dimensionality. A negative value indicates an inverse impact on the factor (Reyn, 2018). Table 4-19 shows the weighted and correlation between each variable and the factor. Low loading values are less than 0.3 therefore, the threshold of 0.3 deemed appropriate and was used to form the following models.

Table 4-19: Factor Loading

Factors	Factor1	Factor2
Cash and cash equivalents	0.523	0.109
Accounts Payable	0.867	0.247
Additional Paid-in capital	0.263	0.501
Accumulated deficit	0.944	-0.185
Net Revenue	0.85	0.523
Cost of Net Revenue	0.649	0.758
General and Administrative	0.643	0.499
Research and development	0.000	0.135
Sales and marketing	0.503	0.134

Model 7 is based on factor 1 loadings resulted from EFA testing with regression.

Table 4-20: Model 7

Loadings: Model 7	Loadings
Accumulated deficit	0.944
Accounts Payable	0.867
Net Revenue	0.85
Cost of Net Revenue	0.649
General and Administrative	0.643
Cash and cash equivalents	0.523
Sales and marketing	0.503

Model 7 factors as shown in Table 4-20 are accumulated deficit, accounts payable, net revenue, cost of net revenue, general and administrative, cash and cash equivalent, and sales and marketing. The following model 8 is based on factor 2 loadings resulted from the EFA testing with regression.

Table 4-21: Model 8

Loadings: Model 8	Loadings
Cost of Net Revenue	0.758
Net Revenue	0.523
Additional Paid-in capital	0.501
General and Administrative	0.499

Model 8 factors as shown in Table 4-21 are cost of revenue, net revenue, additional paid-in capital, and general and administrative.

4.2.5 Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was performed to select the better fit model based on Root Mean Square Error Approximation (RMSEA) and model test baseline P-value.

Using RStudio – R programming language, the steps needed to perform CFA and fit the various models outlined in section 4-2-4 was executed.

CFA output consists of latent variables and variances for the eight identified models outlined in Appendix B, and statistic comparison between models outlined in Table 4-22.

The primary objective of a CFA is to determine the ability of a predefined factor model to fit an observed set of data. Some common uses of CFA are to: 1) Establish the validity of a single factor model. 2) Compare the ability of two different models to account for the same set of data. 3) Test the significance of a specific factor loading. 4) Test the relationship between two or more factor loadings.5) Test whether a set of factors are correlated or uncorrelated. 6) Assess the convergent and discriminant validity of a set of measures (DeCoster, 1988).

RMSEA (Root mean square error of approximation) is the error of approximation which refers to residuals. It measures how closely the model reproduces data patterns. The p-value printed with it tests the hypothesis that RMSEA p-value is less than or equal to 0.05, and lower is better for the RMSEA index (Hartman, 2017).

Table 4-22: CFA Testing Results

Confirmatory Factor Analysis Output								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Number of observations	15	15	15	15	15	15	15	15
Estimator (Maximum Limit)	ML	ML	ML	ML	ML	ML	ML	ML
Minimum Function Test Statistic	8.504	8.504	17.008	31.484	47.965	194.092	151.827	67.934
Degrees of freedom	2	2	5	9	14	27	14	2
P-value (Chi-square)	0.014	0.014	0.004	0	0	0	0	0
Model test baseline model:								
Minimum Function Test Statistic	8.504	8.504	17.008	31.484	47.965	194.092	151.827	67.934
Degrees of freedom	6	6	10	15	21	36	21	6
P-value	0.203	0.203	0.074	0.008	0.001	0	0	0
User model versus baseline model:								
Comparative Fit Index (CFI)	0	0	0	0	0	0	0	0
Tucker-Lewis Index (TLI)	-6.792	-6.792	-2.427	-1.273	-0.889	-0.409	-0.58	-2.194
Loglikelihood and Information Criteria								
Loglikelihood user model (H0)	-776.833	-776.833	-984.316	-1171.217	-1401.391	-1842.471	-1443.303	-849.319
Loglikelihood unrestricted model (H1)	-772.581	-772.581	-975.812	-1155.474	-1377.409	-1745.424	-1367.389	-815.352
Number of free parameters	8	8	10	12	14	18	14	8
Akaike (AIC)	1569.667	1569.667	1988.632	2366.433	2830.782	3720.941	2914.606	1714.637
Bayesian (BIC)	1575.331	1575.331	1995.712	2374.93	2840.695	3733.686	2924.518	1720.302
Sample-size adjusted Bayesian (BIC)	1550.908	1550.908	1965.184	2338.295	2797.954	3678.734	2881.778	1695.879
Root Mean Square Error of Approximation:								
RMSEA index	0.47	0.47	0.4	0.41	0.4	0.64	0.81	1.482
90 Percent Confidence Interval	0.177 0.807	0.177 0.807	0.202 0.617	0.259 0.568	0.281 0.530	0.559 0.729	0.697 0.929	1.192 1.795
P-value RMSEA <= 0.05	0.017	0.017	0.006	0	0	0	0	0
Standardized Root Mean Square Residual:								
SRMR	0.214	0.214	0.264	0.32	0.35	0.449	0.535	0.523

Root Mean Square Error of approximation (RMSEA) index tests the lower number of errors among the models, it assesses the extent of which model fits reasonably, therefore the lower the number, the better the fit. While the p-value RMSEA fits model that is less than or equal to 0.05 (Brown, 2006).

Table 4-22, shows that RMSEA index for model 3 and model 5 are the same index of 0.4 while the p-value RMSEA for model 5 is zero and model 3 is of 0.006, which explains that model 5 is better than model 3.

Comparative fit indices evaluate the models against a more restricted baseline, where model 3 p-value is 0.074 and model 5 p-value is 0.001. Therefore, model 5 has a better fit.

4.2.6 Multidimensional Scaling

SPSS multidimensional scaling is used to validate the model and calculate its stress and squared correlation (RSQ) in distance values. Per chapter 2 discussion, any stress results under 0.1 is acceptable and equal to or greater than 0.15 is unacceptable.

$$\textit{Matrix Euclidean Distance } d_{ij} = \sqrt{\sum_a (X_{ia} - X_{ja})^2} \qquad (4.1)$$

Where distance (d_{ij}) between points *i* and *j* is defined as equation *(4.1)* where X_{ia} and X_{ja} specify coordinates of points i and *j* on dimension *a,* respectively.

$$\textit{Stress} = S = \sqrt{\frac{\sum_{ij}(S_{ia} - d_{ja})^2}{\sum_{ij} d_{ij}^2}} \qquad (4.2)$$

Where S_{ij} denotes the value between point *i* and j on dimension *a* and d_{ja} denotes the spatial distance between them. Stress value is between zero and one. Kruskal identified stress results under 0.1 are acceptable and results above 0.15 are not acceptable. (Chupetlovska and Anastasova, 2009) The proposed model matrix results are as follows:

Stress = 0.03248 → Results are under 0.1 which conveys an acceptable model (Chupetlovska and Jaworska, 2009).

RSQ = 0.99826 → Results are greater than 0.6 which conveys acceptable model (Chupetlovska and Jaworska, 2009) and the RSQ scaling will be used for the calculation of the proposed capital funding model.

Using IBM-SPSS, the three-dimensional Euclidean distance, Figure 4-11 and the two-dimensional Euclidean distance, Figure 4-13 were plotted. Model 5 was fitted into a scatterplot of the linear fit of the three-dimensional Euclidean distance Figure 4-12. The scatterplot of the linear fit of the two dimensional Euclidean distance Figure 4-14 was used to visualize the fit for model 5 and further prove that model 5 was a good fit model statistically.

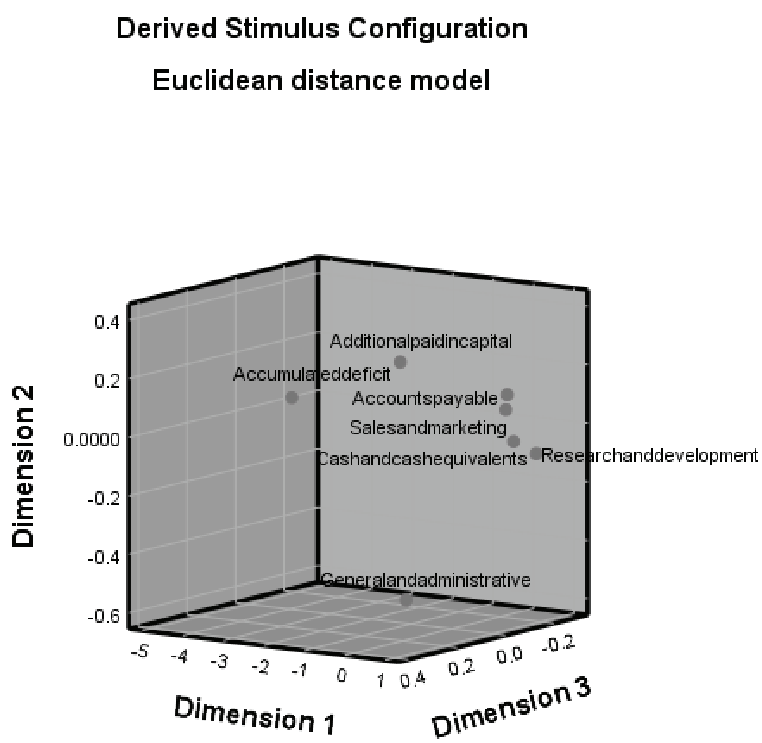

Figure 4-11: Model 5 Euclidean Distance

The three-dimensional Euclidean distance Figure 4-11 shows the close distance between factors in three dimensional graph.

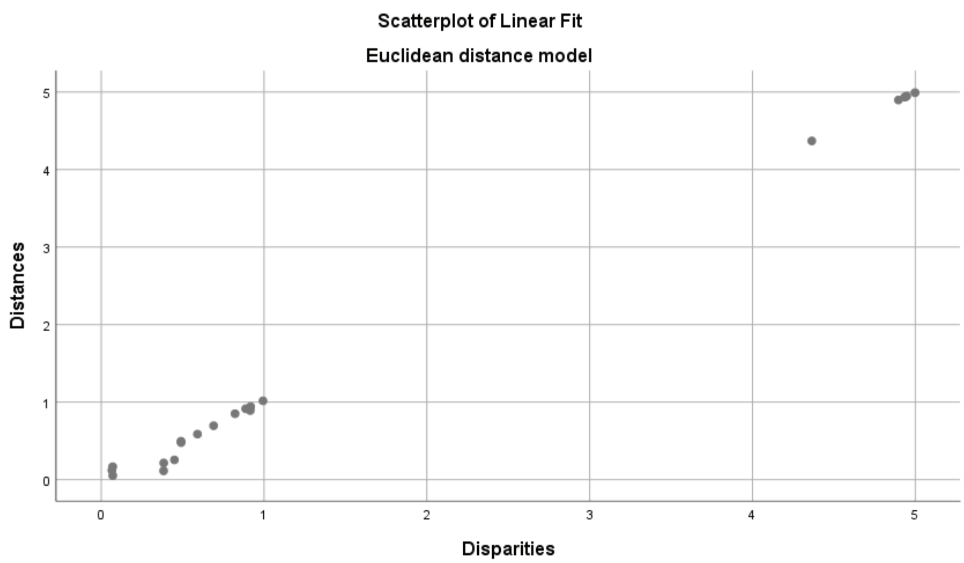

Figure 4-12: Model 5 Scatterplot of linear fit

The scatterplot of model fit in Figure 4-11 shows the close grouping of factors and forming almost a straight line.

