

Modeling and Comparing a Startup Dynamics in the US and Egypt

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ABSTRACT

In today's world startups are playing a key role to stimulate the economy, and create fulfilling employment opportunities. However, the failure rate of startups in the US, a prominent country in encouraging startups, has been eight out of ten, a very high proportion. In this paper, I explore this topic further with a hypothesis that company's sustained success depends not only on its financial growth, but also its dynamic ability to continuously fulfill its key stakeholders' needs and aspirations, and its ability to adapt to the specific conditions of its evolving ecosystem. This paper provides a holistic, system-driven conceptualization of a startup and its internal dynamics from human resources, product development, customers, and financials perspectives. I develop a System Dynamics model to represent these internal dynamics and simulate it over a period of five years. In addition, I bring in the impact of exogenous factors from the entrepreneurial ecosystem as a "second layer" of variables in the entrepreneurial model. I then compare and contrast the US and Egyptian cases. A significant difference in final Firm Valuation and Job Attractiveness was observed. I conclude with a discussion of the high leverage points in the Egyptian ecosystem based on this analysis.

Keywords: startup, entrepreneurship, Egypt, ecosystem, system, success, dynamics, and simulation.

Introduction and Motivation

Companies, and organizations in general, have a lifecycles and evolutionary patterns that have been identified by many researchers and practitioners in the field. These patterns are related to product development, customer acquisition, employees and leadership recruitment, financial growth (most dominant perspective), and competitors' development, among others. Most of the lifecycle and evolution theories and frameworks examine the evolutionary patterns from particular perspectives; very few have taken a holistic approach and integrated various evolutionary patterns and trends. It's my hypothesis that very often startups fail because they consciously or unconsciously don't recognize this overall evolutionary pattern of behavior, and instead focus on the most urgent and obvious challenges, namely product development, customer acquisition and financial growth without seeing the larger implications. Large companies, who are also

mature, sometime can afford delays to respond to the broader set of dynamics since they typically have resource buffers that can absorb transients, but startups typically don't. It's very much like sailing; small boats are very sensitive to instabilities and bad steering, large ones less so. Further, early decisions and policies in a startup could have both very positive and negative impacts on the subsequent phases of its lifecycle.

Another problem that most entrepreneurs face is that the more the startup grows the more its complexity increases. More customers mean more relationships, orders, and complaints management. The more investment and cash the startup manages to raise and generate, the more obligations and taxation rules it has to comply with. After a certain threshold, it becomes paramount for the entrepreneur to have a structured organization with internal tools and systems to manage the ever-increasing complexity. One of the most useful tools that might help entrepreneurs in their startups' early years is a holistic simulation model that can replace their trial and error decision making approaches with a more scientific and data-driven model that can simulate their anticipated policies and decisions. Such a model would aid entrepreneurs in exploring different policy and decisions options, and their dynamic impact over time during the company's lifecycle. This thesis develops such a model.

Main Hypothesis & Primary Research Question

Main hypothesis: a company's sustained success depends not only on its financial growth, but also its dynamic ability to continuously fulfill its key stakeholders' needs and aspirations, and its ability to adapt to the specific conditions of its evolving ecosystem.

Research Question: What are the most important external factors that impact a startup's success? And how are the differences between the U.S. and Egyptian ecosystems influencing outcomes for entrepreneurial ventures?

Organization of the Paper

First part of this paper will highlight the role of organizations as tools to help humans manage increasing complexity of their day-to-day lives, and the genesis of the need to create and build organizations. Startups will be introduced as the early forms of mature organizations with special characteristics and behavior dynamics. Moreover, the importance of startups' effective design and architecture in the later growth stages of an organization will be argued from organizations' lifecycle theories perspectives.

Second part will argue the importance of viewing startups as systems, and what this entails. System thinking concepts applied to organizations, Management Cybernetics and System Dynamics concepts will be summarized, and presented as innovative and practical ways to diagnose and design organizations, i.e. startups.

Third part will be dedicated to developing a System Dynamics model of a startup firm. The model will be built on existing models of new ventures, and will be modified based on current system-related concepts and the author's own professional experience.

Moreover, key external environment variables will be added to reflect the interaction and dynamics between the startup as a whole and its environment.

Fourth part will discuss the different entrepreneurship dynamics between the US and Egypt based on the developed system dynamics model. The research question and hypothesis will be explored in this section. Special similarities or differences will be highlighted and interpreted.

Fifth part will be the conclusion and the recommendations from this study. Recommendations for policy makers will be presented to increase the viability of startups and increase their sustained success. Limitation of the research and suggestions for future study will be discussed.

Research Methods & Approaches

System Dynamics modeling will be used to represent the different dynamics that affect the evolution of a startup over time, and to simplify the complex interactions and relationships between its key elements.

This model will be developed utilizing Forrester and Sterman's existing models of a company. The model will be modified to fit a startup, and to incorporate latest findings in the organizational lifecycle literature. The main stocks in the model will be Product Features, Customers, Cash, Human Resources, Competitors, Suppliers/Partners and Management Systems. The Viable System Model (VSM) will be used to quantify the development of the Management Systems inside a startup.

Sterman's methodology for step-by-step System Dynamics modeling (Sterman, 2000) is consulted throughout the whole modeling and simulation.

Viewing Startups as Systems

In this section, we introduce the systems perspective on startups that informs our study. We begin with a simple descriptive "stages" model of startups. We then introduce the VSM model, a simple but insightful systems model of business organizations, and develop the related concepts of complexity and variety. We then retrace the stages in the context of the VSM model and demonstrate how it expands as the firm grows in size, complexity, and variety.

A system structure is in essence a structure of channels and regulators for different flows. For a start-up firm, the principal flows are data/information, money, materials, people, and products/services. The key difference between a holistic and reductionist approach is that the former pays attention to the structure of channels between the different elements, the interactions, and the different flows that go through these channels, while the reductionist approach breaks down a system into isolated elements, and then tries to study each element in isolation of the others, ignoring the existing relations between the different elements. It is useful to draw an analogy to the human body whose systems are

basically different organs connected together via different channels, i.e. the blood vessels and nerves, which keep them working properly by getting them basic resources and operation directions. It's the author's belief that the main challenge in designing systems lies not in the design of the different subsystems or elements, but in the design of the structure of channels connecting these subsystems/ elements. The supply chain system in the Beer Game¹ is composed of different elements, i.e. factory, wholesaler, retailer and consumer, and the connection between them. The connection and hence the communication between these elements were linear in this case. The design of channels and their connection points between the subsystems/elements is a key indicator of the structure of the system.

The Viable System Model (VSM)

The recursion concept is a very important concept in almost all systems sciences, including cybernetics. In its simplest definition, this concept implies that all systems around us are composed of lower level subsystems and higher-level super-systems. For example, a human's biological systems are composed of organs and cells subsystems and are part of the whole human body super-system. Humans themselves are subsystems of social systems, i.e. populations, startups, etc. When diagnosing or designing a system, it's paramount to clearly identify which level of recursion of the system one is focusing on, usually termed System-in-focus according to Stafford Beer's terminology. In this study, the system-in-focus is the startup as a special form of organizations (Beer, 1985).

Human beings are viable systems; we maintain our own separate existence (Beer, 1985), and are able to adapt and survive in complex changing environments. However, humans are not omnipotent, we as viable systems have limits and thresholds that we naturally can't exceed, i.e. very high or low temperature, deep skin cuts or injuries, viruses, etc. Yet, employing our intelligence we managed to create tools and techniques that enable our viable systems to further adapt and survive in conditions that our own very systems couldn't before. We have created higher recursion systems to enable us to reach endeavors that we couldn't with our basic biological systems. It fair to say that human beings since their existence have been developing systems, both mechanical and social. These man-made systems have been evolved to imitate the viability of the humans and/or the natural systems. In the subsequent discussion we will also model startup firms as viable systems whose survival depends on the right mix of environmental conditions and the right flows in and out of the organization as well as the control of internal flows such as staff, knowledge, and money

¹ The Beer Game is an interactive classroom game where teams simulate a supply chain of a factory, wholesaler, retailer and customer for beer. The game simulates common behavior in supply and demand and the resulted delays in the process (Sterman, 2000)

Complexity and Variety

In the early days of a startup firm, the complexity of the internal and external environment as measured by variety is manageable by the founder(s) themselves as the viable organizational system. As in Figure 1, the founder(s) becomes System 1, producing the product/service of the startup, System 2, managing themselves, System 3, developing simple tools and techniques to stabilize and audit their own day-to-day operations and results, System 4, investigating future market potentials and threats, and System 5, balancing their time, effort and focus on the urgent day-to-day operations and keeping an eye on the market future, and creating the startup's identity.

As the number of customers/users increase, and consequently the needed additional

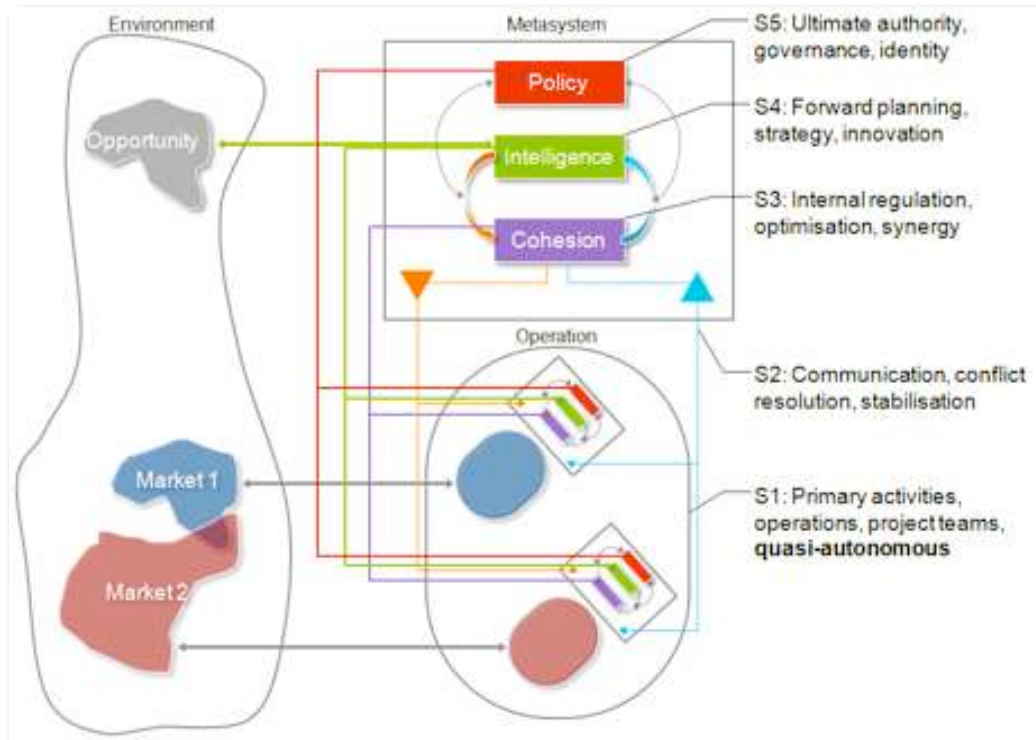


Figure 1: The Viable System Model

features and services increase, the complexity that the startup is dealing with sharply increases. To absorb such complexity, or variety, the founder(s) tries to amplify the startup system by getting more human, technological and financial resources. Eventually, the complexity increases to a threshold level that the founder(s) can't perform all the functions of Systems 1-5; a significant need for organization and structure emerges. As more people are hired, new system recursions are created by the grouping of individuals into teams, initially usually into a technical team and business team. These teams formulate now System 1 with its lower recursion, and the founder(s) keep acting as Systems 3-5 while usually involved in System 1. System 2 is simple in this stage and shared by the new hires and the founder(s).

More employees form new teams to handle System 1,2 and parts of 3. Founder(s) and/or appointed top managers handle System 4, 5 and partially 3.

Consequently, based on the Viable System Model fundamentals and the author observations, a Startup's sustainable growth is actually tied to its ability to effectively reproduce viable systems at different recursion levels.

Structure or Strategy, Which Comes First?

Alfred D. Chandler's study on four large US companies concludes, "outside market opportunities determine a company's strategy, which in turn determines the company's organization structure" (Greiner, 1998). However, Greiner argues that this conclusion is only valid for the studied companies and their own special conditions, and that "more recent evidence suggests that organization structure may be less malleable than Chandler assumed; in fact, structure can play a critical role in influencing corporate strategy" (Greiner, 1998). Moreover, in his seminal article, *Evolution and Revolution as Organizations Grow*, Greiner presented a model that shows how organizational structure affects future growth. Moreover, one of the key conclusions of the Beer Game (Sterman, 2000) is that behavior is a function of structure; no matter what you might try to do, if you keep the same system structure, you will get the same behavior. The performance of governments, NGOs, universities and companies is closely related to the way these organizations are structured. This is a very insightful and proved concept, but the real challenges are many. What do we mean by system structure in organizations? Is it the organizational chart? Or is it something much deeper than that? How can we know the needed structure to generate desired performance or behavior? Additionally, how can we migrate from an existing structure to a desired one? And how can we repeat this migration in today's continuously changing world?

The Startup Lifecycle: Which Perspective?

Looking at organizations, and startups in particular, *as a system* has led many system thinkers and cyberneticists to draw analogies to organisms or living systems. As a result, organizations have a lifecycle that they go through from inception to aging to death. In addition, because organizations are such very complex systems, it is useful to describe such a lifecycle from different perspectives. Contrary to many researchers and practitioners who try to describe an organization's lifecycle from only one perspective, management cyberneticists and system thinkers would rather try to describe and integrate multiple perspectives to give a holistic idea of what an organization, in our case a startup, would go through. In the next section, six different perspectives of a startup lifecycle will be presented based on the author's experience, two years of observing startups in the Boston area, and the cited references. These are the different perspectives that will be described; Financial, Product/Services, Team(s), Customers, Organizational Systems and Management.

Financial Perspective

The financial view encompasses the endogenous bootstrap funding generated from the organizations' core business or function with customers, and the exogenous funding generated from external sources like banks, investments and grants. For the indigenous

financial flows, the main parameters are revenues and costs. Founders contribute initial funds, and once products/services are developed revenues are generated from sales of products and/or services to customers in exchange for money. While costs are the money spent by the organization to develop and produce and/or provide such products and/or services. Over the early phases of the lifecycle, the revenues are typically very low, starting from zero revenues in the early months of the inception of the organization, and gradually revenues start growing slowly in an S-curved shape as more sales are achieved. On the other side, even though unit costs fall with scaling, total costs grow consistently as the startup continues developing and improving its products and/or services, attracting competent employees, acquiring new customers, and procuring new assets. The relationship between the behavior curves of the revenues and costs decides the shape, and consequently, the behavior curve of the profits of the startup. For a startup to be profitable, its costs need to be lower than its revenues over the accounting periods in question, a condition that usually can't be achieved in the early two phases of its lifecycle. Consequently, startups need exogenous funding in their early stages and in every scaling stage that would exceed its indigenous financial resources.