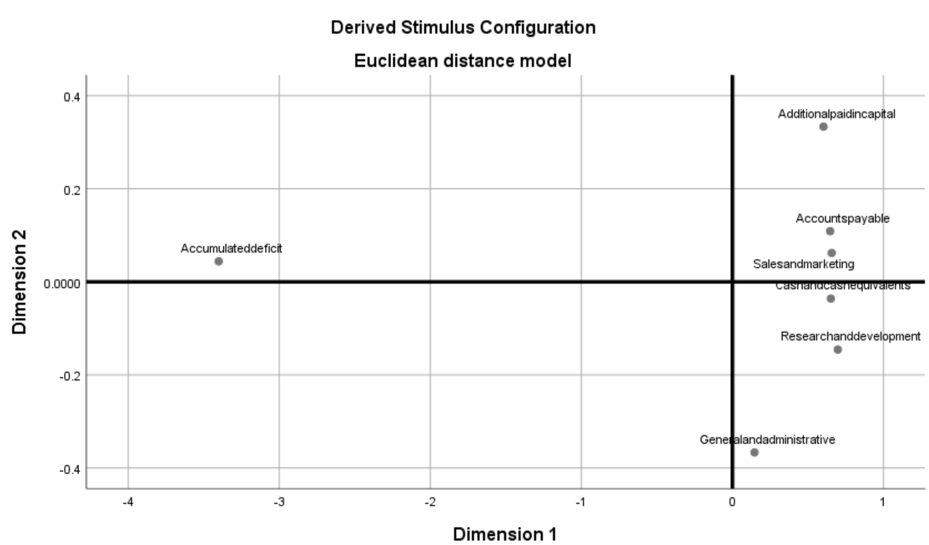

Figure 4-13: Model 5 Two-Dimensional Euclidean Distance

The two-dimensional Euclidean distance Figure 4-13 shows the close distance between factors in two-dimensional graph.

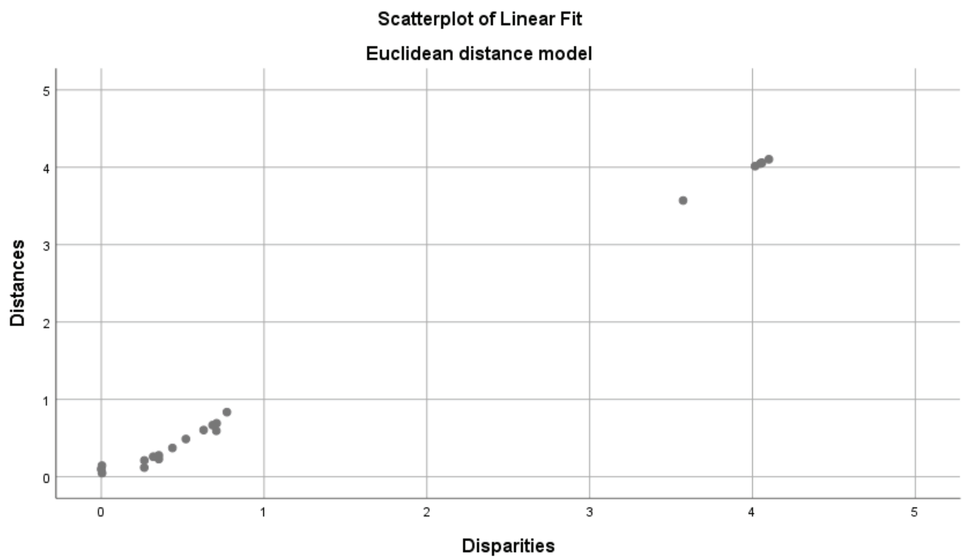

Figure 4-14: Model 5 Two-Dimensional Euclidean Distance Scatterplot of linear fit

The scatterplot of model fit in Figure 4-14 is based on the two-dimensional analysis and it shows the close grouping of model factors and the forming of almost a straight line.

4.2.7 Proposed Model

The proposed model is depicted by the following expression.

$$\textit{Capital funding} = \sum_{i=1}^{n}(Xi \ * Li) \ * \ \sqrt{\sum_a (X_{ia} - X_{ja})^2} \qquad (4.3)$$

Where X denotes the factor dollar amount, L denotes the factor uniqueness, and n denotes the number of factors.

Where distance (d_{ij}) between points *i* and *j* is defined as equation *(4.1)* where X_{ia} and X_{ja} specify coordinates of points i and *j* on dimension *a*, respectively.

The proposed model is further depicted by using the RSQ value computed in section 4-2-6 as follows:

$$Capital\ funding = \sum_{i=1}^{n}(Xi * Li) * 0.99826 \quad (4.4)$$

Where Xi denotes the factor dollar amount, Li denotes the factor uniqueness, and *n* denotes the number of factors.

Table 4-23: Proposed Capital Funding Model Compared to Other Models

Models	Data Source	Equation
Allen's Model	Cash Flow Statement	*Capital Funding = C + WC + SF* *(4.5)* Where C denotes capital expenditures, WC denotes working capital, and SF denotes safety margin. (Allen, 2016)
Gruber's Model	Graham Simple Formula	*Funding needs = N * $15,000 * 18* *(4.6)* N denotes the start-up number of employees. (Gruber, 2014)
Proposed Capital Funding Model	Balance Sheet and Income Statement	$Capital\ funding = \sum_{i=1}^{n}(Xi * Li) * 0.99826$ *(4.7)* Where *X* denotes the factor dollar amount, *L* denotes the factor uniqueness, and *n* denotes the number of factors.

4.3 Models Analysis

4.3.1 Models and Crowdfunding Correlation Analysis

Correlation coefficient analysis was performed for three models: the proposed model "model 5", Allen's model, Gruber's model and the crowdfunding received as shown in Figure 4-15.

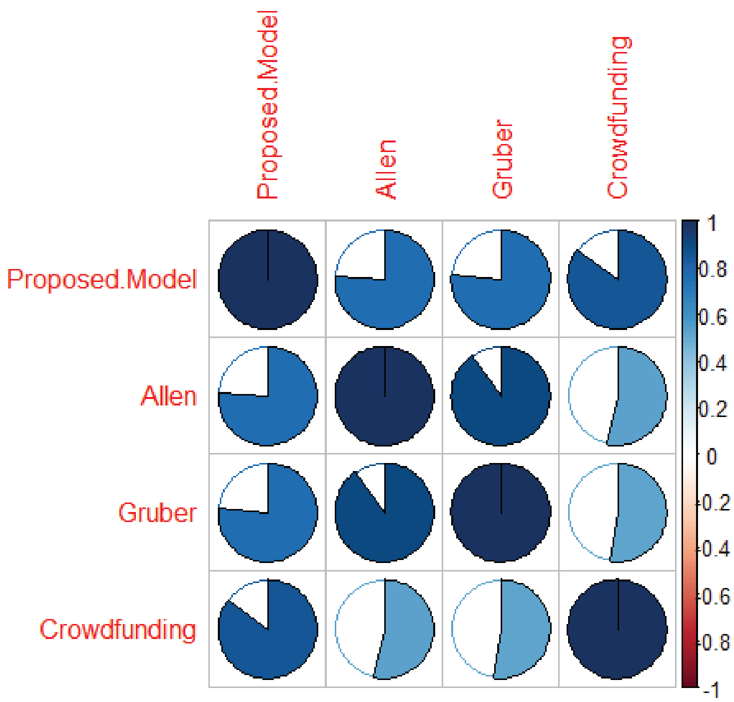

Figure 4-15: Models Correlation Coefficient Analysis

The angle line depicts solid dark circles due to the correlation between the model variables and themselves. In general, positive correlations are displayed in blue and negative correlations are displayed in red, in Figure 4-15 there is no negative correlation present; therefore, there are no red circles. Color intensity is proportional to the correlation coefficients. The proposed model has the strongest correlation with crowdfunding (0.85) while Allen's correlation with crowdfunding is (0.69) and Gruber's correlation with crowdfunding is (0.12). The following table will show those circles in numbers.

Table 4-24: Correlation Matrix Between Models.

Proximity Matrix

Correlation between Models

	Model 5 Scaling	Allen	Gruber	Crowdfunding
Model 5 Scaling	1.000	.686	.423	.853
Allen	.686	1.000	.859	.277
Gruber	.423	.859	1.000	.125
Crowdfunding	.853	.277	.125	1.000

This is a similarity matrix

Table 4-24 above shows that the proposed model has a better correlation with crowdfunding than both the Allen's model and the Gruber's model. The correlation between the proposed model and crowdfunding is 85% while Allen's correlation with crowdfunding is 28% and Gruber's correlation with crowdfunding of 13%.

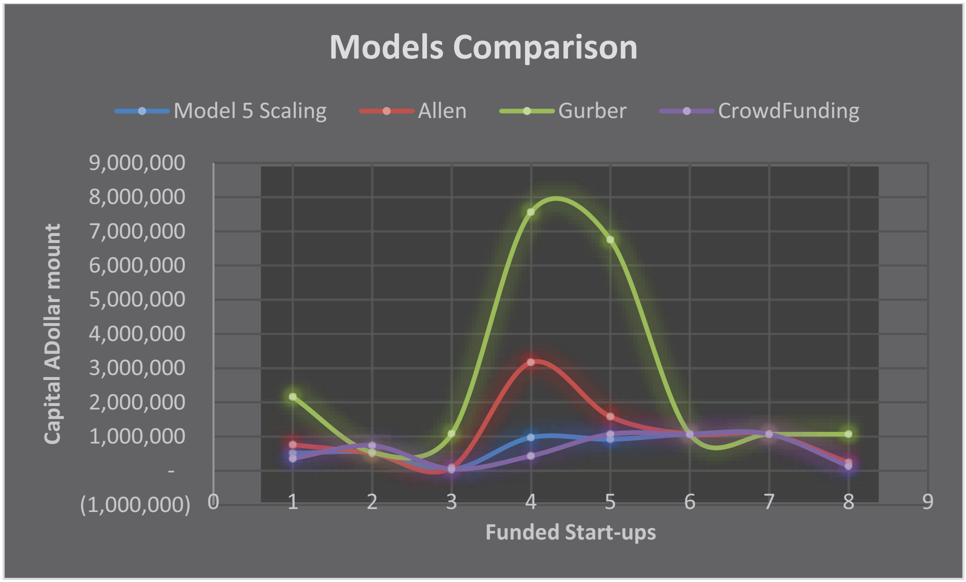

Figure 4-16: Model Comparison Chart

The above graph is another illustration of the correlation and the comparison between the proposed model, the Allen's model, the Gruber's model, and the crowdfunding received. The X-axis represents the funded companies within the dataset, and the Y-axis represents the dollar amount of capital funding. Proposed model in blue is running closer to the purple line representing crowdfunding, while Allen's model in red is running a little further from the crowdfunding. The Gruber's model in green is running the furthest from the crowdfunding received.

Table 4-25: Percent Difference

Company	Model 5	Model 5 Scaling	Allen	Gurber	CrowdFunding	Model to Crowdfunding	Allen to Crowdfunding	Gurber to Crowding
Chirrp, Inc	216868	216434	$ 108,344	$ 1,350,000	0	na	na	na
CHRGR, INC	139565	139286	$ 163,812	$ 810,000	0	na	na	na
Crema Co	122020	121776	$ 183,017	$ 540,000	0	na	na	na
GoSun, Inc.	515277	514246	$ 760,447	$ 2,160,000	360000	30%	53%	83%
Hear My Voice, Inc.	571052	569910	$ 497,128	$ 540,000	0	na	na	na
Lendsnap, Inc.	529335	528276	$ 507,788	$ 540,000	735425	-33%	-45%	-36%
LevelTherapy	37673	37598	$ 97,237	$ 1,080,000	49000	-26%	50%	95%
Likeable Local	974134	972186	$ 3,168,414	$ 7,560,000	433267	77%	86%	94%
Ondello, Inc.	921041	919199	$ 1,583,692	$ 6,750,000	1070000	-15%	32%	84%
Legalpassage.com, Inc.	151686	151383	$ 171,813	$ 1,620,000	0	na	na	na
Trikke Tech, Inc.	789782	788202	$ 1,637,508	$ 2,700,000	0	na	na	na
CentSai Group	703505	702098	$ 741,406	$ 2,700,000	0	na	na	na
Modamily, Inc.	120588	120347	$ 53,350	$ 270,000	0	na	na	na
Rivalcade, Inc.	251885	251381	$ 169,695	$ 540,000	0	na	na	na
Snowledge Corporation	177370	177015	$ 107,623	$ 3,240,000	0	na	na	na

Table 4-25 represents all companies within the dataset, those companies' data were used to build the proposed model. The crowdfunding column in table 4-25 represents the amount reported, raised, or received by those companies to the SEC. According to Literature review, only one in three companies are able to raise and receive crowdfunding. (Gyro, 2017) Table 4-25 shows five companies out of the fifteen companies reported receipt of crowdfunding, which is consistent with the Literature review. Percent difference is calculated between the models and the crowdfunding received, therefore, percent difference was not calculated for those companies that did not receive crowdfunding and shows as (na) in table 4-25.

A percent difference is applied to the proposed model, the Allen's model and to the Gruber's model. It shows that the proposed model has better percent difference than Allen's and Gruber's models. The proposed model provides a new and better tool for engineers to use in their capital funding process.