External funding has developed over the last few years in the startup and entrepreneurship communities to have distinct phases with special set of norms and definitions. The first phase is called Bootstrapping, and it usually refers to the very initial funding that founders invest in their startups from their own savings and/or ongoing salaries. Bootstrapping is usually used to get the very basic and essential resources to develop the initial business model and product/service prototype. The second phase is funding from Friends and Family, which is basically getting money from friends and/or family members either as a loan or as an investment in the startup in exchange for equity or shares of the company. Funding raised in this stage is usually used to further develop the prototype to a working alpha or beta product, and acquire customers as early adopters. Overlapping with this phase, entrepreneurs start seeking additional funding either from startup competitions prizes, grants agencies/foundations, incubation programs, and/or seed (angel) investors. Business plans, executive summaries and pitching competitions have been increasing in numbers worldwide. In the US alone there are 500 entrepreneurship competitions organized by business schools (e.g. MIT's \$100K), entrepreneurship foundations (Ewing Kauffman Foundation), governmental agencies (SBA), and large corporations (IBM Smart Camp). In Egypt such opportunities also exist, although the number of these competitions is much smaller, as one should consider the relative difference between the US and Egypt in terms of population, and number of organizations, business schools and large corporations. Over the last few years, the American University in Cairo, Google Egypt, Microsoft Egypt, and key NGOs have been organizing many entrepreneurship competitions, and incubation programs. The funding raised in this phase is typically used in substantially improving the product or services provided, maturing the business model, contracting essential service providers (lawyers, PR/Marketing agencies, Technical Consulting, etc.), recruiting the first employees (typically involved in the core operations of delivering and selling the product/service, and not much involved with the strategy), and procuring additional assets, i.e. office space, equipment, etc.

After successfully surviving the previous phase, validating the market need for and interest in the product/service and establishing a solid customer base, entrepreneurs

usually seek angel investments. In the US, such investments typically range from \$25,000 to \$500,000 in exchange for equity of the benefitting startup. Angel investors have been historically entrepreneurs or experienced business professionals themselves who want to help other entrepreneurs or just enjoy the whole process of building and growing startups. Angel investors are increasingly forming networks, and syndicated funds among themselves to be able to pool their available funds together and fulfill startups increasing needs for funds. Venture Capital (VC) companies fulfill funding needs beyond \$1 million across multiple rounds; i.e. round A, B, C, etc. VCs are established companies with solid funding resources, and they usually receive hundreds of business plans every month to study and decide on whether to invest in or not. VC funding is used in scaling up the company (usually not a startup anymore) in number of employees, products/services offerings, assets, and customer base in multiple segments. Before and during this stage, companies have the option to go public, Initial Public Offering (IPO), where they will be listed on the stock market, and become open for public investments in exchange for some of the companies' shares. Very few startups, 200 companies out of 600,000 per year on average (Ritter, 2002), make it to the IPO stage, but those who do are faced with a totally different set of influencing factors and challenges. It's worth mentioning that companies who fail to raise enough exogenous funding to close gaps between generated revenues and existing costs or investments will eventually go bankrupt. Also, it's very common that well performing companies at any of the above mentioned phases can be acquired or bought by larger companies. After the acquisition they either maintain their identities as wholly owned subsidiaries or are absorbed into the structure of the acquiring parent company.

Product/Service Perspective

Most products/services that are developed and sold by startups go through different stages. The first stage is the identification of an existing need that is not fulfilled by existing products/services or could be fulfilled much faster, cheaper or with higher quality. After this stage, entrepreneurs decide which of these needs are most relevant and start brainstorming together to come up with multiple innovative solutions to satisfy an identified subset of needs, and then settle on 1-3 solutions that they want to spend more time and resources exploring and developing. This phase is popularly known in the innovation literature as Product Innovation. Mentors, advisors and few potential customers are consulted to give feedback on the initial solutions. Once consensus is achieved, the founding team starts developing a prototype of the chosen solution. The prototype is usually very rough and meant not to be perfect yet it often represents a minimal viable product (MVP). Such prototype is used to get customer's feedback and test their product experience. Alpha and Beta versions of the product are launched with more improvements and enhancements based on the collected feedback from customers and mentors. After this very dynamic phase, the number of changes or fixes in the product starts to decrease while the sales ideally increase. Concurrently, the entrepreneurs will focus more on finding efficient and effective ways to generate multiple units/packages of the product/service. That is they start generating variants of the baseline product/segment for different market niches. This phase is often identified as the Process Innovation phase in the innovation literature. After developing such processes, the startup gets into the scaling phase where it focuses more on the producing and selling

more units/packages. Startups usually defend this stage of scaling up against other competitors or they disrupt their own innovative solutions, and generate other solutions that would start the whole cycle from the beginning in an S-curve like fashion. The evolution of the firm itself is the superposition of the S-curves of its individual products/services under development and production.

Team(s) Perspective

Startups are formed by a small number of people known as the founding team. The founding team is initially formed due to multiple reasons; members could be part of the same company, academic course of study, local community or club or just friends that have known each other for some time. The interesting thing about founding teams is that they get united around certain ideas, approaches, values and interests. Strong founding team members usually are diverse in professional background, specialty, and connections. As the startup goes through the different financial and product phases, the founding team attracts more people to join the startup either as employees, summer interns or mentors and advisors. The first employees are usually technical ones who help the founding team further develop and enhance the product/service, and further sell and market to more customers. These initial employees are usually offered a share of the company in addition to or in lieu of salary. Depending on the funding and growth of customers, this stage is usually followed by an increase in both technical employees to further enhance the product/service, and sales and marketing employees to increase the number of customers and users. Customer support team gradually starts to ramp up in the startup as the number of customers increase, paralleled by an increase in the number of accounting, legal and finance people to manage the increased number of transactions and financial needs of the startup. Eventually, the human resources team starts to evolve to make sure that the startup has a timely supply of competent employees to fulfill increasing business demands. As the business of the startup continues to grow, and consequently the number of employees increases, other support teams get formed. Examples of these support teams are: procurement, administration, and communication. One can observe that, contrary to the financial and product lifecycle perspectives, the team perspective doesn't have its own milestones. It is rather linked to the growth patterns of financial and product perspectives. The number of employees in the company could grow or decline vertically (number of people in certain team/function) or horizontally (the creation of whole new teams/functions). Reorganization, downsizing, rightsizing, and turnaround programs involve substantial decreases in the number of employees in a company, and the formal communication and authority channels. Examples of major team milestones are usually when the founders become involved full-time, and when the first employees are hired first part-time and then later full time. One of the early questions for many startups is how much of the work to do in-house with its own teams and what to outsource to established firms who can carry out certain tasks more quickly (e.g. website design, product testing etc.) but potentially also at higher cost.

Customers Perspective

In *Four Stages to Epiphany*, Steve Blank speaks about startups' four stages of customer development (Blanks, 2005). The first is discovering who are the target customers, what their needs and pain points are, what they really value. Usually this stage is very

unstructured as the founding team tries to reach out to potential customers in their own personal networks, and tries to get some early personal feedbacks (Blanks, 2005). This stage is very critical as the ultimate goal of a startup is to develop a product/service that customers need, use and would pay for. If the founding team misses that stage or didn't spend enough time in understanding their potential customers, valuable time, money and energy could be wasted downstream in developing a product/service that customers don't need, like or pay for. It is worth mentioning that many times customers don't really know what they need either because they couldn't articulate it or because what their need hasn't been developed yet. A good example of this is the iPhone and iPad, which revolutionized the way we interact and interface with "smart" machines. Therefore, new design companies like IDEO and Continuum employ ethnographic techniques to observe and interview customers in their daily lives, and the way they deal with or handle the need in focus. Based on the findings of this discovery phase, the founding team develops product/service prototypes, and uses them to move to the next phase of the customers' lifecycle validation (Blanks, 2005). In this phase, the founding team tries to make sure that they accurately understood the customer's needs, and developed a desirable solution for such needs. Sample of customers, usually called early adopters or lead-users, are approached to use the product/service (either to buy it or use it for free in exchange for feedback). Close communication between the founding team and the early adopters should ideally take place to further assess how successful the product/service is in meeting customer's needs (Blanks, 2005). From this point on, a continuous feedback loop should be established between the product development team and the customers to further improve and develop the product and its features. Once, the startup has an enhanced minimal viable product (MVP), it starts to shift more focus on the sales and marketing aspects of the product to a wider audience of mainstream customers, in a phase called customer creation (Blanks, 2005). In this phase, a startup is trying to "cross the chasm" by finding customers other than the early adopters to widely buy the product. The objective in this phase is to sell more and more units of the product to generate more revenues, which impacts the indigenous funding of the startup. This is usually synchronized with an increase in the size of sales and marketing team, and a gradual lagging increase in customer service team's size. Usually the time, energy and investment in product development and enhancement slows down at this stage as the founder's team focus more on quickly capturing a large customer base before existing or potential competitors catch up with the new innovation. During this stage, the founding team usually needs to develop "accessories" or "derivatives" to the main product to be able to reach wider customer segments. An example for this would be a mobile application for a web-based platform without much change in the basic functionalities and features. At the end of this stage, the startup focus more on leveraging a network of suppliers and distribution channels to further speed up the acquisition of customers, and the enlargement of its market share. This leads the startup to the next phase of scaling up the customer base, and consequently the generated revenues. In this stage, most companies move from product innovation to process innovation as the focus shifts from developing an innovative product to mass-producing such product with the lowest costs to maximize profits. Also, in this stage most startups would have abandoned informal structures and communications, and moved to a distinct grouping of teams, roles and responsibilities, clear authorities, and formal communication methods. Such transition has its own

advantages and disadvantages on the company as an organization. In addition, substantial funding is needed in this stage, and, therefore, multiple VC fundraising rounds or IPO usually occur in that stage.

Organizational Systems Perspective

An organizational system includes the structure of the organization in terms of departments, teams, roles, responsibilities, processes, tools, policies and communication techniques. In the founding phase of a startup, there is no clear documented organizational system; rather the founders are actually the system. Their attitudes, communication skills, sense of ownership, personal behavior and learning abilities define what kind of a team, or an organization, they are. This explains why many investors, incubation programs and startups competitions put a lot of emphasis on the founders characteristics, harmony, experience and education. The communication between the founders is informal and not bound by timings or formalisms. They meet in a dorm room, café, or study room whenever they can meet either early in the morning or even late around midnight. For the founders, product development, customers and financing are the urgent and important aspects they pay all their attention to in this phase. Once startups start to acquire customers and have some decent funding, they gradually realize the increasing need for some standards, processes, policies and structure. Examples for this would be recruitment process to get needed human resources to fulfill increasing demands, standard reports on the performance of the startup, bookkeeping and accounting processes, and procurement and compensation policies. As the startup grows in size and business, more formal structures, processes and policies evolve. Most notably, coordinated business and financial planning processes develop to set priorities of resource allocation and utilization. Gradually the company procures or develops software packages and information systems to automate and manage some or all of the business processes and communication techniques. Contrary to the development of a human being with clear knowledge on the timing of each organ and biological system development, there is limited literature on the development timing of an organization's subsystems and processes.

Management Perspective

Greiner refers to this aspect in his Evolution and Revolution model of organizations as the management style (Greiner, 1998), while Ichak Adizes tackles the issue from an organizational behavior perspective (Adizes, 1999). The first phase is characterized by focus on creativity and innovation, and thinking outside the box. By the end of this phase, most startups face a problem of leadership, as they need to move from the innovating mode to the execution mode. A strong and experienced leader is needed to smoothly transition to the following phase of direction. The appointed leader tries to establish order and direction by centralizing decisions to ensure formal communication among the increasing number of employees, and secure and control financial resources. In this stage, usually conflicts arise between the founders and the appointed manager for the company (Adizes, 1999). After some time, the directive style fails to energize the growing complex organization as the centralization of management restricts the proactivity and prompt adaptation to changing market conditions (Greiner, 1998). As a result, the company leaders start to delegate more authority to middle and front managers to take decisions on

their own (Adizes, 1999). Many managers find the shift very challenging; those who used to make all the decisions find it hard to delegate, and those who used to wait for approvals find it hard to make their own decisions. Those organizations that succeed in fostering delegation, manage to penetrate new markets, respond quickly to customers, and enhance products or create new ones. Gradually, top executives lose control over the growing organization, and empowered managers get accustomed to running their own show (Adizes, 1999) (Greiner, 1998). However, such a situation creates misalignment and incoordination in terms of investment, technology, operations and employment plans. Consequently, most top managers react either by falling back to centralized control, which usually fails due to the expansion of the company, or by instilling coordination systems and tools (Greiner, 1998) (Adizes, 1999). A mix of centralization and delegation characterizes this coordination phase; certain strategic functions get centralized in the headquarters of the firm, while other operational functions get delegated to relevant managers. In many cases tensions and power games arise between central or headquarters functions and operational functions. Such tensions have the potential to spoil the internal culture and create distractions from the main customers focus. Moreover, due to the fact that even functional decisions have an impact on strategic decisions, operational managers tend to take safer decisions that wouldn't jeopardize their positions by the corporate "watchdogs". In Greiner's words "procedures take precedence over problem solving, and innovation is damped...the organization has become too large and complex to be managed through formal programs and rigid systems" (Greiner, 1998). As a result, companies move to the collaboration phase where the focus becomes problem solving through the creation of collaborative teams. Multiple tools and information systems get unified and simplified in fewer systems or even one system, and decisions become governed by social control and self-discipline (Greiner, 1998). Researchers predict that the main challenge of this phase is the "psychological saturation of employees who grow emotionally and physically exhausted by the intensity of teamwork and the heavy pressure for innovative solutions" (Greiner, 1998). Hence, companies need to find a new structure that would enable employees to "rest, reflect, and revitalize themselves".

A Systems Dynamics Model of a Startup

In this section, we develop a Systems Dynamics model to conceptualize the most important internal and external dynamics that are related to startups.

As any modeling technique, System Dynamics is limited to the modeler's experience, understanding and mental model/world view of the system he/she is trying to model. In essence, the model is as good as the modeler's understanding of the actual system. Hence, the author believes that his eight years of professional experience and ten years of social entrepreneurial experience combined with his deep involvement in a Cambridge-based startup for two years, put him in a good position to contribute to the modeling of organizations', and startups', system dynamics.

Developing the System Dynamics Model

Previously developed models of organizations and new ventures were used as a starting point to develop this model, namely (Miller, 2007) and (Hsueh, 2011). These models were modified based on the authors' experience and understanding of startups and their entrepreneurial ecosystems. Like most existing models in the literature these models either focus on the internal dynamics within a startup without including exogenous variables, or include such variables but simulate the aggregate behavior of multiple startups instead of just one. Our model is unique in that it achieves a balance between understanding the internal dynamics inside a startup firm, the key variables/stocks, and critical management decisions, and the effect of the environment, represented by exogenous variables, on the viability of a startup as discussed and presented in second part of this paper.

The Model's Main Stocks

The model developed has four main stocks as shown in Figure 2: the human resources, product features, customers and cash. The blue loops are part of the base model used (Hsueh, 2011), the green loops are modifications to this base model, the red variables are management decisions, all purple loops and variables representing the exogenous environment. Each stock and its dynamics will be elaborated as follows:

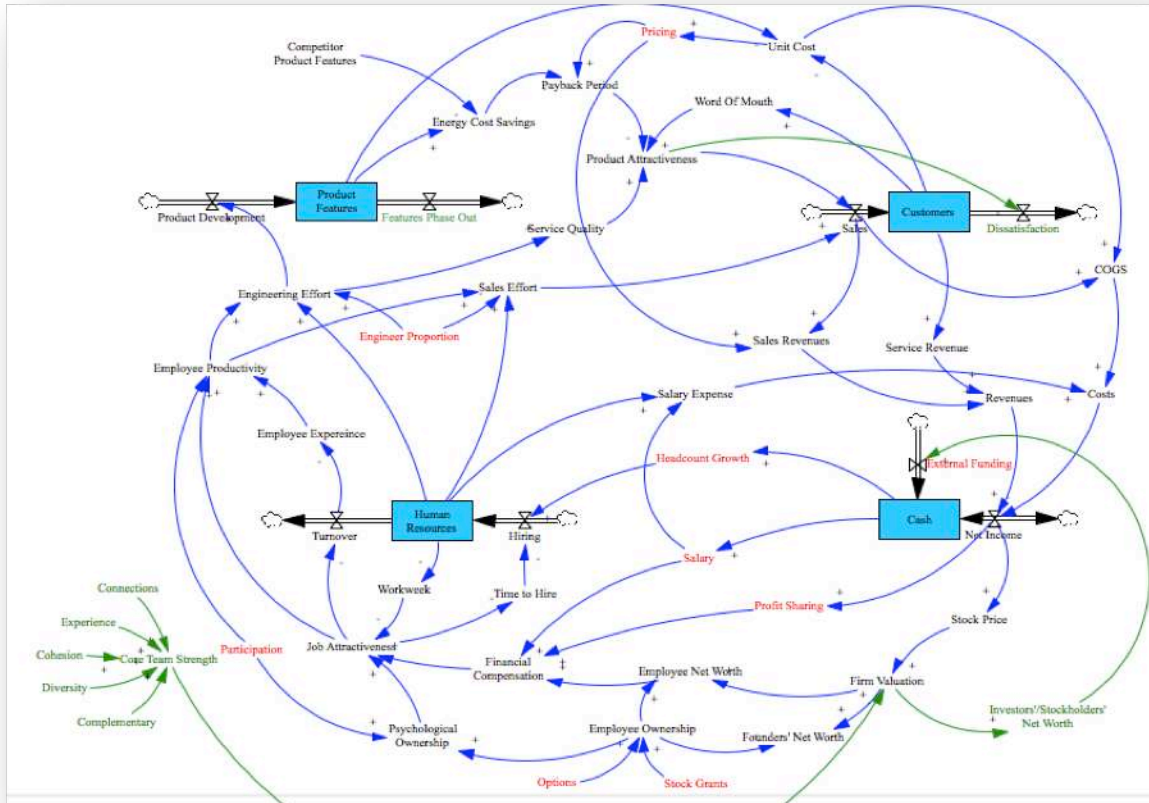


Figure 2: Initial System Dynamics Model of a Startup

1. **Human Resources:** this is the accumulation of the number of full-time employees working in the startup. This stock is increased by hiring new employees, and can be decreased by turnover either due to layoffs or resignation. This stock has effects on startups costs due to salaries and benefits, engineering and sales capacities, and the distribution of the workload among employees that is reflected in the workweek.

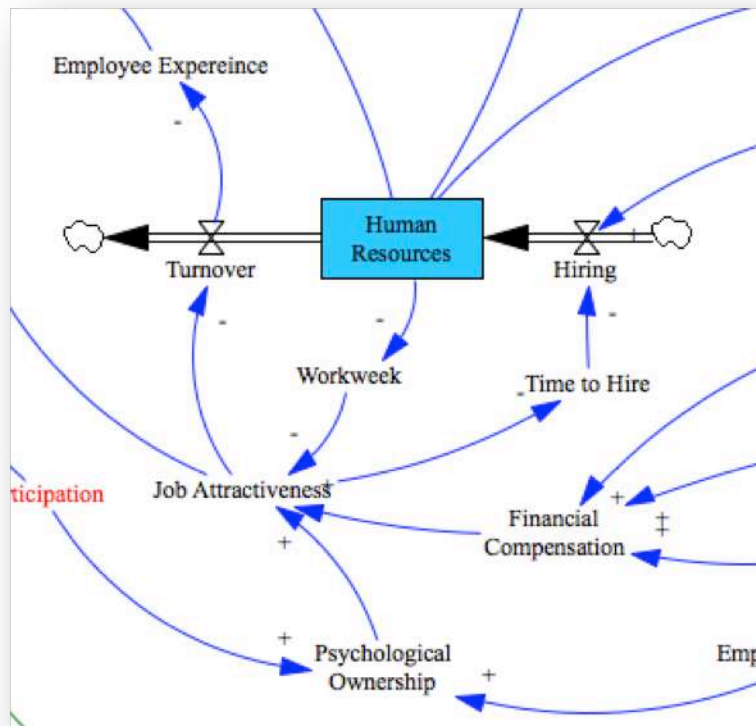


Figure 3: Human Resources Stock (zoomed in)

- Product Features:** this stock reflects the number of features in a given product due to continuous product development activities. This stock is increased by investing more engineering effort into the product development, and is decreased by phasing out of certain features based on customers feedback/buying behavior, competitors features list and incurred costs. The effects of this stock couples product attractiveness for current and potential customers, with unit costs (more features leads to higher costs), and ultimately the number of customers.

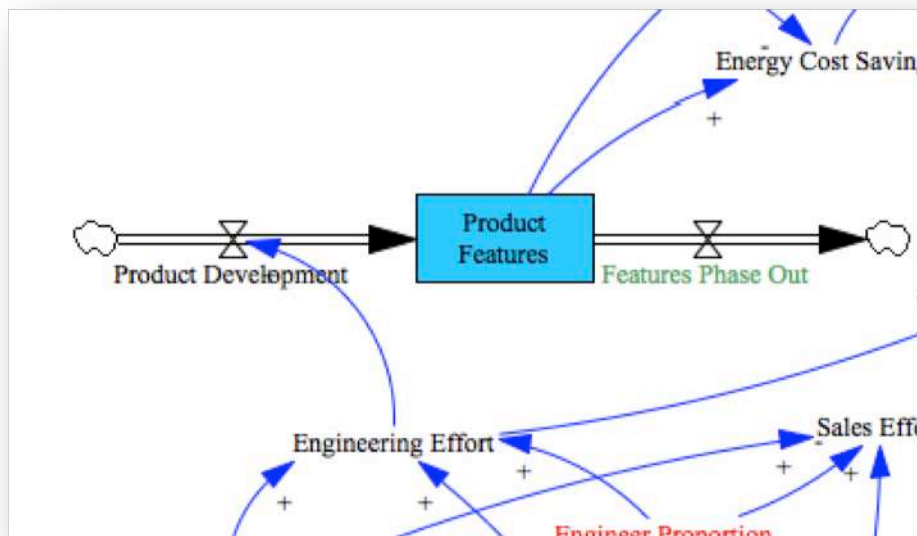


Figure 4: Product Features Stock (zoomed in)

3. **Customers:** this stock is the number of customers, paying users that the startup managed to acquire. Investing in sales and marketing efforts to promote the product and close sales deals can increase the number of customers. Product attractiveness is a major contributor to increased sales and hence increased customer base. The customer base could be decreased due to dissatisfied customers that churn to other competitors or stop using the product. This stock has a direct influence on the word of mouth reputation of the product, recurring revenues, typically from service revenues, and the product unit cost, which ultimately impacts the profitability.

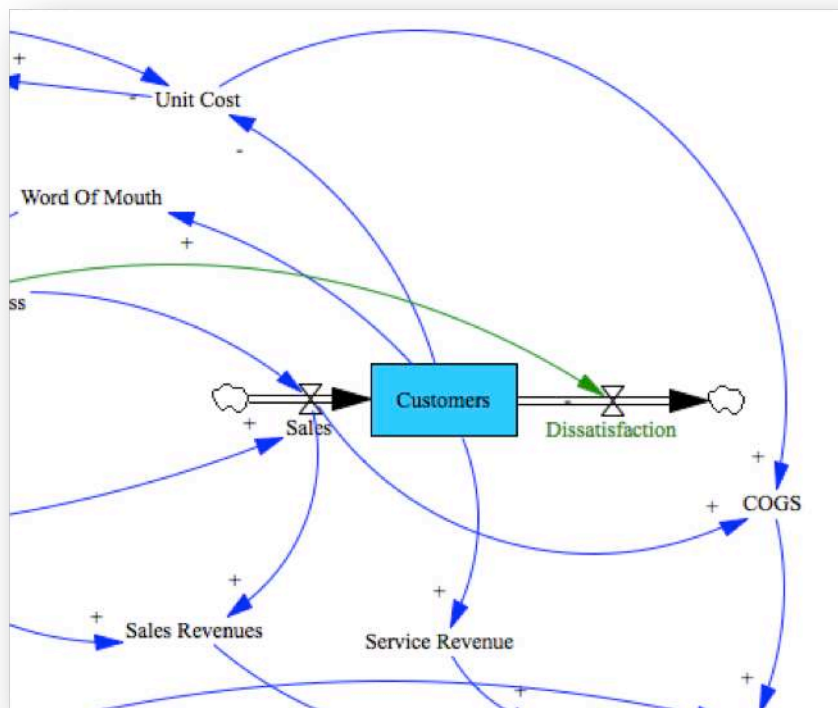


Figure 5: Customers Stock (zoomed in)

4. **Cash:** this stock represents the amount of net cash the startup has available over time. It can be increased organically from selling the product(s) and generating revenues, or inorganically from external funding, whether it's investments, loans or grants. Cash is decreased if the startup has losses, i.e. negative net income, or due to investment in hiring new employees and purchasing new equipment and tools. Cash is also decreased due to operational expenses needed to run the startup, and acquiring resources to develop the product(s). Both of these will be reflected in net income even though in reality they are cash outlays that should be associated with future revenues and net income.

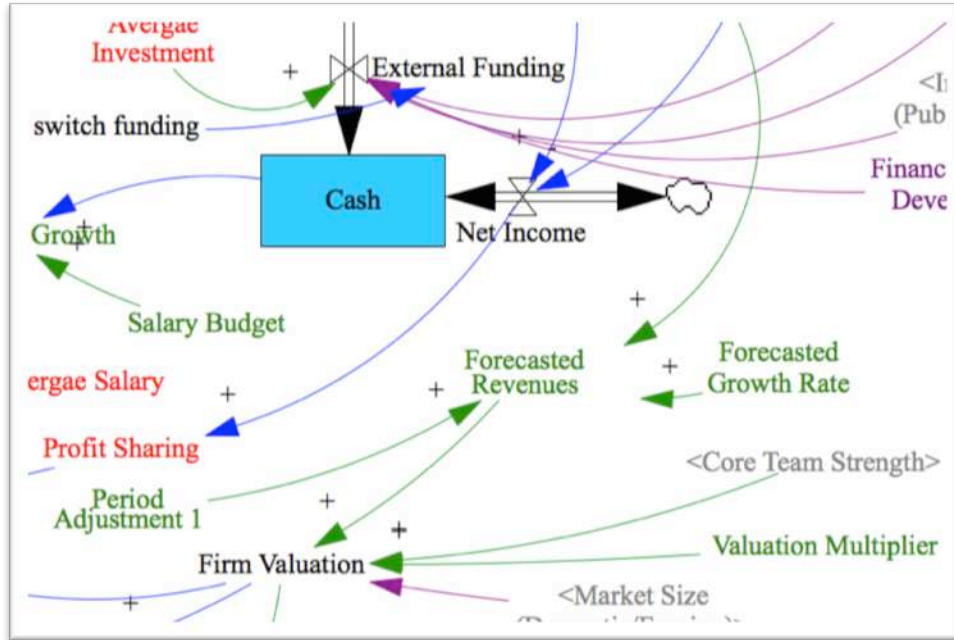


Figure 6: Cash Stock (zoomed in)

The Model's Seven Sectors

In addition to the four blocks, the model's causal loops can be divided into seven functional sectors: the hiring and turnover sector, the compensation and motivation sector, the product development sector, the sales and marketing sector, the pricing and competition sector, the financial sector, and the valuation sector. The key dynamics in these sectors are summarized as follows:

1. **The Hiring and Turnover Sector:** This sector is a representation of the dynamics of employees being hired by the startup with all the time-to-hire and compensation related variables. It also incorporates job attractiveness as a key variable in attracting, recruiting and retaining employees in the company. This sector takes into consideration the impact of workload on the attractiveness of a job and ultimately on the productivity of the workforce. A key part of this sector is Core Team Strength, which is a measure of the founding team or executive team span of relevant personal connections either with other potential team members, or with mentors, investors, customers and other relevant resources.