The proposed model suggested that the amount of capital funding for GoGun Inc. is $514,246. Allen's amount is $760,447 and the Gruber's amount is $2,160,000. The reported amount raised through crowdfunding is $360,000 which shows that the proposed model amount is the closest to the raised amount.

The proposed model suggested that the amount of capital funding for Lendsnap is $528,276. Allen's amount is $507,788 and the Gruber's amount is $540,000. The reported amount raised through crowdfunding is $735,425 which shows that the proposed model amount by Allen's and Gruber's models are somewhat close together, and the Gruber's model being the closest.

The proposed model suggested that the amount of capital funding for level

Therapy is $37,598. Allen's amount is $97,237 and Gruber's amount is $1,080,000. The reported amount raised through crowdfunding is $49,000 which shows that the proposed model amount is the closest to the raised amount.

The proposed model suggested that the amount of capital funding for Likeable Local is $972,186. Allen's amount is $3,168,414 and Gruber's amount is $7,560,000. The reported amount raised through crowdfunding is $433,267 which shows that the proposed model amount is the closest to the raised amount.

The proposed model suggested that the amount of capital funding for Ondello Inc. is $ 919,199. Allen's amount is $1,583,692 and Gruber's amount is $6,750,000. The reported amount raised through crowdfunding is $1.070,000 which shows that the proposed model amount is the closest to the raised amount.

Table 4-26 Case Study - Percent Difference

Company	Propsed Model	Allen	Gurber	CrowdFunding	Model to Crowdfunding	Allen to Crowdfunding	Gurber to Crowdfuning
Waverly Labs	1,070,000	1,070,000	1,070,000	1,069,915	0%	0%	0%
World Viz	1,070,000	1,070,000	1,070,000	1,070,000	0%	0%	0%
ZipZap	145,396	241,357	1,070,000	134,933	7%	57%	155%

Table 4-26 represents the actual implementation of the proposed model using the crowdfunding regulations limit of $1,070,000. Three additional companies' data were obtained from the SEC EDGER system to apply the model and perform percent difference analysis between the proposed model and both Allen's and Gruber's models using the JOBS Act limits of $1,070,000 as explained in the Literature review.

The proposed model, as well as the Allen's model and the Gruber's model, suggested that the amount of capital funding for WorldViz is $1,070,000. The reported amount raised through crowdfunding was $1,069,915, which shows that the proposed model amount is very close to the raised amount.

The proposed model, as well as the Allen's model and the Gruber's model, suggested that the amount of capital funding for Waverly Labs is $1,070,000. The reported amount raised through crowdfunding was $1,070,000, which shows that the proposed model amount is the same as the raised amount.

The proposed model suggested that the amount of capital funding for ZipZap is $145,396. Allen's amount is $241,357 and Gruber's amount is $1,070,000. The reported amount raised through crowdfunding is $134,933, which shows that the proposed model amount is the closest to the raised amount.

The application of the model to those three companies illustrated the validity of the model. The correlation confident analysis shows that the proposed capital funding model is 85% better than Allen's model 28% and Gruber's model 13%.

Chapter 5 - Limitations, Conclusion, and Future Research

This Praxis produced a Practical Capital Funding (PCF) model that is built for the technology start-ups. The PCF model's data is driven from the balance sheet and income statement. PCF is constructed based on actual financial data available to the entrepreneur and does not have estimates or guessing. PCF is easy to use, and engineers will be able to use the template in Appendix C. Whether the start-up financials includes all the factors or some of the factors, engineers will be able to use PCF to calculate the capital funding amount they need to initiate the capital funding process.

5.1 Proposed Capital Funding Model Limitations

Regardless of the model used to calculate funds, there are external factors outside the control of the engineers that will directly or indirectly impact the success of their capital funding efforts. Below are examples of those limitations:

- The volatility of the financial market and availability of funds.
- Location and the local economics of start-ups.
- Likeability of the start-up product or service.
- Competition from other start-ups seeking the same source of fund.
- The financial strength of the engineers and owners.

In addition to the external limitation factors stated above, the following items are other specific limitations on the use of the proposed capital funding model:

a. The engineering start-up must prepare financial statements to be able to use the model.

b. The model is for the engineer to calculate the capital funding regardless of the source of funding. If the engineering and technology start-up is seeking equity crowdfunding only, and the calculated capital funding amount is higher than the JOBS Act Title III limits of $1,070,000, then the start-up should reduce the capital funding request to the allowable amount of $1,070,000.
c. The top 7 factors are the mechanism for calculating capital funding requests, and it is not necessary that the received capital will only be used for those seven factors.
d. Start-ups may use the received capital as deemed necessary by its management.

5.2 Conclusion

This Praxis provides a practical capital funding model which uses engineering management methods to approximate the amount of capital needed by engineering and technology start-ups. The capital funding model introduced seven factors to be used for computing the capital funding which are research and development, sales and marketing, general and administrative cost (income statement accounts), additional paid-in capital, accumulated deficit, account payable, and cash and cash equivalent (balance sheet accounts).

The capital funding model enables the engineer entrepreneurs to calculate their capital request amount based on information they have in their income statement and balance sheet. The engineer will have the information needed to complete the necessary crowdfunding SEC form C, loan application or investor presentation.

The proposed capital funding model provides a structured method supporting the engineer in their efforts of pursuing capital for their start-ups.

5.3 Research Limitations

There is no historical data for equity crowdfunding due to the fact that it is relatively new and the model used current engineering and technology start-up data. Therefore, the model was not able to measure the impact of the proposed capital funding model on those start-ups.

The capital funding model focused on internal data and did not take into consideration external factors that may contribute to the success of receiving the capital requested.

5.4 Contributions

The practical capital funding model that is built specifically for technology start-ups. PCF utilized crowdfunding data and was developed using the JOBS act parameters. PCF used seven financial statements accounts and did not use any estimates. PCF template in Appendix C is easy to use. Engineers will be able to plug-in their start-up financial data into the template and calculate their capital funding amount they need to initiate the capital funding process.

5.5 Future Research

There is a need for future research in engineering and technology entrepreneurship finance. It is also essential to further refine the tools and methods used for determining capital funding and for pursuing the various sources of funding. This proposed capital funding model was built using an engineering management approach and can be further enhanced by expanding the research to include other factors impacting the amount of funding received through crowdfunding.

As data becomes available, future research will address other areas that were not addressed in this research. For example, measuring the impact of funding received on those companies could be a future research that is worth pursuing. Another interesting topic for future research would be exploring the impact of start-up debt posture on receiving crowdfunding capital.

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Appendix A: Factors Descriptive Analysis

A-1 Factor 2: Accounts Receivables

The accounts receivables factor represents the amount of money owed to the company by its customers as a result of the sale of the company's product of service. Accounts receivables are periodically reviewed by the company management to evaluate the collectability of such debts by customers.

Some companies will not have accounts receivables for various reasons. For example, a company may have not sold any services or products, or a company's sales have collected all outstanding receivables, therefore their year-end reporting amount is zero. In this dataset, the highest amount reported was $451,510 and accounts receivable mean was $36,883.

Table A-0-1: Descriptive Statistics - Accounts Receivable

	N	Minimum	Maximum	Mean	Std. Deviation
Accounts receivable	15	0	451510	36883.93	115916.790

The graph below shows the wide range of reported cash among companies in the dataset.

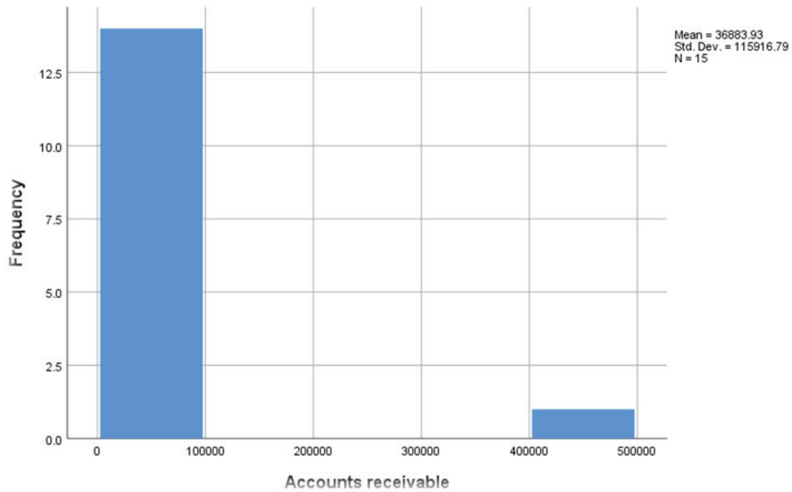

Figure A-1: Accounts Receivables

A-2 Factor 3: Inventory

Some companies will have raw materials or items used for production; thereby, an account for those inventoried is reported in their financial statements. The dataset shows some companies with zero inventory which may be due to the fact that those companies are in the service business. An inventory account will not have items to report, and it also could be as a result that the companies may not keep inventory on hand. The dataset highest amount of inventory was $552,600 and the inventory account mean is $58,985.

Table A-0-2: Descriptive Statistics - Inventory

	N	Minimum	Maximum	Mean	Std. Deviation
Inventory	15	0	552600	58985.20	158755.874

The inventory axis shows the dollar amount of inventory and the frequency axis shows the number of companies.

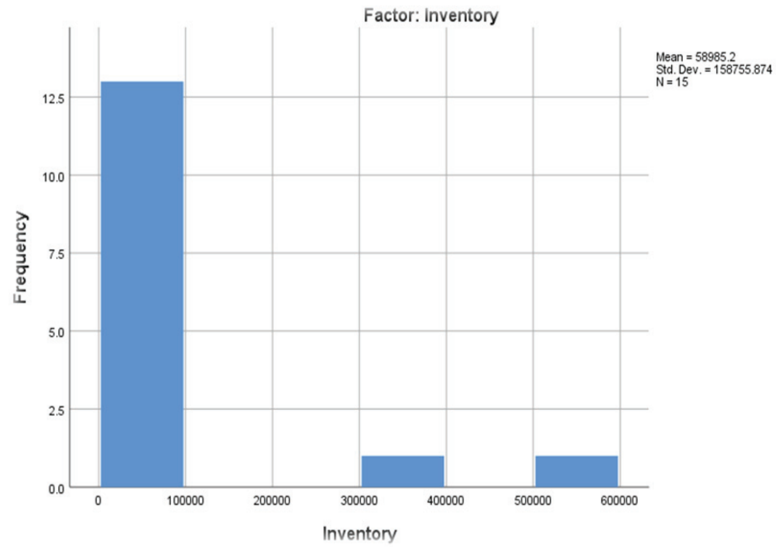

Figure A-2: Inventory

A-3 Factor 4: Prepaid Expenses

The prepaid expenses account is used to capture expenses like rent that is prepaid by businesses for future periods. The account shows that some companies do not have prepaid accounts. It reported zero and the highest prepaid expenses was $37,184 while the mean is $3,031.

Table A-0-3: Descriptive Statistics - Prepaid Expenses

	N	Minimum	Maximum	Mean	Std. Deviation
Prepaid expenses	15	0	37184	3031.87	9671.75

The following histogram displays the prepaid expenses axis that shows the dollar amount of the reported prepaid expenses and the frequency axis shows the number of companies.

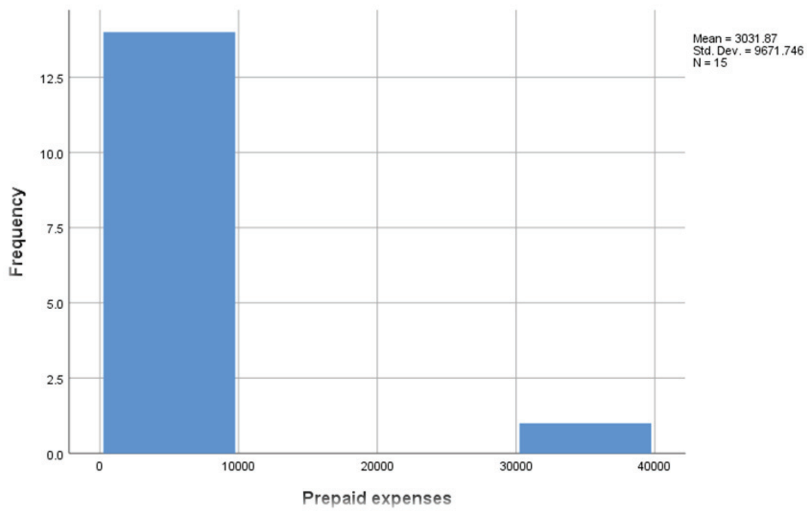

Figure A-3: Prepaid Expenses

A-4 Factor 5: Advances to Shareholders

Advances to shareholders represents the amount disbursed to the owners of the company in advance of actual distribution of percentage of profit in the form of dividends. It is common practice for owners to withdraw money from their companies against the potential shares of profit anticipated to be distributed at year end.