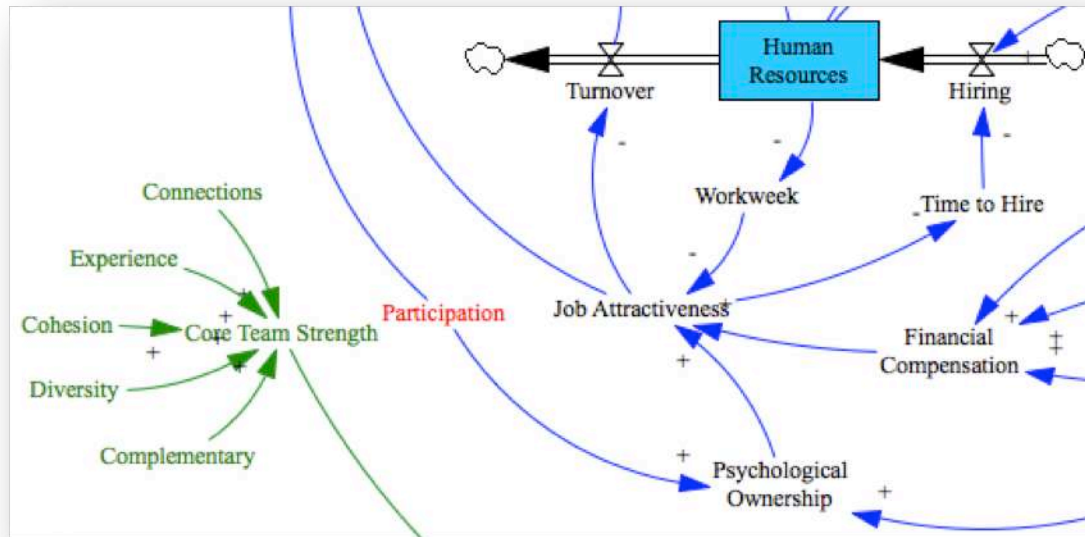


Figure 7: The Hiring and Turnover Sector

- In addition to personal connections, it incorporates the team’s collective professional experience, cohesion between the members to stay together, diversity of the team members’ backgrounds, and communities that they are affiliated with, and the complementary aspects between the team members’ skills, experience and backgrounds. Complementary factors are different than diversity because backgrounds could be diverse and different, but not necessarily complementary, i.e. a mechanical engineer and software engineer with no businessperson in the team.
2. **The Motivation and Compensation Sector:** This sector embodies the relationship between financial compensation, including profit sharing and stock options, and employees’ psychological ownership of the startup and their tasks, and actual ownership of the startup. Compensation includes salaries, benefits, bonuses, and special incentives.

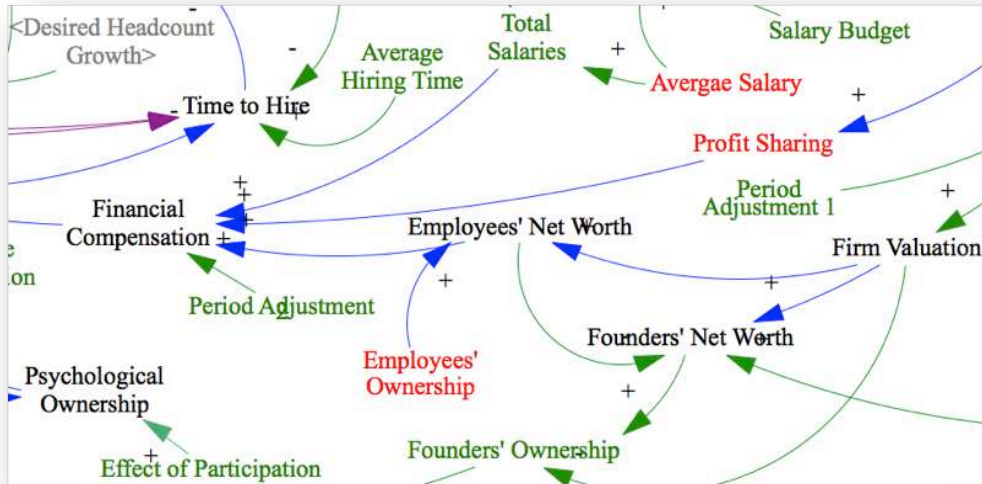


Figure 8: The Motivation and Compensation Sector

The stock options are the number of distributed stocks to employees, usually after IPO, or the percentage equity employees have either as part of their total compensation or part of their “sweat compensation” in the early days of starting the company when they couldn’t be paid in cash. This is typically applicable to founders and the first few employees. This sector is closely related and directly impacted by and impacting the previously discussed Hiring and Turnover Sector.

3. **The Product Development Sector:** this sector represents the engineering activities to develop and produce the product. It depends to a great extent on the

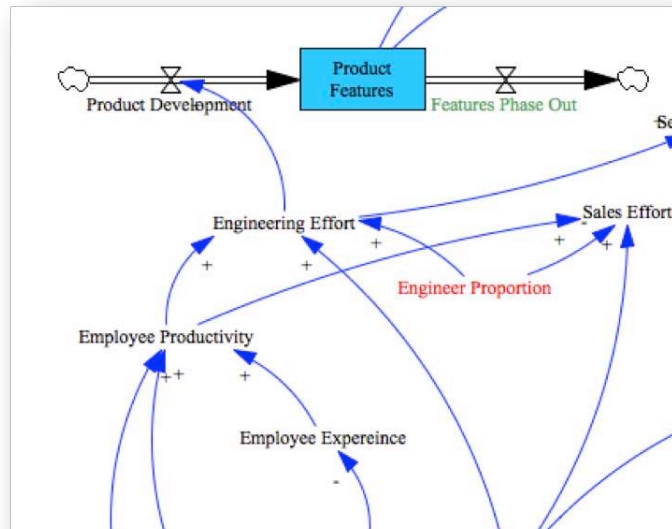


Figure 9: The Product Development Sector

experience of the current pool of employees, not only the engineering employees, but also the business employees. Product development is understood and modeled by the author as a holistic process that incorporates business factors like customer feedbacks, competitors' products analysis, market surveys, and feasibility studies, and engineering factors like technology trends, available materials and tools, needed expertise and resources, and design factors.

In this context, a product is actually an artifact system of the startup organizational system. The more robust and integrated the startup organizational system, the more robust and integrated the product(s) will likely be able to produce. Moreover, innovation can be understood as an emerging property of the startup organizational system (SOS); it's a property hard to predict that arises from the interaction of different elements in a complex system. The speed of product development and possibly innovation is attributed to employees' active participation in the process increasing their overall productivity, their accumulated experience, and the management decision regarding the split of employees between the engineering and business efforts.

4. **The Sales and Marketing Sector:** it incorporates all customer acquisition activities including potential customers segmentation and identification, business development, relationship building, sales offers and packages development, technical and financial discussions, contracts negotiation, and actual contracting to realize the sales.

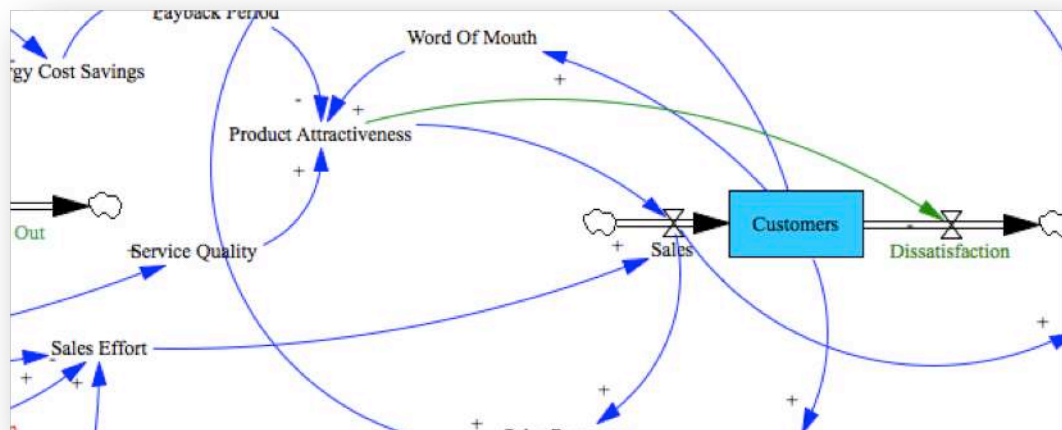


Figure 10: The Sales and Marketing Sector

Marketing activities on the other hand include the promotion and advertising of the product(s) to target customers through the use of marketing channels. For a startup, these channels could be printed flyers and posters to be distributed in events and selected locations, local magazines and newspapers, online advertisements, and social media channels. Together with service quality, sales and marketing efforts directly contribute to product attractiveness, and continued word of mouth marketing, where existing customers are promoting the product(s) on behalf of the company to potential customers due to a very positive experience with the company and/or using the product(s). The combined effect of the sales

and marketing efforts and product attractiveness lead to repeated sales and a reinforcing feedback loop is kicked off. Increased sales result in increased numbers of customers, the previously discussed stock, which eventually affects two key variables; the unit cost of a product as a function of total capital expenses divided by total number of customers (sometimes referred to as economies of scale), and generated service revenues. Service revenues are additional proceeds that a startup can generate from selling services related to a previously sold product(s). These revenues are typically very profitable because they don't involve customer acquisitions costs, and lower costs of goods sold.

5. **Pricing and Competition Sector:** this sector represents the pricing dynamics and their relations to the competitive forces in the market. Prices are set based on three main factors; customers willingness to pay in exchange for the value proposition of the offered product(s), unit costs as startups need to make profits from selling their product or the business wouldn't be sustainable, and competitors' or alternative products/solutions prices that the customers would

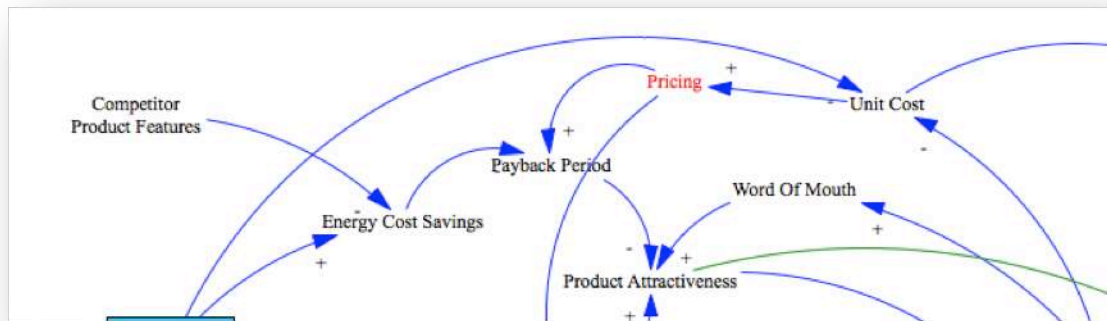


Figure 11: Pricing and Competition Sector

consider as alternatives in their transaction decisions. Prices are linked to a great extent to the product attractiveness and hence the product value propositions.

Pricing is one of the management key decisions that has a significant impact on the whole business cycle of a startup; it determines the profitability, number of customers and sales rate, and consequently all the generated cash from the operations that enables the managers to make more growth investments in the startup, i.e. recruiting more people and purchase more assets and resources. Competition is dealt with in this model as an exogenous variable beyond a startup boundary, but obviously has a direct impact on many of the internal dynamics and decisions that a startup experience. Price elasticity is an important assumption relating price and actual sales volume.

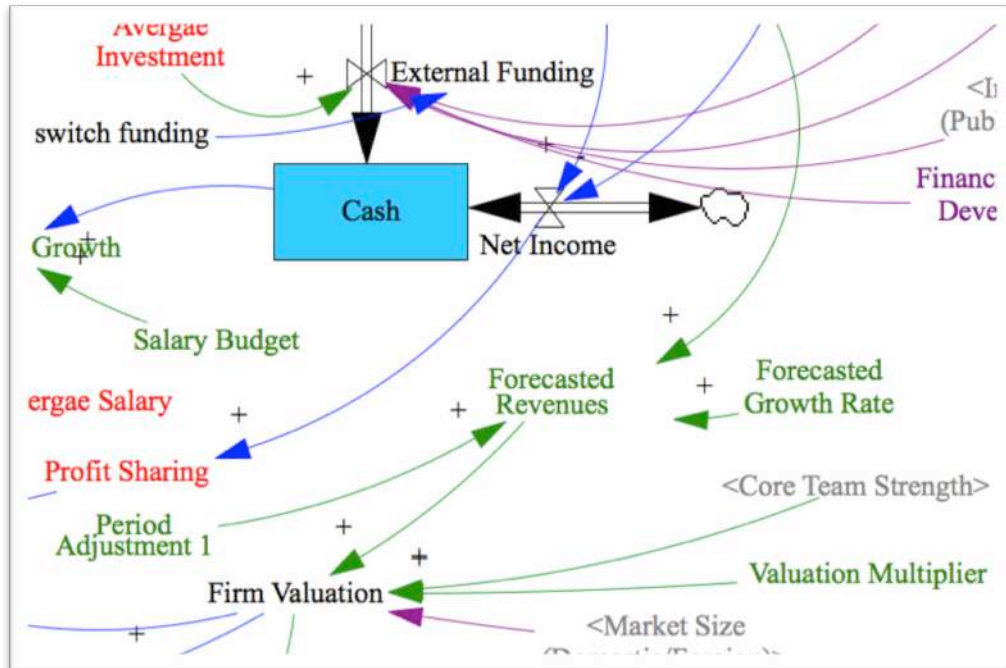


Figure 12: The Financial Sector

6. **The Financial Sector:** this sector captures financial flows of the startup operations. Cost of Goods Sold (COGS) and operational costs are subtracted from product revenues and service revenues to indicate generated net income. Operational and other costs include salaries and administrative, amortization, depreciation, interest rates on debts and taxes. Net income is the final net profit or loss at the end of a certain accounting period, and it directly affects the cash in hand. Moreover, net income indirectly impacts a startup's ability to generate external funding as net income indicates the feasibility and viability of a startup.

Cash generated from net income directly affects the company's ability to offer competitive compensation packages for the founders and employees, hire new competent employees and acquire additional assets and tools to enable further growth. In case the company had an IPO, i.e. it is publically traded in the stock market, net income directly impacts employees' profits share.

7. **Valuation Sector:** this sector represents the dynamics involved in a company valuation, and the impact this would have on stockholder's net worth. As discussed in the financial sector, current net income and generated cash are key indicators to determine the total dollar value of a company. Other exogenous variables like market size, industry trends, barriers to entry, number of competitors and relative market shares are considered to determine potential future net income. The impact of the startup's valuation impact on investors'/stockholders' net worth directly affects its ability to raise external funding, especially from seed, angel or venture capital investors.

In the very early stages of a startup, Core Team Strength is a major contributor to its valuation as they represent the very core value of the startup, and many investors emphasize that their investment decisions are dramatically influenced by the founding team members experience and achievements. Startup valuation also impacts employees' net worth and founders' net worth based on their equity/stocks ownership.

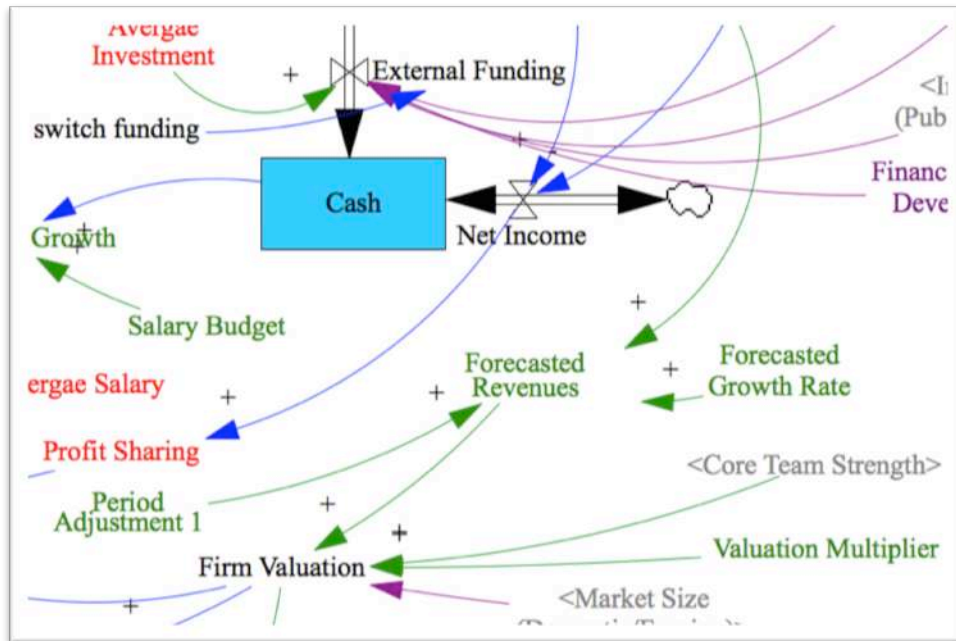


Figure 13: The Valuation Sector

Entrepreneurship Ecosystem Impact on Startups' Dynamics

In order to model the impact of the entrepreneurship ecosystem on the startup dynamics, research was carried out to identify key factors that are considered and measured for the different countries. The reports from the World Economic Forum, Global Entrepreneurship Monitor, World Bank and Organization for Economic Cooperation and Development were investigated and studies. From the study the author selected the following indicators to be added to the developed System Dynamics model to simulate the impact of the ecosystem on the startup's evolution:

- Public Institutions which influence property rights, intellectual property protection, levels of corruption, rule of law, government efficiency, security in the respective country, and the enforcement of the law.
- Private Institutions, which reflect the accountability inside private organizations, efficacy of corporate boards, corporate ethics, and protection of minority shareholders' interests.
- Infrastructure in the respective country which includes the development of transportation systems, electricity infrastructure, and basic ICT telephony services

- Macro-economic Environment represented by government budget balance, inflation rates, government debt, country credit rating, and gross national savings
- Health and Primary Education, which measures the level of basic health and mortality rates in the target geography. Also, it measures the levels of primary and secondary education for the total population.
- Higher Education and Training which focuses more on higher education rates both from quantity, and quality perspectives. It also measures levels of on-job training implementation and utilization as an effective way of gaining skills and knowledge
- Labor Market Efficiency, which incorporates labor-employee relations, wage determination mechanisms, hiring/firing practices, brain drain from the country, and female participation in the labor market
- Domestic Competition measured by the intensity of local competitors represented by number and practices, anti-monopoly policies in place, taxation structures for the different stakeholders, and ease of starting businesses in in different industries
- Foreign Competition, or international economical integration in general stemming from foreign competition in domestic market or the insertion of domestic firms into the global supply chains, reflected by trade barriers with other countries, tariffs for exports and imports, foreign ownership laws in the target country, rules of Foreign Direct Investments (FDI), customs procedures, and trade (imports and exports) and FDI as % of GDP
- Market Size (domestic & foreign) measured mainly by the local population, but also the foreign populations that the country has active trade agreements and can reach to as an extension of its own domestic market.
- Financial Market Development represented by the availability of different financial services, ease of access to loans/venture capital, and general funding mechanisms in general, legal rights index, and effectiveness of local equity market
- Technological Readiness measured by the technology absorption by consumers in the target country, FDI and technology transfer, internet users, internet bandwidth, and mobile broadband subscribers
- Business Sophistication which incorporates local suppliers quantity and quality, clusters development, value chain breadth, international distribution, extent of marketing, and reliance on professional management
- R&D Innovation measured by quality of scientific research institutions, spending on R&D by corporations and private entities, university-industry collaboration, government procurement, availability of scientists and engineers and IP protection

These factors are added in Figure 14 as exogenous factors that represent the ecosystem in which the startup firm first evolves. Adding these exogenous factors allows testing the

evolution of otherwise identical firms with identical initial conditions in different environments or entrepreneurial ecosystems.

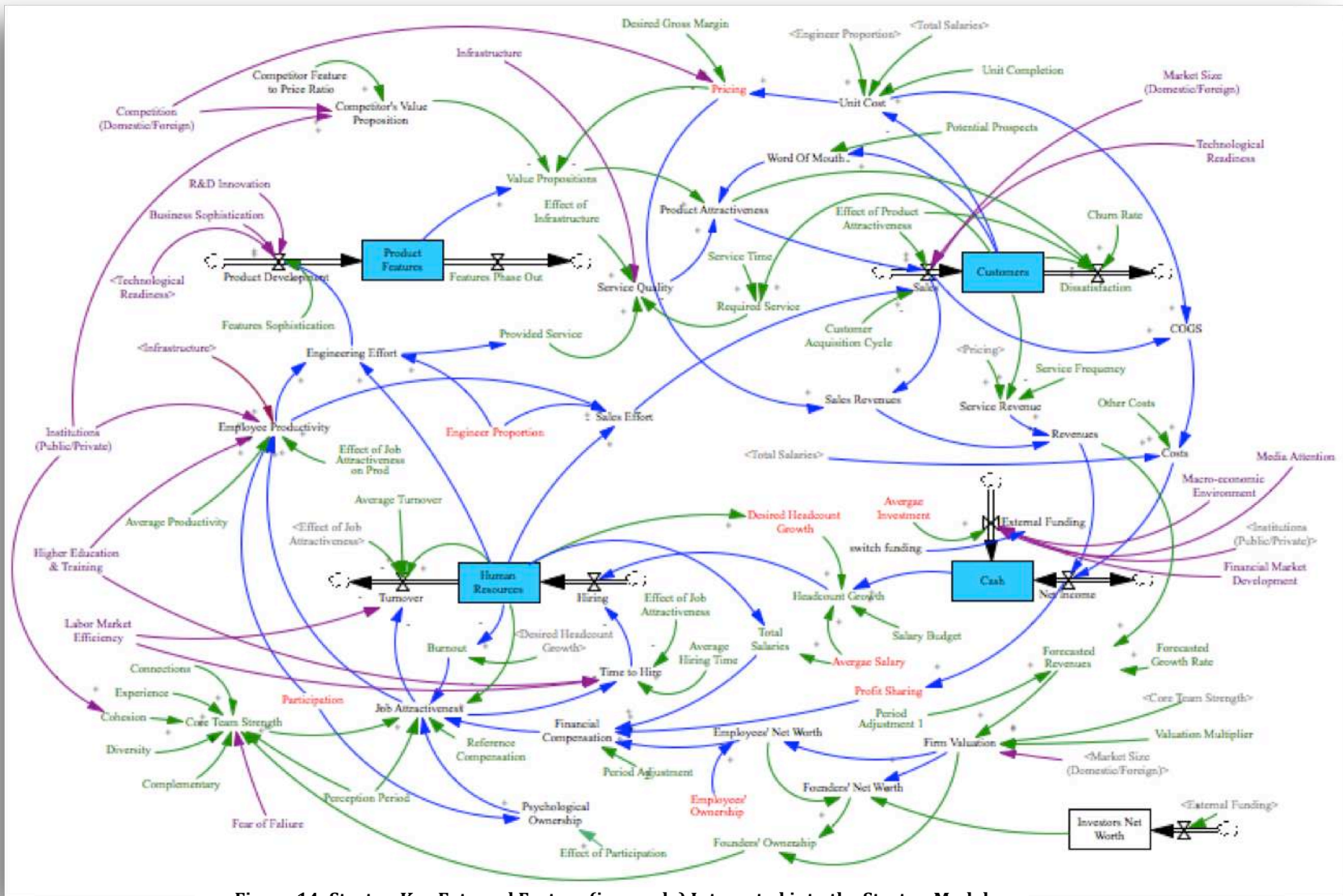


Figure 14: Startup Key External Factors (in purple) Integrated into the Startup Model

System Dynamics Model Calibration and Results

The model was calibrated on a startup that I have been personally involved with during the last two years. I had the chance to perform a deep ethnographic study on this startup where I not only has had access to the quantitative data, but also the qualitative ones like degree of participation, and psychological ownership. Also, in order to refine the model structure and equations I had discussions with over 80 entrepreneurs, mentors, investors and service providers mainly in Boston, Massachusetts, and Cairo, Egypt. I also participated in multiple entrepreneurial events that took place in MIT and the Greater Boston area where I collected empirical data from experienced serial entrepreneurs and investors on their experience in building and scaling startups, and from hundreds of questions and concerns from students and first-time entrepreneurs.

The ABC (original name was replaced) startup that was used in the calibration is a Cambridge, Massachusetts-based Startup that started operation in January 2011. ABC is classified as a Web/IT company that licenses online platforms to customers. The business model is a business-to-business license model. Five co-founders started the company. The following are some of the initial inputs that were used to calibrate the model:

- The average hiring time is assumed to be 2 months
- The average working hours are assumed to be 50 hours/week
- The average (possible) external investments are assumed to be \$2.6 Million/Year
- The average salary per employee is assumed to be \$4,000/Month
- Employees' Net Worth or the stock options pool is assumed to be 10% of Firm Valuation
- The percentage of hours dedicated to engineering (versus sales and marketing) is assumed to be 50% of total available hours
- The percentage of hours dedicated to Customer Service (versus Product Development) is assumed to be 30% of total Engineering hours
- Management, support and fundraising efforts are assumed to be equally distributed across the Engineering and Sales hours
- Features Sophistication (advancement and complexity of features) is assumed to have a rate of 2.6 Feature/Month
- The Headcount Growth is assumed to be 20% (10% increase in headcount and 10% to compensate for turnover) of total employees every 6 months
- Company ABC has sales from Month 0 due to the existence of the first version of the product and existing customers' orders

Behaviors in the Financials Sector

As shown in Figure 15, six variables behaviors are shown in this sector:

- Cash during the first 12 month is almost zero due to the hiring of additional team members and increased ramp-up costs for the company. Also, the cash resulting from the Net Income during this period is low due to the lower profitability resulting from initial high Unit Cost. After Month 12, cash starts to increase at an increasing rate with a step function every 12 months. The reason for the annual jump in cash is due to the External Investment.

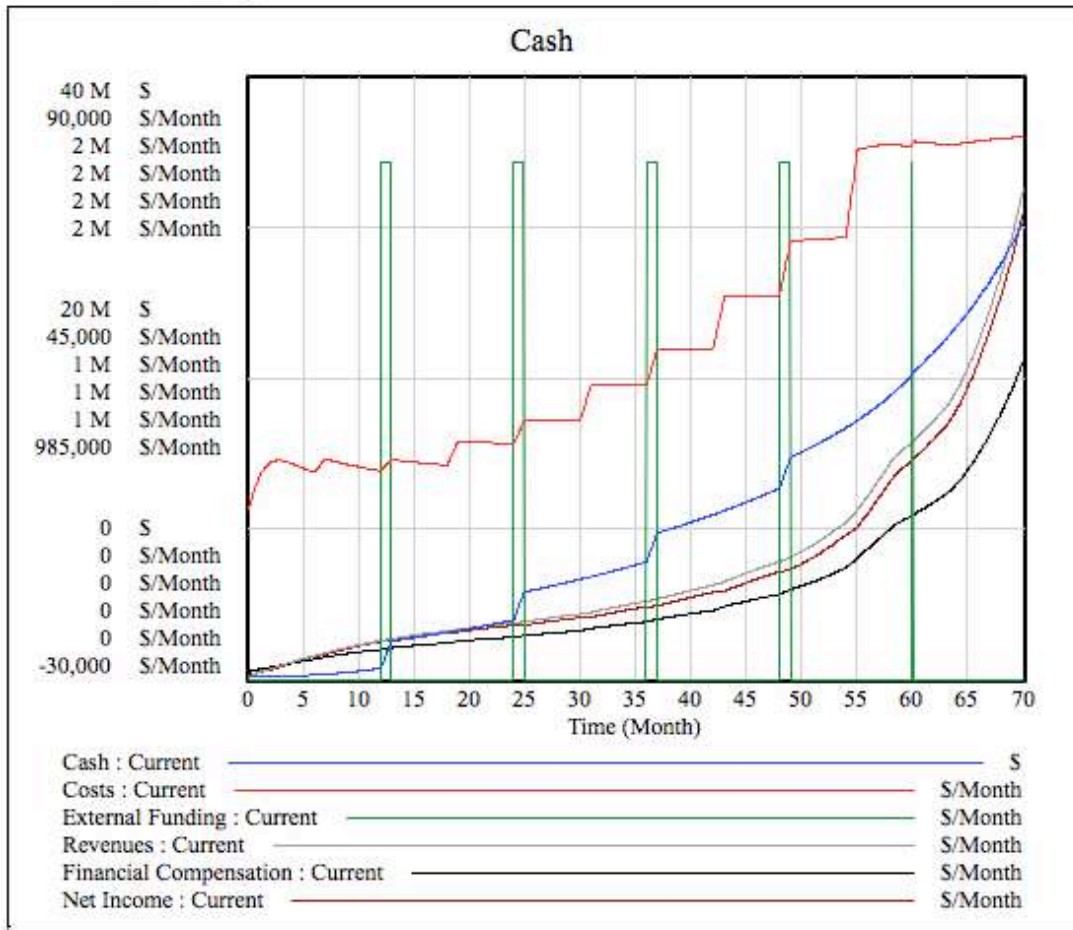


Figure 15: Behaviors in the Cash (Financials) Sector

- Costs during the first 25 months are almost stable due to the lack of hiring of additional team members and modest increase in ramp costs for the company. After Month 25, Costs start to increase at an increasing rate with a step function every 6 months. The reason for the semi-annual jump in Costs is due to the hiring activities needed to scale the company operation and reach to and serve more customers. Costs are highly impacted by the hiring activities due to the fact that in the Web/IT business the product licensing cost is almost zero.
- Revenues are increasing slowly during the first 25 Months due to the low number of customers and the delay in the Word of Mouth reinforcing loop effect, and after that it increases exponentially due to the effect of the Word of Mouth (reputational effect) and the Product Attractiveness loops.
- Financial Compensation to team members, which is a combination of monthly salary, profit sharing and equity, is increasing at a constant rate during the first 36

months, and then increases exponentially mainly due to the increased valuation of the firm based on the previous and forecasted performance. Equity ownership is the main driver for this increase in compensation, as the monthly salary is assumed to be constant and profit sharing is at 10% from Net Income.