Some owners opt not to receive any advances. Most companies reported zero and only one company reported $44,835 paid to shareholders with the advances to shareholders mean of $2,989. This will lead to the elimination of this account during the data preparation step.

Table A-4: Descriptive Statistics - Advances to Shareholders

	N	Minimum	Maximum	Mean	Std. Deviation
Advances to shareholders	15	0	44835	2989	11576.35

The histogram below displays the amounts reported by companies for cash received by shareholders in advance of the actual distribution of dividends.

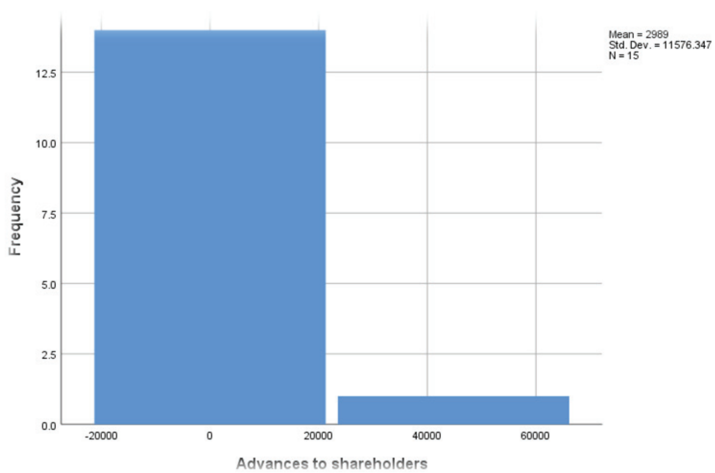

Figure A-4: Advances to Shareholders

A-5 Factor 6: Due from Related Parties

The “due” from a related party account represents the amount owed to the company from the related party. In the dataset, most companies reported zero and only one company reported $90,101 with the account mean at $6,006. Therefore, this account will be eliminated during the data preparation step.

Table A-0-4: Descriptive Statistics - Due from Related Parties

	N	Minimum	Maximum	Mean	Std. Deviation
Due from related Parties	15	0	90101	6006.73	23263.98

The following histogram depicts the majority of companies reporting zero for due from the related party account, while few reported amounts from.

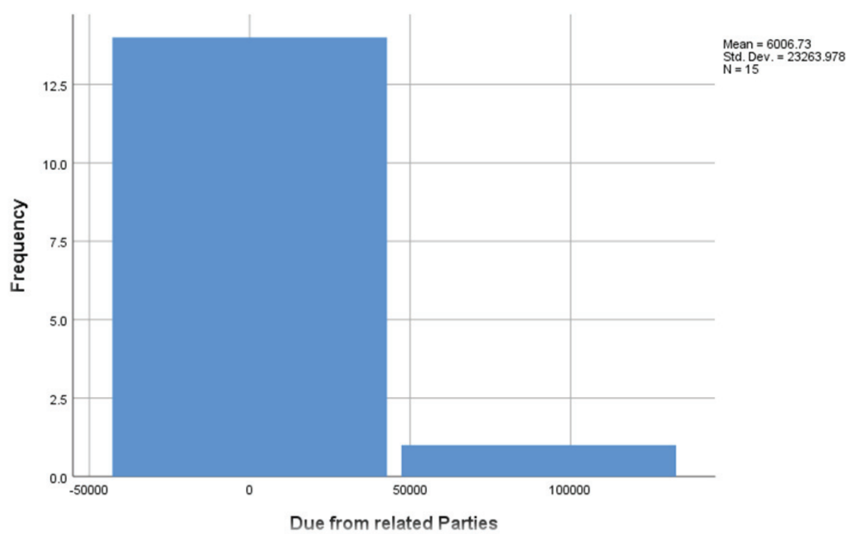

Figure A-5: Due from Related Parties

A-6 Factor 7: Property and Equipment

The Property and Equipment account is widely used by companies and it represents the amount of funds invested in property and equipment net of the deprecation. The Allen's model uses this account in the capital funding calculation.

Few companies did not own properties or equipment. The account is showing a zero amount. In the dataset, the highest amount of property and equipment reports was $502,816 with the mean at $44,752.

Table A-0-5: Descriptive Statistics - Property and Equipment

	N	Minimum	Maximum	Mean	Std. Deviation
Property and equipment net	15	0	502816	44752.20	128677.340

The histogram below illustrates the dollar amount reported by companies and the number of companies that reported dollar value for their property and equipment.

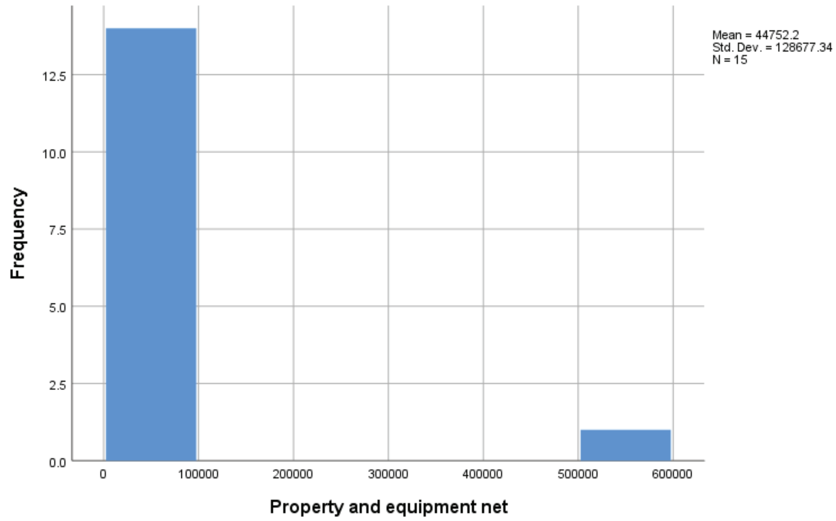

Figure A-6: Property and Equipment

A-7 Factor 8: Capitalized Software Development

Technology companies in the business of developing an application, software or system have the opportunity to capitalize all costs associated with the development of such system. The start-up will report at year end the capitalized software cost, and will deduct any amortization if they passed the development phase and are into the production phase. In the dataset, we have start-ups that are in the business of developing an application, or system and others are in the business of developing a product.

In the case of developing a product, the company may not have any software development cost. Those companies will report zero at year end. The highest amount reported in the dataset was $118,568 and the mean is $7,904.

Table A-0-6: Descriptive Statistics - Capitalized Software Development

	N	Minimum	Maximum	Mean	Std. Deviation
Capitalized software development	15	0	118568	7904.53	30614.13

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their capitalized software development cost, net of amortization.

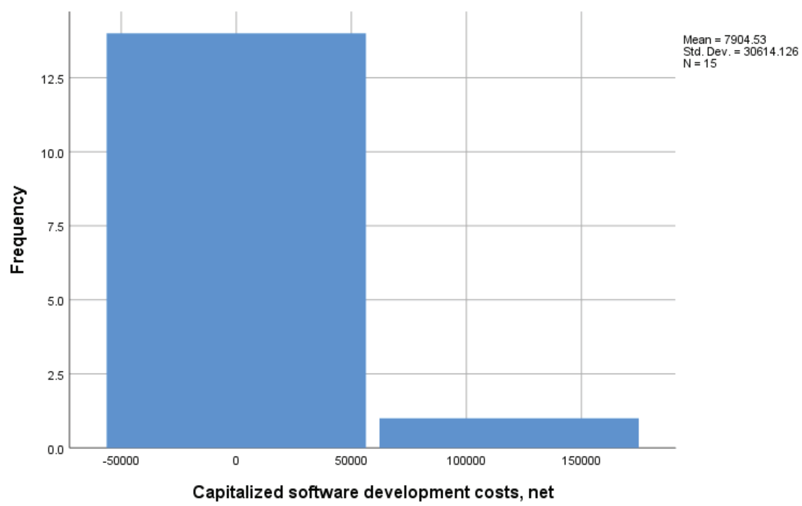

Figure A-7: Capitalized Software Development

A-8 Factor 9: Intangible Asset

Some start-ups may acquire a patent or invention or develop their own innovative solution that will gain knowledge from the respective industry. The cost of acquiring this type of asset is reported in the intangible asset account. Not all start-ups acquire intangible assets. The dataset will have companies reporting zero balance in this account. Since we have a start-up dataset, the intangible asset tends to be small, and the highest reported amount was $16,711 and the mean is $1,912. This account will likely be eliminated during the dataset preparation.

Table A-0-7: Descriptive Statistic - Intangible Asset at Cost

	N	Minimum	Maximum	Mean	Std. Deviation
Intangible Asset at cost	15	0	16771	1912.07	4855.59

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Intangible Asset.

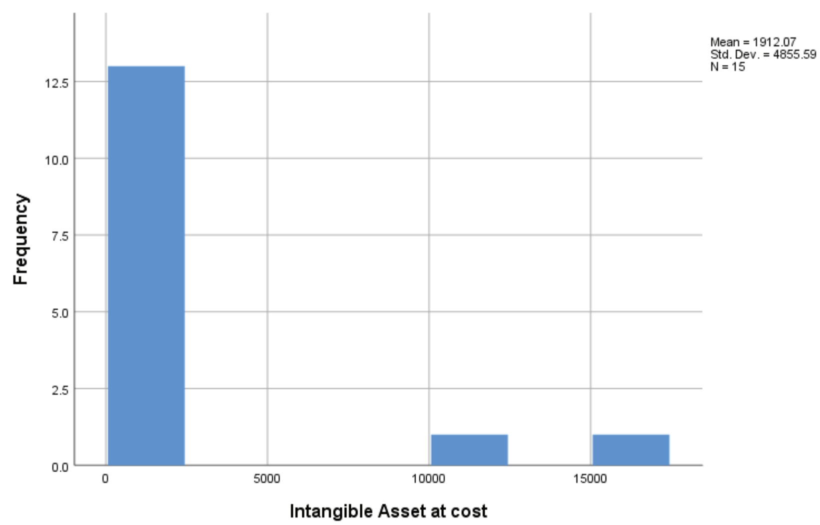

Figure A-8: Intangible Asset

A-9 Factor 10: Deposits

The deposit account is one of the small accounts reported by a start-up and it will likely be eliminated during the dataset preparation. Only three companies reported amounts in this account ranges from $1,400 to $3,728.

Table A-0-8: Descriptive Statistics – Deposits

	N	Minimum	Maximum	Mean	Std. Deviation
Deposits	15	0	3728	508.53	1141.08

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Deposits.

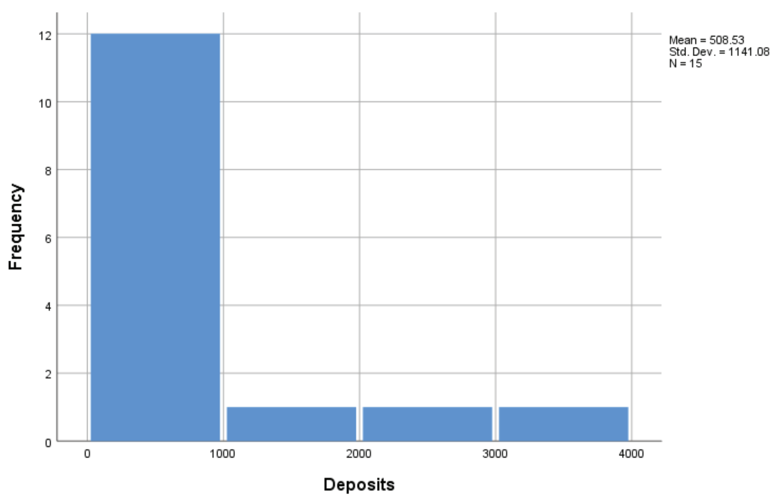

Figure A-9: Deposits

A-10 Factor 11: Other Assets

The other assets account is used by companies to track assets that are not reported elsewhere in the financial statements. In this dataset, only one company reported other assets in the amount of $4,584. This account will likely be eliminated during the dataset preparation step.

Table A-0-9: Descriptive Statistics - Other Assets

	N	Minimum	Maximum	Mean	Std. Deviation
Other assets	15	0	4584	305.60	1183.59

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Other Assets.

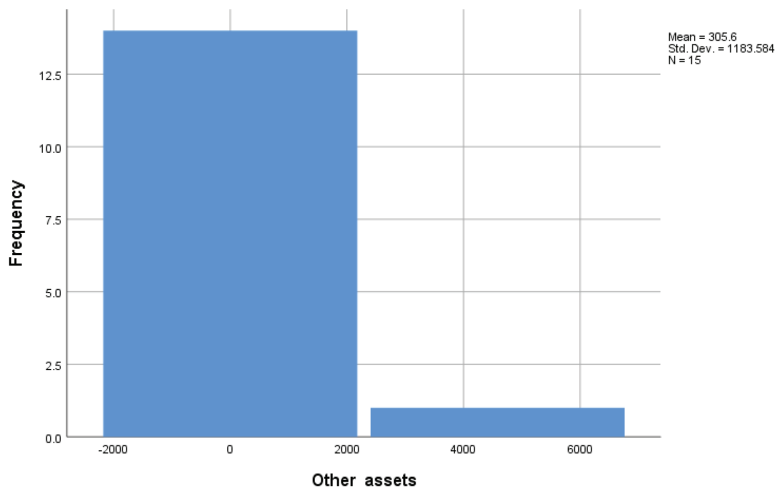

Figure A-10: Other Assets

A-11 Factor 13: Accrued Liabilities

The accrued liabilities account captures the liabilities that incurred for the current period. An amount is not paid, i.e., accrued rent. In a start-up, this account is rarely used, and only one company reported accrued liabilities in the amount of $80,930. This account will likely be eliminated from the dataset during the dataset preparation step.

Table A-0-10: Descriptive Statistics - Accrued Liabilities

	N	Minimum	Maximum	Mean	Std. Deviation
Accrued liabilities	15	0	80930	5395.33	20896.04

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Accrued Liabilities.

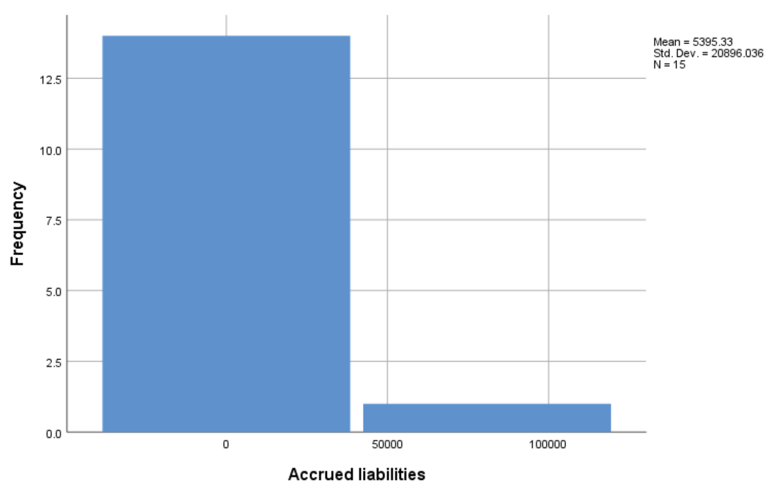

Figure A-11: Accrued Liabilities

A-12 Factor 14: Accrued Interest Payable

The accrued interest payable account captures and tracts interest payable on credit cards, short term loans, short term line of credits, and other accrued interest on general liabilities. In the dataset, there are ten companies that reported accrued interest and five companies did not have accrued interest. The highest amount of accrued interest reported in the dataset is $368,441 and mean is $35,598.

Table A-0-11: Descriptive Statistics - Accrued Interest Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Accrued interest payable	15	0	368441	35598.27	95157

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Accrued Interest Payable.

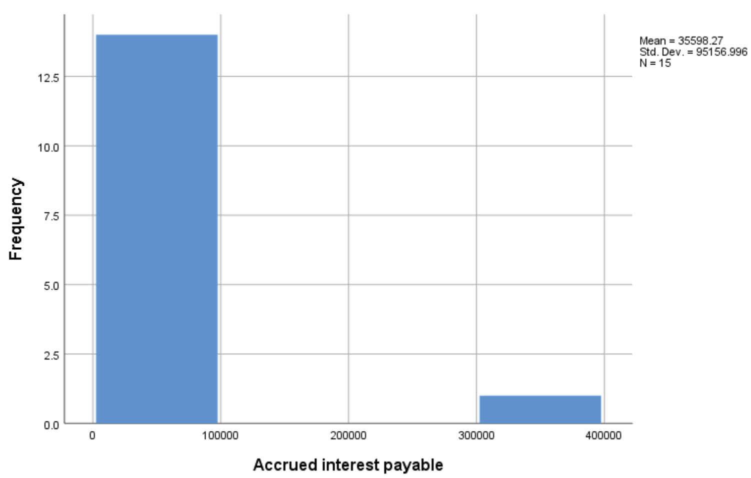

Figure A-12: Accrued Interest Payable

A-13 Factor 15: Accrued Expenses

The accrued expenses account captures any expenses the company incurred but did not pay at the end of their financial period. For example, a company could have acquired office supplies for their office but did not pay the vendor for the supplies. This amount of expenses should be tracked and recorded in the accrued expenses account. The account tends to have lower dollar value as it relates to an operating expense account. In this dataset, the highest amount reported by a start-up was $56,645 and the mean is $6,557.

The following table shows the minimum and maximum amount reported and the mean.

Table A-0-12: Descriptive Statistics - Accrued Expenses

	N	Minimum	Maximum	Mean	Std. Deviation
Accrued expenses	15	0	56645	6667	15720.38

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Accrued Expenses.

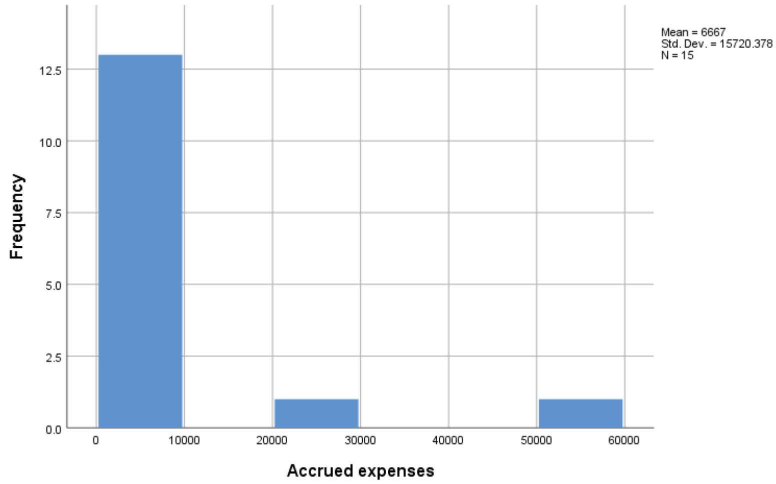

Figure A-13: Accrued Expenses

A-14 Factor 16: Notes Payable

The notes payable account tracks and captures current payables based promissory notes that the business obtained from lenders. This includes the amount of the notes and the interest the business promised the lender to pay back. This account is important to an investor because it reveals how much current debt the start-up has taken.

Table A-0-13: Descriptive Statistics - Notes Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Notes Payable	15	0	45000	5666.67	14984.12

Start-ups usually do not have high amounts reported in this account as they struggle to obtain funding for their operations. The highest amount reported in the dataset was $45,000 with the mean of $5,666.

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Notes Payable.

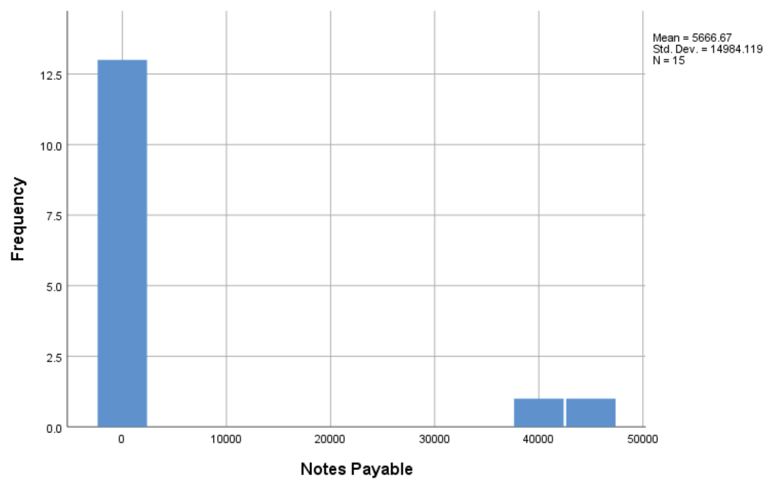

Figure A-14: Notes Payable

A-15 Factor 17: Loans Payable

The loans payable account captures all the loans the company has acquired and still owe to the lenders. The account tracks the amount of the loans and is reduced by the loan principle amount paid by the company to the lenders.

Table A-0-14: Descriptive Statistics - Loans Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Loans payable, current portion	15	0	280242	25417.53	71824.21

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their current Loans Payable.

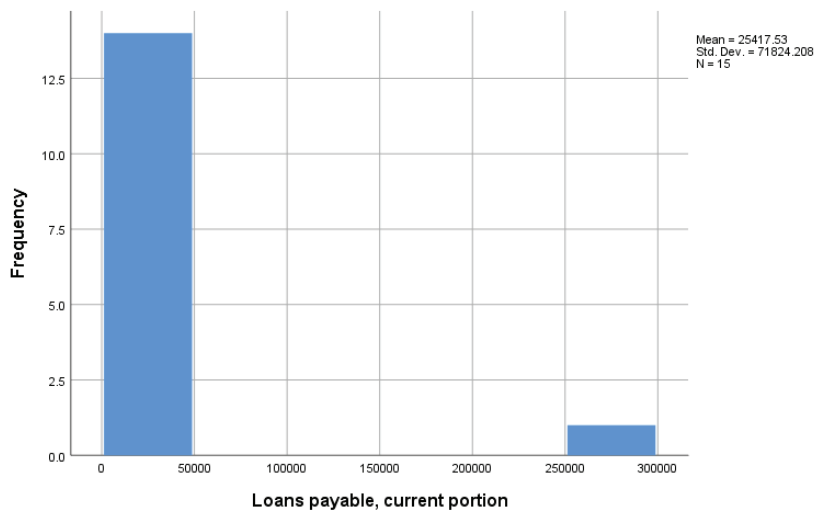

Figure A-15: Loans Payable

A-16 Factor 18: Royalties Payable

The royalties payable accounts are used when a company obtain royalty rights and sign an agreement with the royalty holder to pay a defined amount or percentage to the royalty holder in exchange for the rights to use that royalty. The royalty could be a patent, franchise or copyrights. There are two accounts (factors) to track royalties' payable, the first account (factor) is for the current portion and the second account (factor) is for long-term royalties.

Table A-0-15: Descriptive Statistics - Current Royalties Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Royalties payable - current	15	0	13334	888.93	3442.83

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their current Royalties Payable.

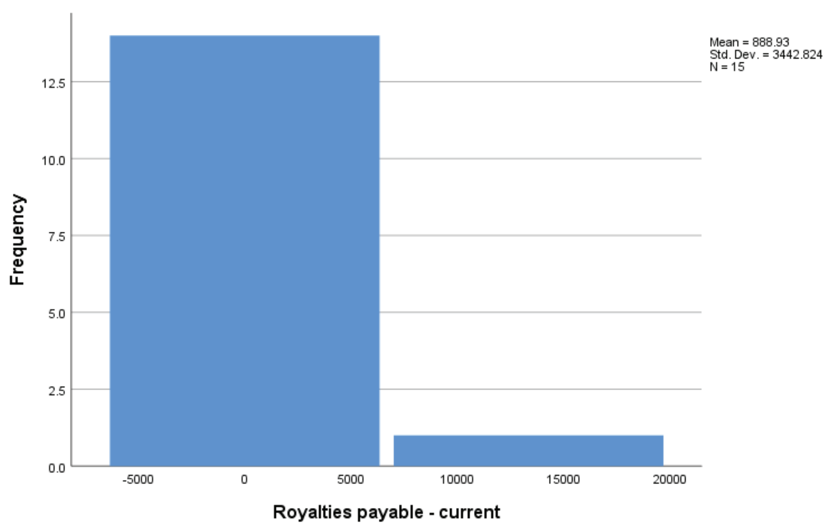

Figure A-16: Current Royalties Payable

A-17 Factor 19: Long Term Royalties Payable

As explained in factor 18, royalty's payable is tracked in two different accounts. This factor represents the long-term royalties' payable.