Behaviors in the Human Resources (HR) Sector

As shown in Figure 16, five variables' behaviors are shown in this sector:

- Human Resources or headcount are increasing as a step function every 6 months as assumed, but it is noticed that the magnitude of the function (or the number of hired employees) varies a lot. In the first 12 month, 1 employee every six month was added. While between Month 18 and Month 42, 2 employees were added every six months, and between Month 43 and month 54, 3 employees were added every six months. On Month 55, 5 employees were added, and no additional hiring occurred till the end of the simulation at Month 70.
- Job Attractiveness had an interesting behavior. During the first 5 months, it was increasing exponentially, then from Month 5 to Month 18 it kept increasing, but at a decreasing rate. From Month 20 till Month 53, it was almost constant. Finally, from Month 53 till Month 70, it increased exponentially at an increased rate.

- Employee Productivity is increasing at an increasing rate during the first 10 Months, and then it stabilizes (with a slight decrease at Months 27 and 47) till Month 55 where it continues to increase at an increasing rate till the end of the simulation. It is worth mentioning that the increased rate of productivity from Month 55 till Month 70 is larger than the increase rate from Month zero till Month 10.

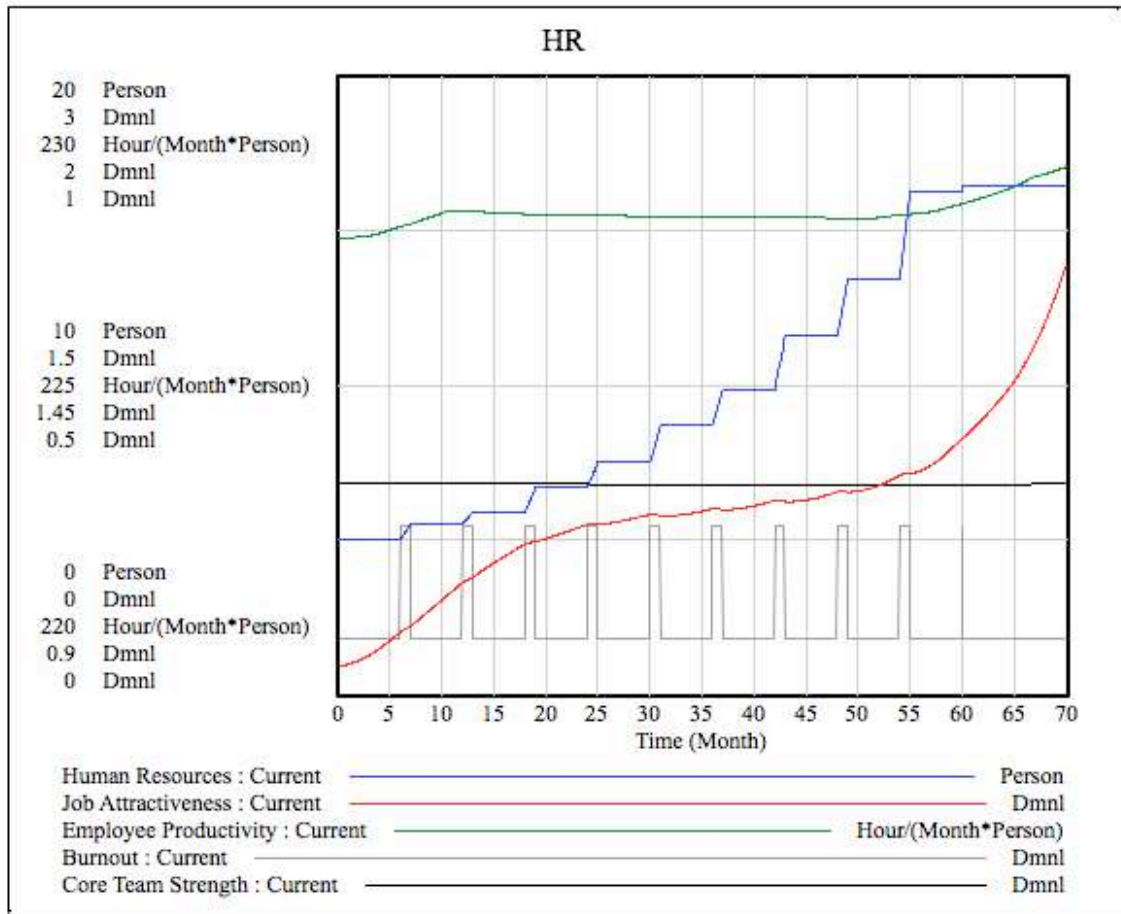


Figure 16: Behaviors in the HR Sector

- Burnout, which is a function of the Desired Headcount relative to current Human Resources, has a behavior that correlates with the assumed Desired Headcount. Burnout has a pulse increase every 6 months as the Desired Headcount is assumed to increase also as a pulse every 6 months. This behavior is constant across the whole period of the simulation.

Behaviors in the Product Development Sector

As shown in Figure 17, five variables behaviors are shown in this sector:

- Product Features is increasing at an increasing rate throughout the simulation 70-Month period mainly due to the continuous dedication of 50% of the human resources time and effort to engineering, and the continuous growth in headcount in later months. Also the assumed rate for Features Phase Out of 1 Feature per month contributes a lot to this continual increase in Product Features.

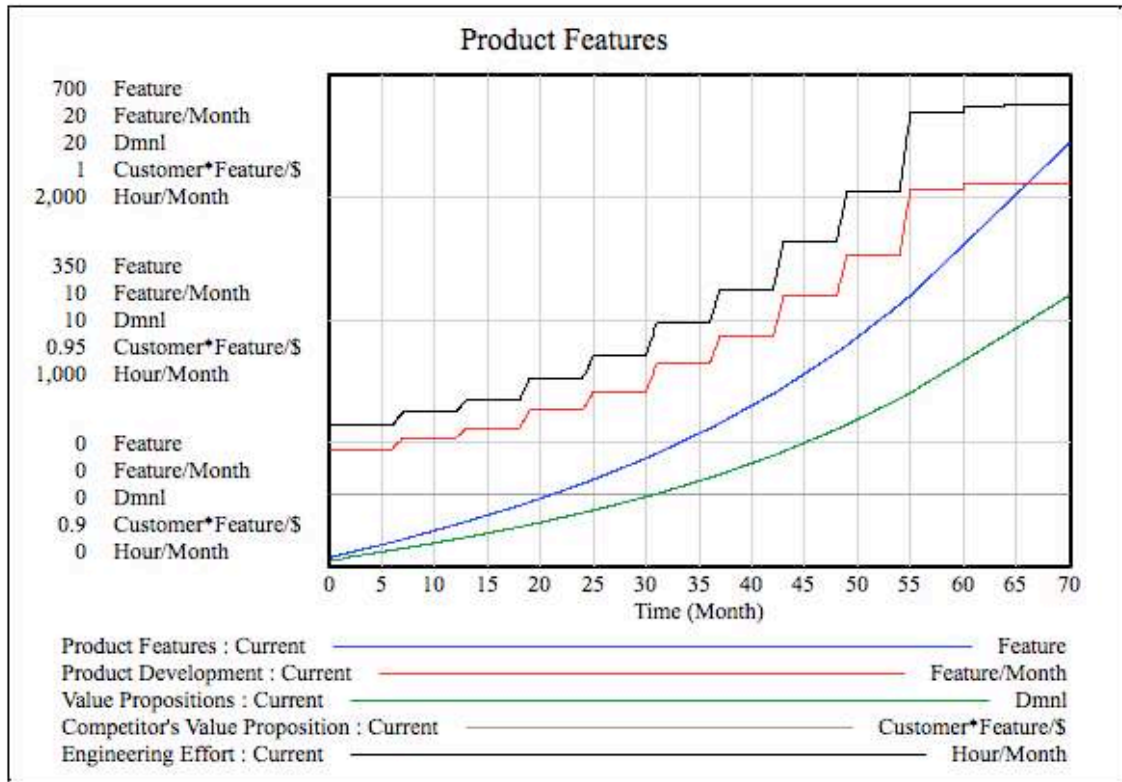


Figure 17: Behaviors in the Product Development Sector

- Product Development is the rate of developing new features and the number of people dedicated to engineering or product development directly impacts it. As a result, this variable is behaving in a similar trend like the Human Resources behavior of a step function every 6 months with change in magnitude similar to that of Human Resources at Months 17, 30, 43 and 54.
- Value Proposition, which is a comparison between company's Feature to Price Ratio and that of competitors, is increasing at an increasing rate due to the fact that the Product Features are increasing at an increasing rate while Price is dropping. It's worth mentioning that one of the assumptions is that the Competitors' Value Proposition is fixed across the entire period of the simulation, which is usually not the case in real dynamic markets.
- Engineering Effort is the main driver behind the Product Development rate, and it's mainly behaving in the same way like Human Resources as a step function every 6 month when new Headcounts are added to the company workforce. Again, the change in magnitude is the same like the Human resources.

Behaviors in the Customer Sector

As shown in Figure 18, six variables' behaviors are shown in this sector:

- The number of customers which is in this case is the same as units sold is increasing at a constant rate from Month zero till Month 50, then the number increases at an increasing rate (exponential) from Month 50 until the end of the simulation at Month 70. A key reason behind this behavior is the fact that the Dissatisfaction rate of customers is assumed to be a fixed percentage (Churn rate) of the current number of customers, which counterbalances the increased Sales rate.
- Dissatisfaction is the rate of losing customers, and it's increasing at an increasing rate from Month zero till Month 12, then at a constant rate from Month 13 till Month 45, and finally at an increasing rate from Month 46 till Month 70. A key reason behind this changing behavior is the effect of Product Attractiveness on Dissatisfaction.
- Unit Cost is dropping significantly from Month zero till Month 17 due to the increase in the umbers of customers licensing the platform, and the relatively fixed costs of developing the software platform. From Month 18 till Month 70, the Unit Cost is almost stable with a slight decrease from Month 50 till Month 70 that corresponds to the exponential growth in Customers in the same period.
- Pricing is significantly dropping with the Unit Cost from Month zero till Month 3, and then it stays constant as defined in the model minimum allowed price for the

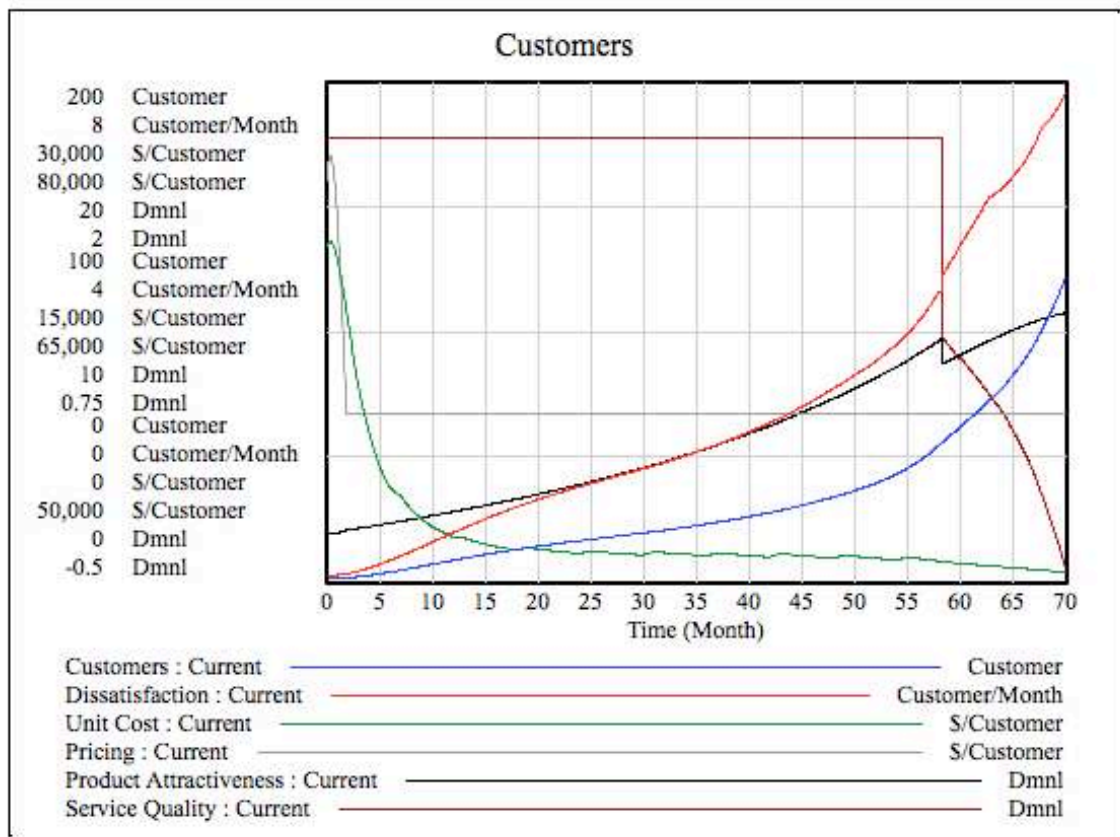


Figure 18: Behaviors in the Customers Sector

platform. The Pricing is function in the Desired Gross Margin and the Unit Cost, but it's defined with a minimum value that the company can't go below, which is one of the assumptions in the model.

- Product Attractiveness is increasing at a constant rate from Month zero till Month 45, then it increases in a slightly increasing rate from Month 46 till Month 58 where it drops suddenly (due to the drop in Service Quality), but it continues to increase at a decreasing rate afterwards. The positive effects of the Value Proposition and Word of Mouth are much stronger than the negative effects of the Quality of Service.
- Service Quality in this model is affected by the ratio of the Required Service hours due to the increase in number of customers to the Provided Service hours assumed to be 30% of the total hours dedicated to Engineering Efforts. As long as the Provided Service hours are higher than or equal to the Required Service hours, Service Quality is assumed to be 1 (highest value), once Provided Service hours are less than Required Service hours, the ratio of the difference to the Required Service is assumed to be the new Service Quality value. Therefore, from Month zero till Month 58 the value is 1 then it drops significantly on Month 58. From Month 59 till Month 70, it decreases at a decreasing rate.

The Most Influential External Factors

In order to identify the most influential external ecosystem factors on the performance of the startup, a sensitivity analysis was carried out on the developed model. Firm Valuation and Job Attractiveness were selected as the two variables to measure their sensitivity to varying external factors. Firm Valuation was selected because it's a good measure of the financial performance of the company, not only in the near term, but also the forecasted performance based on many factors, including Core Team Strength. On the other hand, Job Attractiveness was selected to measure the non-financial success of the company in terms of its external reputation and perception by multiple stakeholders, including current and potential employees. The premise is that startup financial and non-financial success depends to a great extent on its ability to attract the best talent available in the labor market. These talents are naturally attracted to startups with the highest Job Attractiveness values.