Table A-0-16: Descriptive Statistics – Long-Term Royalties Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Royalties payable - long term	15	0	60333	4022.20	15577.91

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their long-term royalties' payable.

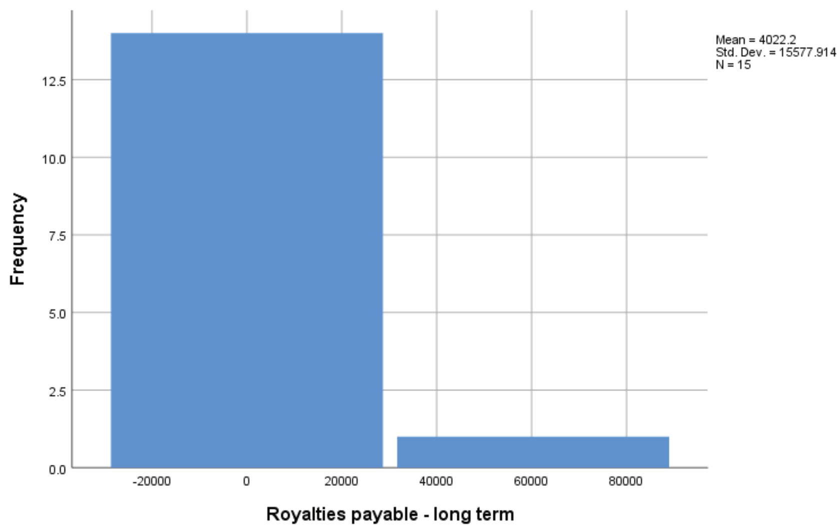

Figure A-17: Long Term Royalties Payable

A-18 Factor 20: Revenue Based Financing

Revenue based financing is a type of financing that companies may use to fund their operations. By promising a percentage of revenue to the lender. Similar to accounts receivables financing, the lender will have the right to receive a portion of the revenue to pay off the loan amount in form of percentage of revenue.

Table A-0-17: Descriptive Statistics - Revenue Based Financing

	N	Minimum	Maximum	Mean	Std. Deviation
Revenue-based financing	15	0	811958	54130.53	209646.65

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their current Revenue Based Financing.

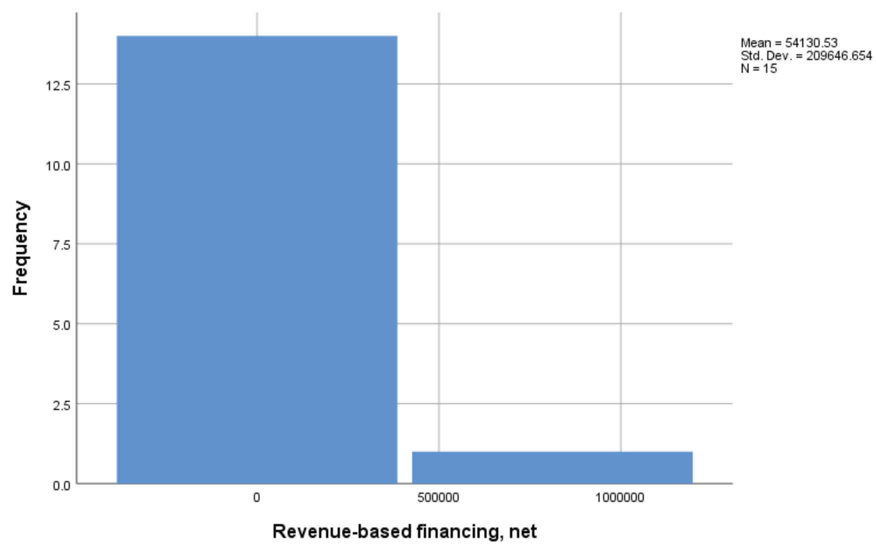

Figure A-18: Revenue Based Financing

A-19 Factor 21: Deferred Revenue

Deferred revenue captures the amount of revenue that was received for product or services that is to be delivered to the customer in the future. Those revenues will be recognized upon the delivery of the product or the service to the customer. Some start-ups prefer to be paid up front for their services and the highest amount of deferred revenue in the dataset was $538,218 and the mean is $55,738.

Table A-0-18: Descriptive Statistics - Deferred Revenue

	N	Minimum	Maximum	Mean	Std. Deviation
Deferred revenue	15	0	538218	55738.60	144323.38

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their deferred revenue.

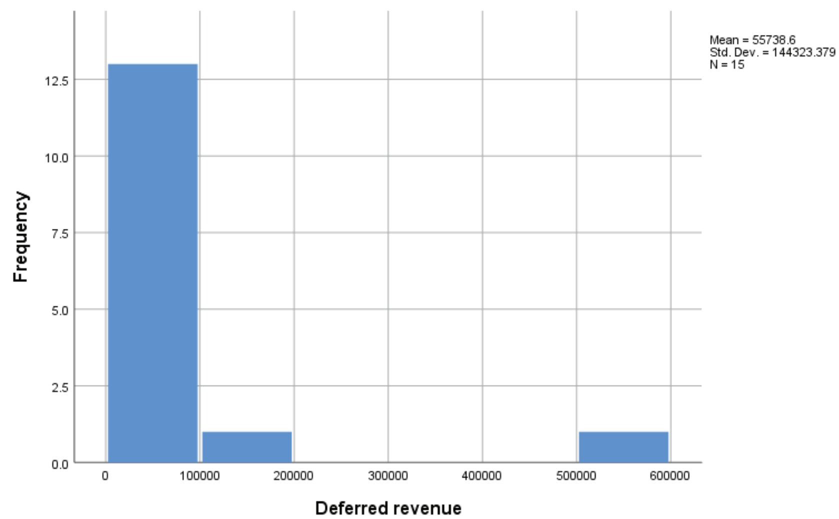

Figure A-19: Deferred Revenue

A-20 Factor 22: Deferred Compensation

The deferred compensation account tracks the amount of compensation incurred by the company but not yet paid. Sometimes the start-up owners will choose to defer paying themselves until they receive revenue. In other cases, the start-up may offer employment with higher than the marker compensation packages in exchange for deferring the payment till later date when the start-up receives money from customers.

Table A-0-19: Descriptive Statistics - Deferred Compensation

	N	Minimum	Maximum	Mean	Std. Deviation
Deferred Compensation	15	0	1275120	91902.80	328409.071

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Deferred Revenue.

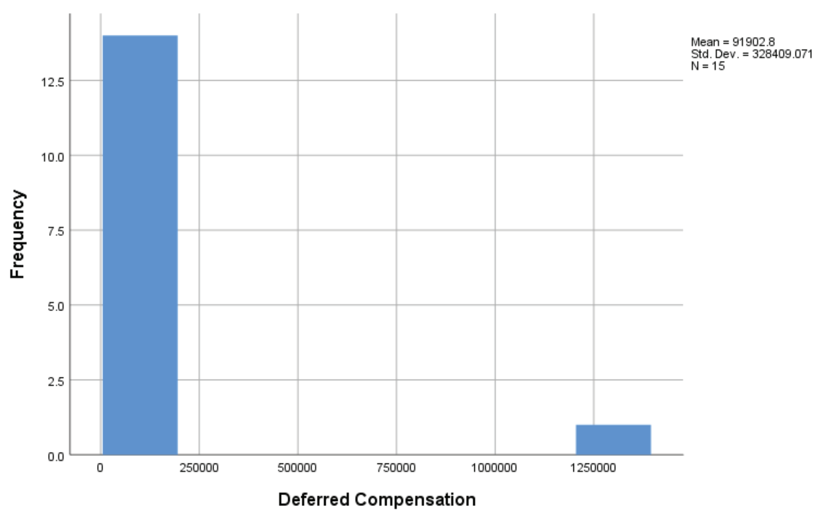

Figure A-20: Deferred Compensation

A-21 Factor 23: Convertible Notes

The convertible notes account is one of the more complex accounts in the financial statements. It accounts for various types of financial instruments used to fund the business. Some investors require start-ups to issue cash settlements with their convertible notes instead of common shares or preferred shares. Therefore, this factor may have a high dollar amount representing the total funding used in the form of convertible notes. The highest amount tracked in this research is $2,915,596 with mean of $237,985

Table A-0-20: Descriptive Statistics - Convertible Notes

	N	Minimum	Maximum	Mean	Std. Deviation
Convertible notes payable	15	0	2915596	237985.67	745661.022

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Convertible Notes Payable.

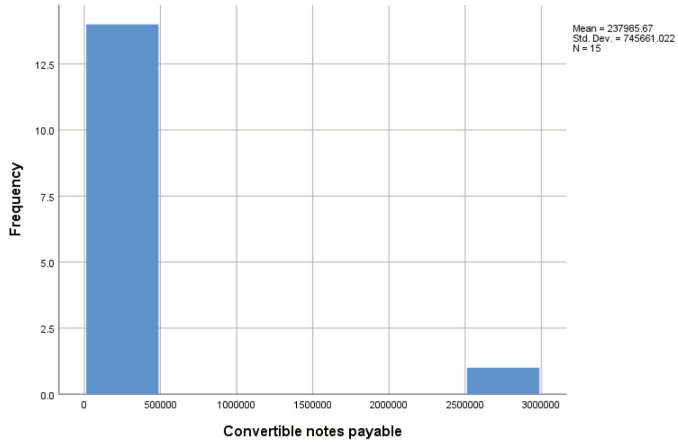

Figure A-21: Convertible Notes

A-22 Factor 24: Advances from Shareholders

Engineering owners and other owners (related parties) usually fund the operations of their start-ups by providing funds in the form of loans that is called advances. In this account, the start-up will track the amounts provided to it by its owners. This account is different than the owners' equity account. The owner's equity account represents the actual ownership of the start-up.

Table A-0-21: Descriptive Statistics: Advances from Shareholders and Related Party

	N	Minimum	Maximum	Mean	Std. Deviation
Advance from Shareholders and related party	15	0	352000	35066.33	91938.66

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Advances from Shareholders and Related Parties.

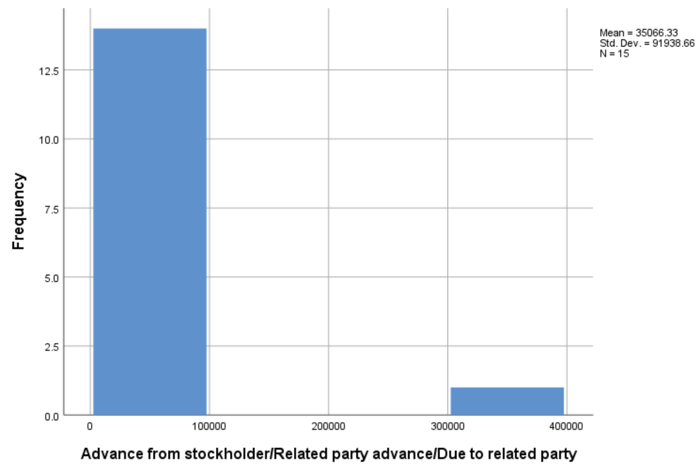

Figure A-22: Advances from Shareholders and Related Party

A-23 Factor 25: Other Current Liabilities

This account tracks the current portion of any other liabilities that are not racked elsewhere in the current liabilities section of the balance sheet. The account has a wide range and the highest value is $71,713 with mean of $ 5,778.

Table A-0-22: Descriptive Statistics - Other Current Liabilities

	N	Minimum	Maximum	Mean	Std. Deviation
Other Current Liabilities	15	0	71713	5778.00	18642.668

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Other Current Liabilities.

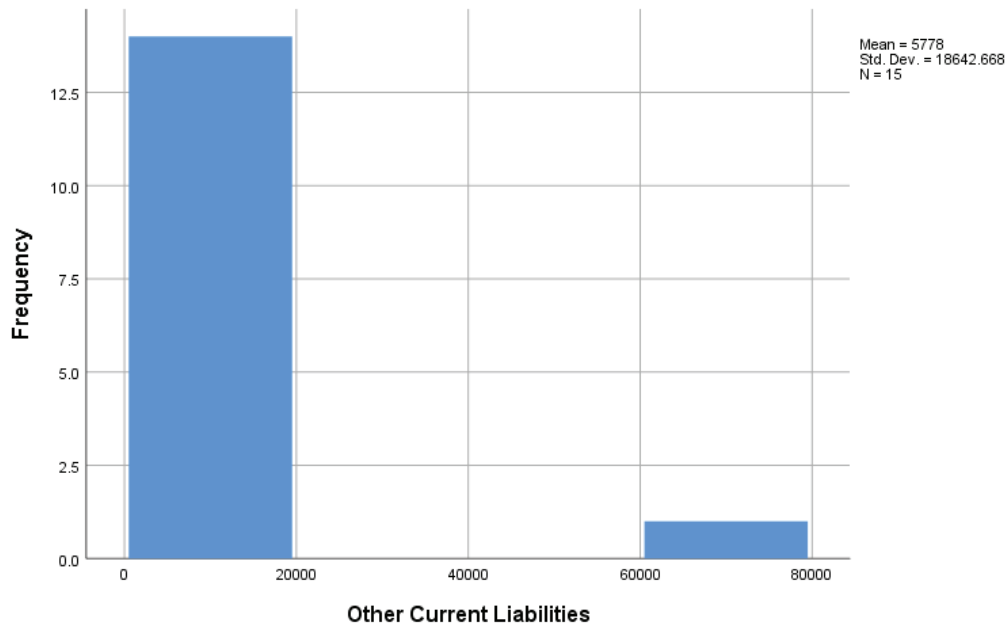

Figure A-23: Other Current Liabilities

A-24 Factor 26: Term Loans Payable

Start-ups track their loans in the loans payable accounts. The loans payable items tend to be short term, and it represents the loans with and without collateral that the start-up received from various lenders. The account highest amount reported is $304,253 and the mean is $43,370.

Table A-0-23: Descriptive Statistics - Term Loans Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Term loans payable, net of unamortized loan fees and current portion	15	0	304253	43370.67	102854.38

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Term Loans Payable.

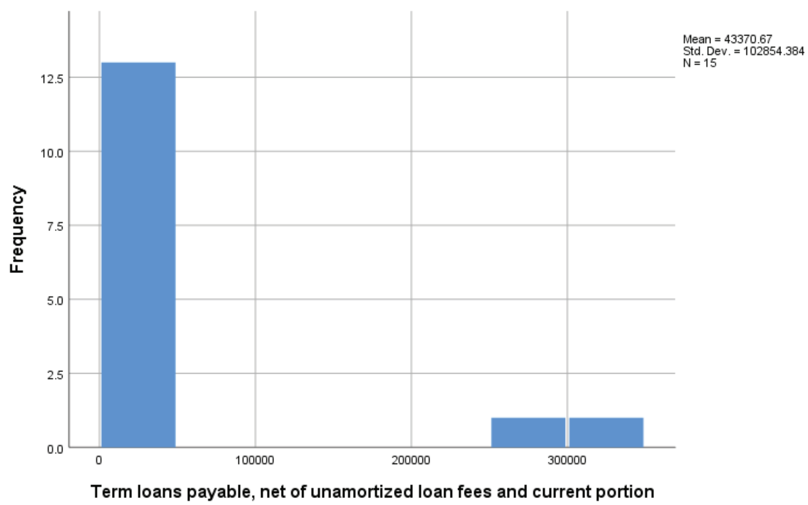

Figure A-24: Term Loans Payable

A-25 Factor 27: Convertible Notes Payable

Convertible notes payable is an important account that tracks financial notes that were issued by the start-up to investors or banks and carries a cash settlement. The reason it is tracked separately is that the terms of the notes may vary. The range of the account ranged from zero to $125,000 and the mean is $16,000.

Table A-0-24: Descriptive Statistics - Convertible Notes Payable

	N	Minimum	Maximum	Mean	Std. Deviation
Convertible notes payable, net of current portion	15	0	125000	16000	39650.26

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Convertible Notes Payable.

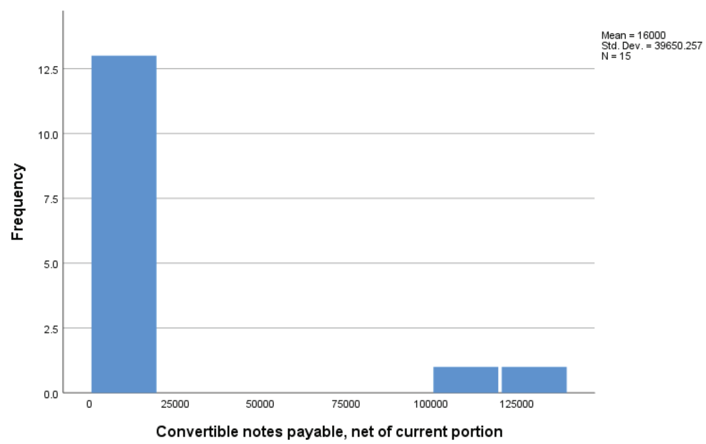

Figure A-25: Convertible Notes Payable

A-26 Factor 30: Accumulated Other Comprehensive Loss

This account is used to track the unrealized income or losses. It is a balance sheet account within the equity section. It is an important account as investors and lenders will be reviewing it to understand the start-up position on unrealized gain or losses that was incurred, but not yet realized. The account spread up to $222,643 and the mean is $14,842.

Table A-0-25: Descriptive Statistics - Accumulated other Comprehensive Loss

	N	Minimum	Maximum	Mean	Std. Deviation
Accumulated other comprehensive loss	15	0	222643	14842.87	57486.175

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Accumulated Other Comprehensive Loss.

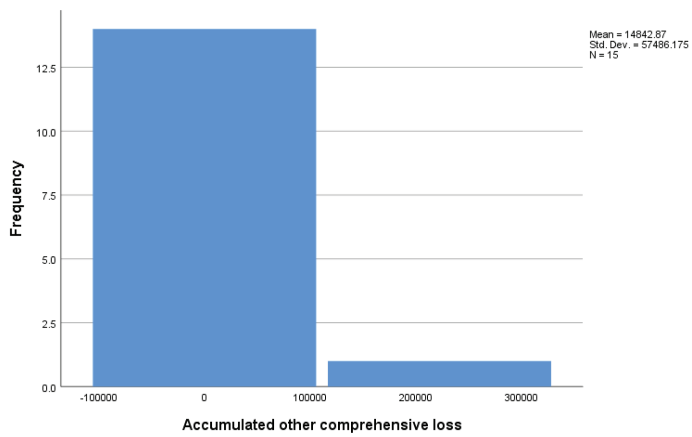

Figure A-26: Accumulated Other Comprehensive Loss

A-27 Factor 34: Compensation and Benefits

Start-ups track their compensation and benefits for their employees separate from their operating cost. This account represents the salaries, and benefits like health care cost to their employees. The highest amount of this account is $1,985,144 and the mean is $159,967.

Table A-0-26: Descriptive Statistics - Compensation and Benefits

	N	Minimum	Maximum	Mean	Std. Deviation
Compensation and Benefits	15	0	1985144	159967.67	516074.137

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Compensations and Benefits.

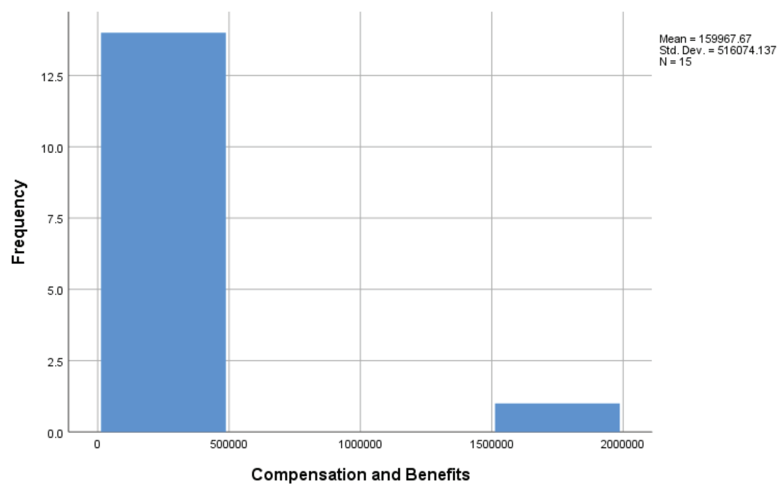

Figure A-27: Compensation and Benefits

A-28 Factor 37: Depreciation and Amortization

Start-ups have fixed assets which are reduced by a certain amount every year to account for the depreciation of the assets. Some companies choose a different number of years for their assets to be depreciated. For example, electronics may be depreciated over three to five years. Those amounts are recorded in this income statement account.

Start-ups tend not to have a significant amount of assets. This is depicted in the dataset of the highest amount recorded of $14,335 and the mean is $955.

Table A-0-27: Descriptive Statistics - Depreciation and Amortization

	N	Minimum	Maximum	Mean	Std. Deviation
Depreciation and amortization	15	0	14335	955.67	3701.281

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Depreciation and Amortization.

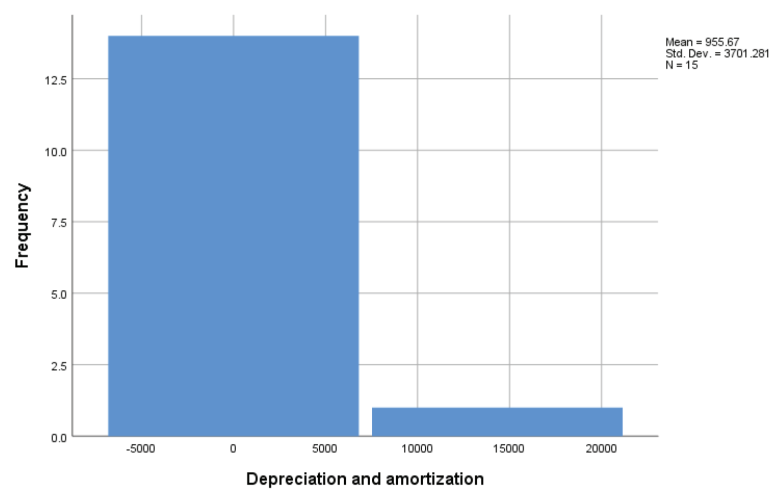

Figure A-28: Depreciation and Amortization

A-29 Factor 38: Interest Expense

Interest expense represent the amount of interest paid annually for loans, credit cards and other instruments that the start-up will have interest expense associated with it. This income statement account highest amount recorded at $277,998 and the mean is $27,955.

Table A-0-28: Descriptive Statistics - Interest Expense

	N	Minimum	Maximum	Mean	Std. Deviation
Interest expense	15	0	277998	27955.80	72227.99

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Interest Expense.

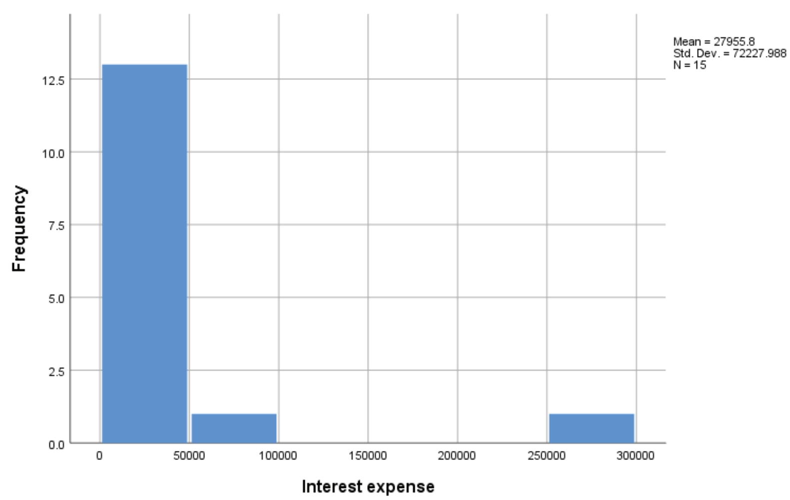

Figure A-29: Interest Expense

A-30 Factor 39: Interest Income

Some start-ups will earn interest on their cash accounts. Those interests are tracked and recorded in this income statement account. The current market interest rates are low; thereby, the amounts reported are small. The highest amount recorded in the dataset is $278 and the mean is $18.