To perform the sensitivity analysis, the variables of the 13 external factors were changed individually from the base value (US Entrepreneurship Ecosystem values) to a High Value (0.9), and a Low Value (0.2). The results are shown below in Figures 20 and 21.

From Figure 19, it can be concluded that Job Attractiveness is very sensitive to Labor Market Efficiency, Market Size (US base value is already high), Institutions, and Fear of Failure.

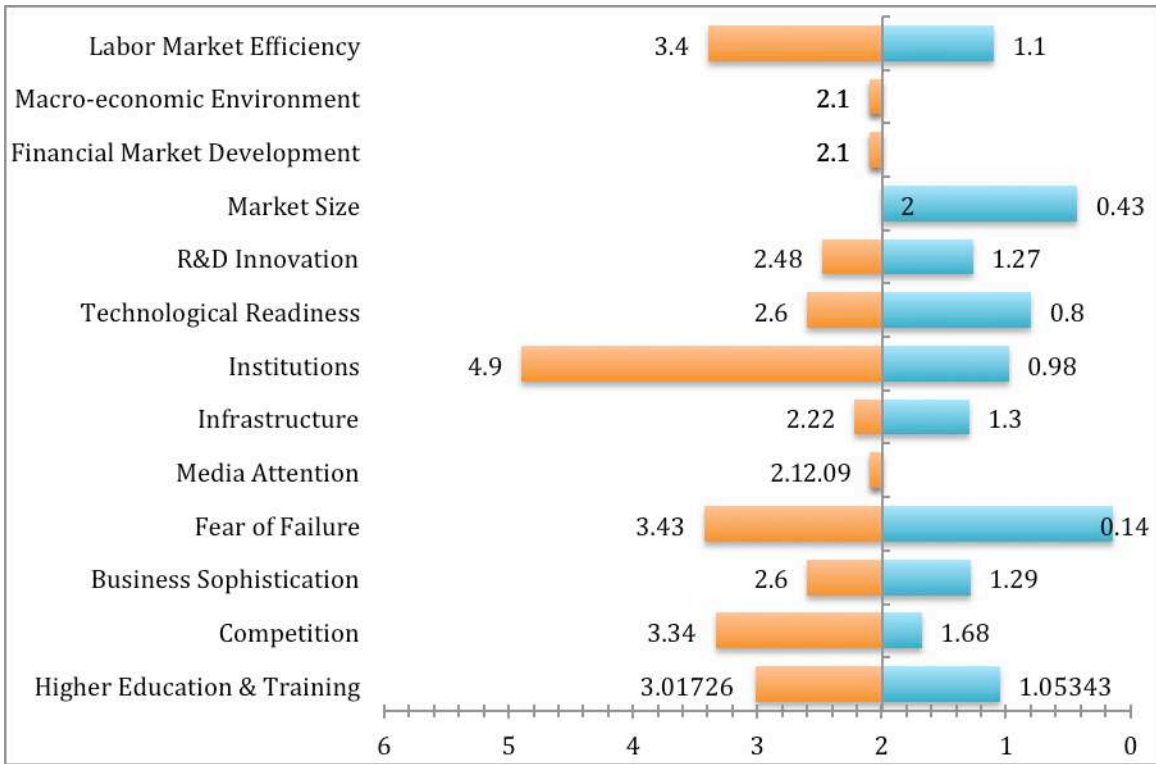


Figure 19: Job Attractiveness Sensitivity Analysis

Looking at Figure 20, it can be concluded that Firm Valuation is very sensitive to Labor Market Efficiency, Market Size, Technological Readiness, Institutions, Fear of Failure, and Higher Education & Training

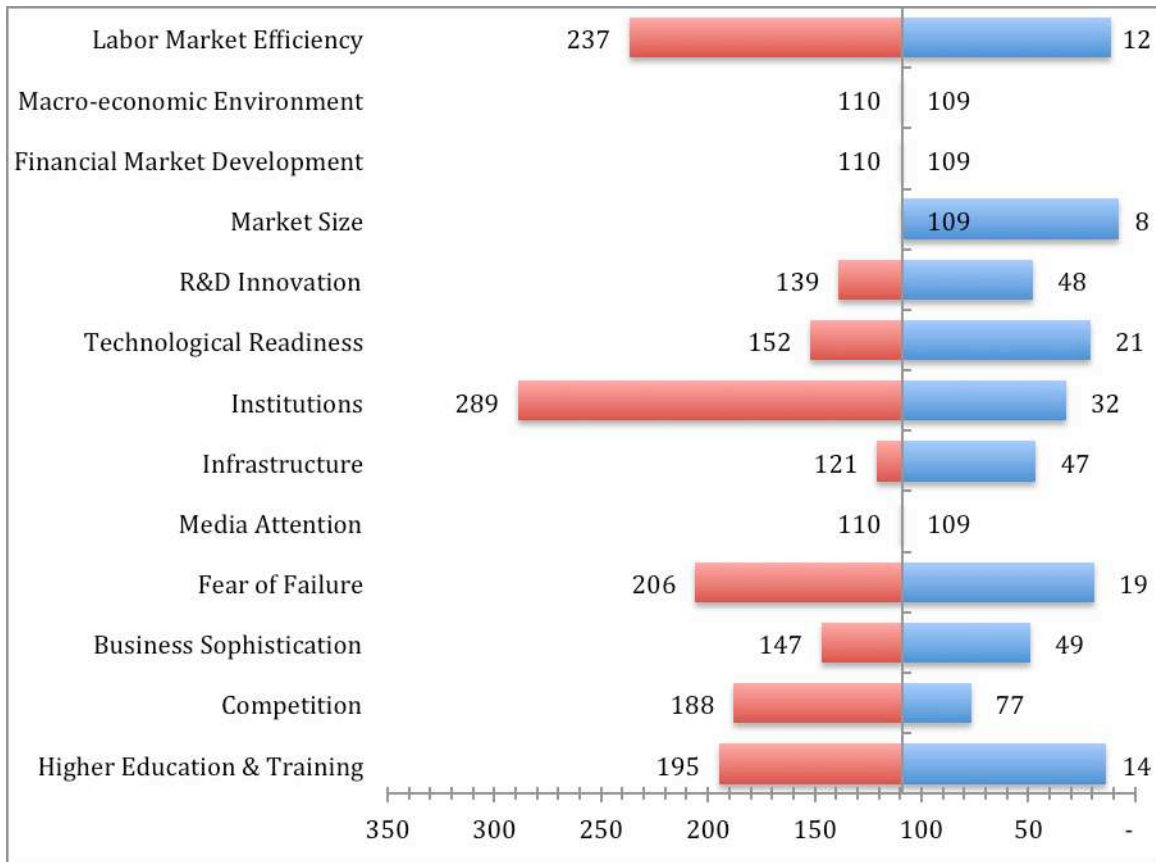


Figure 20: Firm Valuation (in \$M) Sensitivity Analysis

It can be concluded that the modeled startup's success is highly sensitive to the following external factors: Labor Market Efficiency, Market Size, Technological Readiness, Institutions, Fear of Failure, and Higher Education & Training. This would answer the second research question.

The startup is moderately or not sensitive at all to other factors like R&D Innovation, Macro-economic Environment, Financial Market Development, Media Attention, Business Sophistication, Infrastructure and Competition.

Startup Dynamics in the Egyptian Context

Building on the previous sensitivity analysis on the most critical ecosystem factors on the performance of a startup, the same model of the startup with all of its management decisions and assumption was tested in the context of the Egyptian ecosystem by varying the values of the exogenous variables to the corresponding Egyptian ones. The result was a totally different behavior in almost all the different sectors.

Behaviors in the Financials Sector

In the financials section the variables were increasing, but at a significantly decreasing rate, and reached a plateau much quicker than the US case (Figure 21):

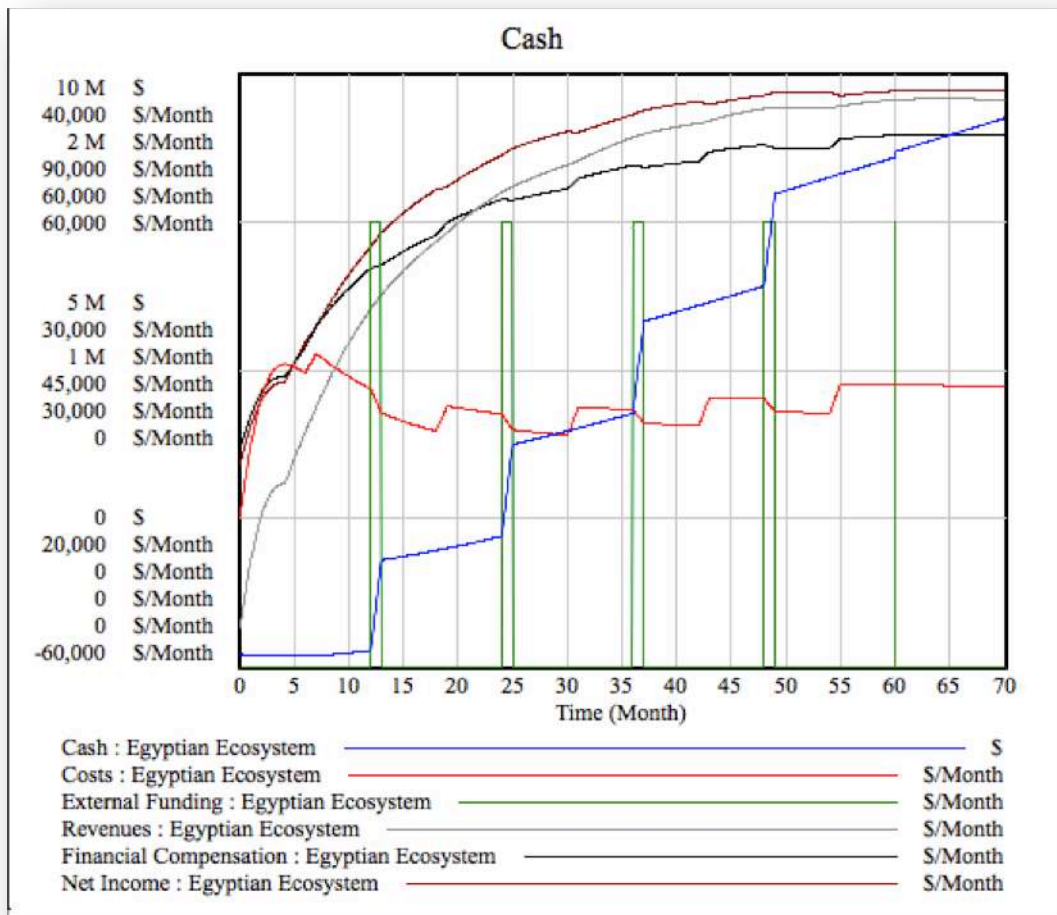


Figure 21: Financials Dynamics in Egyptian Ecosystem

- Cash kept increasing as a step function, mainly due to the assumption of a regular external investment every twelve months, with a comparable magnitude to the US case until month 35. At month 48, the cash reached \$8M while the US case was \$15M. From month 48 till month 70, the step function behavior continued reaching to a final value of \$9M while in the US case the behavior was exponential reaching to a final value of \$30M. Due to the fact that the two models have comparable external funding assumptions, one can conclude that the difference in the Cash behavior is mainly due to the Net Income generated from the company's operations.
- Costs increased till month 7 then decreased till month 12 and stayed almost stable till month 70 compared to continuously increasing costs in the US case. This behavior can only be understood in light of the Human Resources sector behavior. The startup in the Egyptian context couldn't hire additional employees, the main driver for company's costs, due to limited growth.
- Revenues also exhibited an increase at a decreasing rate till reaching to \$90,000 per year at month 70 compared to an exponential growth, in the US case, with a final value of \$1.6M per year at month 70. This is explained in light of the sales and customer acquisitions rates.
- Financial Compensation for employees kept increasing at a decreasing rate until it reached a final value of \$60,000 per month (including distributed Profit Sharing and equity value) while in the US case it reached a final value of \$1M per month.
- Net Income also increased at a decreasing rate until it reached a final value of \$60,000 while in the US case it reached a final value of \$1.5M at month 70. Again, this is explained in light of the sales and customer acquisition rates, and is directly influenced by the respective behaviors of the revenues and costs in the model.

Behaviors in the Human Resources (HR) Sector

As shown in Figure 22, ecosystem differences has a significant impact on the time to recruit new qualified people, and consequently on the ability of the company to increase its human resources, and hence productivity. The following behaviors in the HR sector were observed:

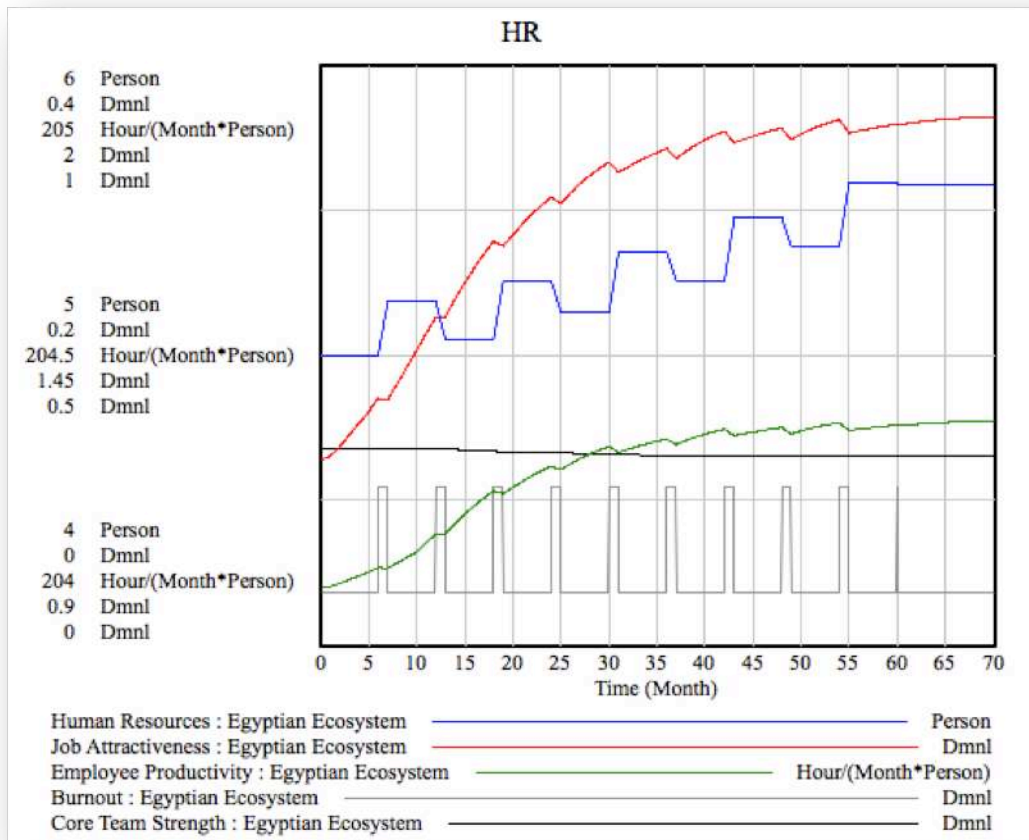


Figure 22: HR Dynamics in Egyptian Ecosystem

- Human Resources number had an oscillating behavior due to the effect of the Turnover rate that almost cancelled the increase in Hiring rate. This resulted in an oscillating behavior around 5 employees with no increase in total number of employees in the company. In the US context, the number of employees kept increasing till reaching a total number of 17 employees at month 70.
- Job Attractiveness exhibited a different behavior than the one in the US context by continuously increasing at a decreasing rate, and eventually reaches a much lower value, 0.36, at month 70 than the one, 3.4, in the US context.
- Employee Productivity increased at an increasing rate from month 0 till month 25, and then it slightly increased at a decreasing rate till it reached a final value of 204 Hour/(Month*Person) compared to 230 Hour/(Month*Person) in the US context.