Table A-0-29: Descriptive Statistics: Interest Income

	N	Minimum	Maximum	Mean	Std. Deviation
Interest Income	15	0	278	18.53	71.78

The following histogram illustrates the dollar amount and the number of companies that reported dollar value for their Interest Income.

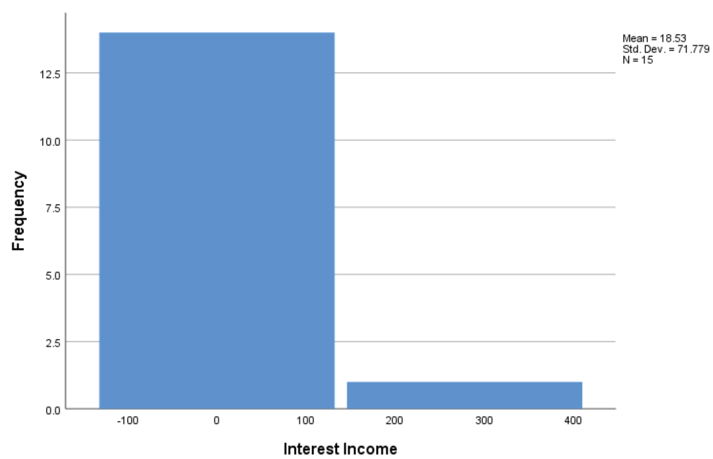

Figure A-30: Interest Income

A-31 Total Accounts

There are several total accounts listed in the balance sheet and income statements.

Those accounts represent a mathematical calculation and do not track or capture activities. Therefore, those total accounts were taken out from the dataset to avoid redundancy.

Appendix B: Confirmatory Factor Analysis Output

RStudio - R, Confirmatory Factor Analysis Output for the Eight Identified Models' Latent Variables and Variances.

Table B-0-30: Model 1 variables

Model 1

Latent Variables:	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding1 =~						
Rsrch.nd.dvlpm	1.000				134384.022	1.000

Variances:	Estimate	Std.Err	z-value	P(>|z|)	Std.lv
.Rsrch.nd.dvlpm	0.000				0.000
Funding1	18059065417.840	6594238331.208	2.739	0.006	1.000

Table B-0-31: Model 2 variables

Model 2

Latent Variables:	Estimate	Std.Err	z-value	P(>|z|)	Std.lv
Funding2 =~					
Rsrch.nd.dvlpm	1.000				0.224
Sals.nd.mrktng	1.196	44601491363.368	0.000	1.000	0.267
Csh.nd.csh.qv.	1.383	58818217690.677	0.000	1.000	0.309
Addtnl.pdn.cpt	0.494	33374641998.624	0.000	1.000	0.110

Variances:	Estimate	Std.Err	z-value	P(>|z|)	Std.lv
.Rsrch.nd.dvlpm	18059065412.468	7167006715.010	2.520	0.012	18059065412.468
.Sals.nd.mrktng	5173017013.691	4210211493.240	1.229	0.219	5173017013.691
.Csh.nd.csh.qv.	4902197864.460	5339658434.483	0.918	0.359	4902197864.460
.Addtnl.pdn.cpt	24690485756.465	9140316114.130	2.701	0.007	24690485756.465
Funding2	0.050	2807491070.392	0.000	1.000	1.000

Table B-0-32: Model 3 variables

Model 3						
Latent Variables:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding3 =~						
Rsrch.nd.dvlpm	1.000				0.224	0.000
Sals.nd.mrktng	0.802	25382373874.205	0.000	1.000	0.179	0.000
Csh.nd.csh.qv.	1.404	45565786174.064	0.000	1.000	0.314	0.000
Addtnl.pdn.cpt	0.694	33474641791.567	0.000	1.000	0.155	0.000
Gnrl.nd.dmnstr	3.911	120231215535.014	0.000	1.000	0.874	0.000
Variances:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.Rsrch.nd.dvlpm	18059065387.036	7065345380.421	2.556	0.011	18059065387.036	1.000
.Sals.nd.mrktng	5173017006.456	2236642057.206	2.313	0.021	5173017006.456	1.000
.Csh.nd.csh.qv.	4902197857.507	3686811615.117	1.330	0.184	4902197857.507	1.000
.Addtnl.pdn.cpt	24690485721.715	9228582987.631	2.675	0.007	24690485721.715	1.000
.Gnrl.nd.dmnstr	60534157317.880	33859207823.150	1.788	0.074	60534157317.880	1.000
Funding3	0.050	2536755077.740	0.000	1.000	1.000	1.000

Table B-0-33: Model 4 Variables

Model 4						
Latent Variables:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding4 =~						
Rsrch.nd.dvlpm	1.000				0.224	0.000
Sals.nd.mrktng	0.463	23943921240.865	0.000	1.000	0.104	0.000
Csh.nd.csh.qv.	0.893	39693766504.248	0.000	1.000	0.200	0.000
Addtnl.pdn.cpt	-0.671	43662945035.986	-0.000	1.000	-0.150	-0.000
Gnrl.nd.dmnstr	2.465	110922498557.768	0.000	1.000	0.551	0.000
Accounts.pybl.	0.734	32527284523.830	0.000	1.000	0.164	0.000
Variances:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.Rsrch.nd.dvlpm	18059065318.284	7403981079.640	2.439	0.015	18059065318.284	1.000
.Sals.nd.mrktng	5173016986.818	2056711722.829	2.515	0.012	5173016986.818	1.000
.Csh.nd.csh.qv.	4902197838.942	2667341561.815	1.838	0.066	4902197838.942	1.000
.Addtnl.pdn.cpt	24690485627.755	9348106434.683	2.641	0.008	24690485627.755	1.000
.Gnrl.nd.dmnstr	60534157088.368	27688338670.382	2.186	0.029	60534157088.368	1.000
.Accounts.pybl.	3892036438.495	1975795592.589	1.970	0.049	3892036438.495	1.000
Funding4	0.050	3366742808.497	0.000	1.000	1.000	1.000

Table B-0-34: Model 5 Variables

Model 5

Latent Variables:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding5 =~						
Rsrch.nd.dvlpm	1.000				0.224	0.000
Sals.nd.mrktng	0.457	26639063709.836	0.000	1.000	0.102	0.000
Csh.nd.csh.qv.	0.900	47432854616.269	0.000	1.000	0.201	0.000
Addtnl.pdn.cpt	-0.562	45850647655.534	-0.000	1.000	-0.126	-0.000
Gnrl.nd.dmnstr	2.588	133045280430.840	0.000	1.000	0.579	0.000
Accounts.pybl.	0.313	20506302948.968	0.000	1.000	0.070	0.000
Accumultd.dfct	5.062	352271847790.496	0.000	1.000	1.132	0.000

Variances:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.Rsrch.nd.dvlpm	18059065184.950	7605532183.002	2.374	0.018	18059065184.950	1.000
.Sals.nd.mrktng	5173016948.630	2089552928.689	2.476	0.013	5173016948.630	1.000
.Csh.nd.csh.qv.	4902197802.755	2995774240.322	1.636	0.102	4902197802.755	1.000
.Addtnl.pdn.cpt	24690485445.430	9293641302.493	2.657	0.008	24690485445.430	1.000
.Gnrl.nd.dmnstr	60534156641.426	30511771427.785	1.984	0.047	60534156641.426	1.000
.Accounts.pybl.	3892036409.801	1510630325.285	2.576	0.010	3892036409.801	1.000
.Accumultd.dfct	1247384954026.939	478596820419.601	2.606	0.009	1247384954026.939	1.000
Funding5	0.050	3789477766.090	0.000	1.000	1.000	1.000

Table B-0-35: Model 6 Variables

Model 6						
Latent Variables:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding6 =~						
Rsrch.nd.dvlpm	1.000				0.224	0.000
Sals.nd.mrktng	-0.063	36740285691.396	-0.000	1.000	-0.014	-0.000
Csh.nd.csh.qv.	0.283	62375380236.874	0.000	1.000	0.063	0.000
Addtnl.pdn.cpt	-0.059	77458531629.362	-0.000	1.000	-0.013	-0.000
Gnrl.nd.dmnstr	0.403	138774396447.022	0.000	1.000	0.090	0.000
Accounts.pybl.	-0.094	34531621363.700	-0.000	1.000	-0.021	-0.000
Accumultd.dfct	-1.686	617778867345.802	-0.000	1.000	-0.377	-0.000
Net.revenues	5.099	1169864879496.975	0.000	1.000	1.140	0.000
Cost.f.nt.rvns	0.243	189990986271.028	0.000	1.000	0.054	0.000
Variances:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.Rsrch.nd.dvlpm	18059065417.671	14360959148.435	1.258	0.209	18059065417.671	1.000
.Sals.nd.mrktng	5173017015.333	1901892121.101	2.720	0.007	5173017015.333	1.000
.Csh.nd.csh.qv.	4902197866.024	2125990397.396	2.306	0.021	4902197866.024	1.000
.Addtnl.pdn.cpt	24690485763.525	9027218337.780	2.735	0.006	24690485763.525	1.000
.Gnrl.nd.dmnstr	60534157422.444	22655205127.373	2.672	0.008	60534157422.444	1.000
.Accounts.pybl.	3892036459.982	1451289226.418	2.682	0.007	3892036459.982	1.000
.Accumultd.dfct	1247384970108.885	465073093320.764	2.682	0.007	1247384970108.885	1.000
.Net.revenues	827991860670.733	455887656225.920	1.816	0.069	827991860670.733	1.000
.Cost.f.nt.rvns	143925757939.558	52748912546.788	2.729	0.006	143925757939.558	1.000
Funding6	0.050	12757475004.690	0.000	1.000	1.000	1.000

Table B-0-36: Model 7 Variables

Model 7						
Latent Variables:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding7 =~						
x1	1.000				0.224	0.000
x2	0.589	17078695448.381	0.000	1.000	0.132	0.000
x4	10.000	296452164582.250	0.000	1.000	2.236	0.000
x5	9.161	259136400431.253	0.000	1.000	2.049	0.000
x6	2.985	94235143163.180	0.000	1.000	0.667	0.000
x7	3.365	89311746191.189	0.000	1.000	0.752	0.000
x9	0.533	17389518168.015	0.000	1.000	0.119	0.000
Variances:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x1	4902197802.634	2448808382.659	2.002	0.045	4902197802.634	1.000
.x2	3892036409.678	1608277314.265	2.420	0.016	3892036409.678	1.000
.x4	1247384953993.351	508547406910.158	2.453	0.014	1247384953993.351	1.000
.x5	827991849966.782	348486121302.460	2.376	0.018	827991849966.782	1.000
.x6	143925756080.328	57144877404.884	2.519	0.012	143925756080.328	1.000
.x7	60534156639.352	29348084081.803	2.063	0.039	60534156639.352	1.000
.x9	5173016948.549	2033778975.769	2.544	0.011	5173016948.549	1.000
Funding7	0.050	1671064547.594	0.000	1.000	1.000	1.000

Table B-0-37: Model 8 Variables

Model 8						
Latent Variables:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
Funding8 =~						
x3	1.000				0.224	0.000
x5	4.060	554716751711.434	0.000	1.000	0.908	0.000
x6	1.953	254407624949.962	0.000	1.000	0.437	0.000
x7	2.161	313657897120.840	0.000	1.000	0.483	0.000
Variances:						
	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.x3	24690485756.395	12514066787.742	1.973	0.048	24690485756.395	1.000
.x5	827991860431.978	346739256232.742	2.388	0.017	827991860431.978	1.000
.x6	143925757897.635	63629430293.630	2.262	0.024	143925757897.635	1.000
.x7	60534157404.745	44450780466.347	1.362	0.173	60534157404.745	1.000
Funding8	0.050	8678662876.091	0.000	1.000	1.000	1.000

Appendix C: Practical Capital Funding Model Template

Table C-1: Practical Capital Funding Model Template

Practical Capital Funding Model Template					
#	PCF Model Factors	Source	Factor Amount	Uniqueness	Total
1	Research and development	Income Statement		0.9815	-
2	Sales and marketing	Income Statement		0.7289	-
3	Cash and cash equivalents	Balance Sheet		0.7143	-
4	Additional Paid-in capital	Balance Sheet		0.6798	-
5	General and Administrative	Income Statement		0.3373	-
6	Accounts Payable	Balance Sheet		0.1865	-
7	Accumulated deficit	Balance Sheet		0.0736	-
Subtotal					-
RSQ					0.99826
Capital Funding Request					-