The differences are mainly due to ecosystems differences in Infrastructure, Institutions and Higher Education and Training.

- Burnout and Core Team Strength had similar behaviors to their equivalent ones in the US context. This is mainly to high dependency on internal factors and fixed assumptions. Fear of Failure that impacts Core Team Strength was almost the same in both the Egyptian and US context, so we ended up with similar behaviors and final values.

Such a behavior in the HR sector slowed down the rate of developing new features in the product development sector as a direct result of the lower Employees' productive Engineering Effort, and total Human Resources employed in the startup.

Behaviors in the Product Development Sector

As shown in Figure 23, the behavior of the product features over time was linear compared to an exponential one in the US context. This is a key driver for the subsequent Value Proposition and Product Attractiveness. The following behaviors were observed:

- Product Features increased at a linear rate until it reached a total of 120 features at month 70 compared to 500 features in the US case. As explained this is mainly due the difference in employed human resources and their subsequent impact on the Engineering Effort (productive hours per month).
- Product Development rate exhibited an oscillating behavior compared to a stepped increase in the US case. This rate reached 2.75 Features/Month compared to 15 Feature/Month in the US case. This difference had a significant impact on the total number of features in the product.
- Value Proposition exhibited a linear behavior compared to an exponential on in the US case. It reached a dimensionless value of 2 compared to 10 in the US case. This difference had a significant impact on Product Attractiveness and

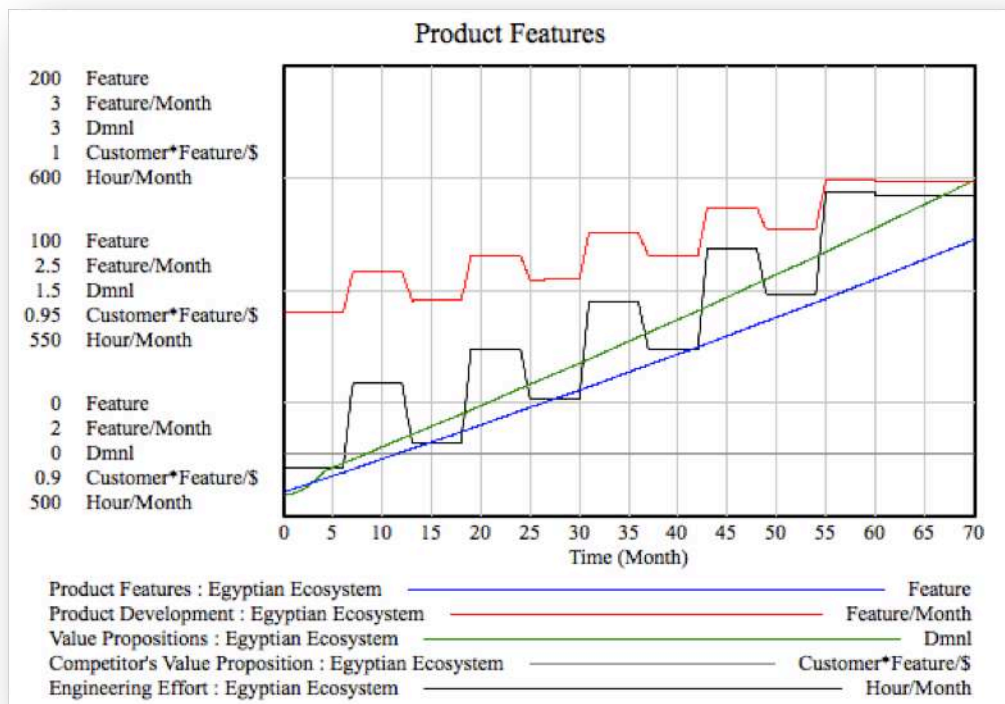


Figure 23: Product Development Dynamics in Egyptian Ecosystem

subsequently customers acquisition rate.

- Engineering Effort exhibited an oscillating behavior that correlated with the Human Resources with a starting value of 510 Hour/Month and a final value at month 70 of 575 Hour/Month. In the US case, the same variable had a stepped increase throughout the simulation period until it reached a final value of 1,800 Hour/Month.

Finally, as a result of these lower values in the HR and Product Development, the Customers sector exhibited also a different behavior than the one in the US context.

Behaviors in the Customer Sector

Contrary to the behavior in the US context, the number of customers increased at a decreasing rate with a significantly lower total number at the end of the simulation five-year period (Figure 24). The following behaviors were observed:

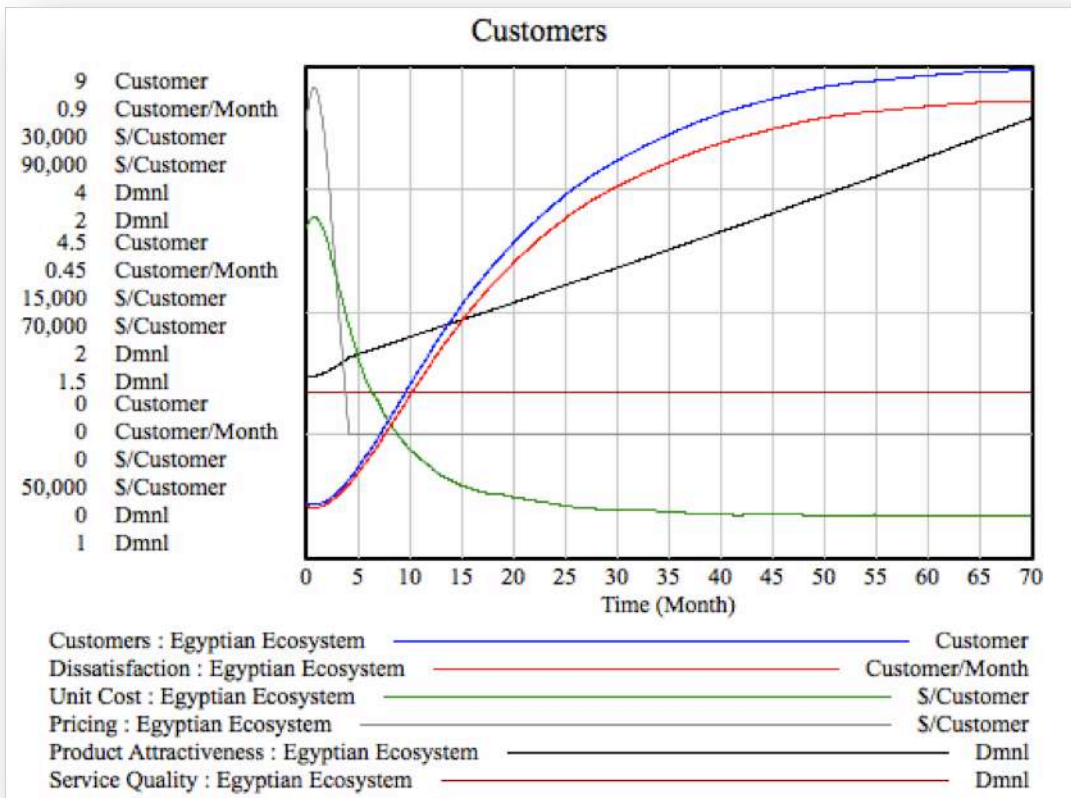


Figure 24: Customers Dynamics in Egyptian Ecosystem

- Customers increased at a decreasing rate until the total number of acquired customers reached 9 customers compared to 120 customers in the US context. This is due to resulted internal dynamics in Sales Effort and Product Attractiveness, which could be traced to Human resources and Product Features respectively, and differences in Market Size and technological readiness.

- Dissatisfaction and Unit cost didn't exhibit significant differences mainly because of the structure of the model and the forced assumptions on the model.
- Product Attractiveness had a very linear behavior throughout the entire simulation period with a final value of 3.5 compared to an exponential growth with a final value of 11 in the US case. Differences in Value Proposition and Word of Mouth (function in number of current customers) are primarily the driver for such differences in Product Attractiveness.
- Service Quality wasn't affected because of the low number of customers, and, as a result, the Required Service. In the US case, Service Quality dropped at month 57 due to the exponential growth in the number of customers, something that didn't occur in the Egyptian case.

Different Ecosystems Mandate Different Strategies

As shown and summarized in Figure 25, while the modeled startup in the US context reached a final valuation at year five of almost \$240 Million, the same startup in the Egyptian context reached a final valuation of \$3.5 Million. In addition, the Job Attractiveness of the startup in the US context reach 3.43 by year 5 while the same startup in the Egyptian context reached 0.364. Taking those two indicators together, one can conclude the following.

	US case	Egyptian case
Firm Valuation (\$)	240 M	3.5 M
Job Attractiveness (Dmnl)	3.43	0.364
Net Income (\$/Month)	1.5 M	60,000
Cash (\$)	30 M	9 M
Human Resources (Person)	17	5
Product Features (Feature)	500	70
Value Propositions (Dmnl)	10	2
Customers (Customer)	120	9
Product Attractiveness (Dmnl)	11	3.5

Figure 25: Summary of US & Egyptian Startup's Key Variables after 5-year Simulation

Despite the fact that the assumptions related to the annual external investment was kept constant, the startup was not able to scale and grow in the Egyptian ecosystem as much as it was able to do in the US ecosystem. Referring back to the most influential external factors that were identified in earlier sections, it is observed that the significant differences between the Egyptian and US ecosystems in Market Size, Labor Market Efficiency, Institutions, and Higher Education and Training are the causes for such different startup dynamics.

In conclusion, fixing all the assumptions about the startup internal variables, and all of its management decisions related to headcount growth, financial compensation and split between engineering and sales efforts, the startup internal dynamics exhibited significant difference by changing the context that startup is operating in from the US to Egypt. It might be possible to get the same dynamics as in the US context by adapting to the Egyptian ecosystem, and changing some or all of the internal management decisions in the startup and hence the cybernetic relationship between a startup and its environment.

Recommendations and Future Research

In this section, the author will develop some recommendations based on the research and developed model in this thesis, highlight some of the limitations in the presented model, and suggest some future research to build on this work. These recommendations would be very relevant to policy makers, and entrepreneurship ecosystems leaders.

Recommendations for Policy Makers and Entrepreneurship Ecosystems Leaders

Based on the sensitivity analysis that was performed and presented in previous sections, ecosystem factors prove to be leverage points that can significantly impact startups' performance. However, I suggest the following regarding these identified leverage points in the entrepreneurship ecosystem:

- Reforming or improving Higher Education is a very complex and expensive process that usually takes many years to bear fruits. However the Training part of this factor could be improved and spread with relatively less resources and less years to show tangible impact. Therefore, I am recommending that encouraging the formation and deployment of training centers that focus on filling the business and technical gaps in the labor market education that prevent them from effectively get engaged with entrepreneurial activities. Also, due to the very practical and quick-paced nature of startups, I recommend that these training centers should adapt a hands-on, learning-by-doing training approach where trainees might intern with operational startups. I believe that the best approach for these startups training hubs would be handled through public-private partnerships or through private entities to ensure the speed and the relevance of the training programs to the demands of the local startups. It is worth mentioning that these training hubs are different than incubators and accelerators that help existing startups.
- It might seem difficult to change factors like Market Size, but this would be true for local markets. Policy makers and ecosystems leaders should be able to expand the entrepreneurs' market horizon to go beyond local boundaries. A good example is Skype, which started in Estonia, a country with about 1.3 million people, but very quickly became a global company that serves millions of people all around the world, and was recently acquired by Microsoft. Expanding entrepreneurs' market horizon is mainly a mental model change which could be achieved by emphasizing on the idea of reaching out to not only local, but foreign markets. No doubt that laws and regulations are needed to facilitate the process of exporting

product and/or services to foreign markets, but the change in the mindset, I believe, is a precursor to this regulatory process. In addition, with the crowd-based and web-based business models, reaching out to foreign markets became affordable and relatively easy to many startups. Changing the market size horizon could be tied to the previous recommendation regarding training hubs for startups. Such a vision should be integrated in the ideation and competence development processes in these hubs.

- Because a startup's performance proved to be very sensitive to the Fear of Failure factor in the respective ecosystem, policy makers and leaders should work in nurturing a culture of support and actually appreciation of failures. The US is an exceptional example in nurturing such a culture where previous failures are appreciated as much as previous successes, and sometimes these failures are a prerequisite for raising funding and building market credibility. In Egypt for example, failing could be the end of one's entrepreneurial reputation, and would discourage talent, partners, investors and other stakeholders from collaborating with such a failing entrepreneur. One way to propagate such a culture would be to highlight previous failures of successful entrepreneurs in such ecosystems. Media and social networks could be easily utilized to highlight such messages.

Future Research

This thesis offers a new way of looking at startups and the ecosystems they operate in. The system approach that was adopted in this thesis enabled me to conceptualize and model the startup as a system embedded in another system. Also, the developed System Dynamics model could be the first of its kind to model the individual behavior of one startup and the influence of the ecosystem in such behavior. Previous models either modeled a startup without taking into consideration the effect of the environment or modeled the ecosystem with the collective behavior of many startups in such an ecosystem. Despite these contributions, the presented work has certain limitations and many assumptions that need to be explored and tested in future research.

- The model needs to be tested with multiple comparable startups to ABC company for further verification. Data from the evolution of actual startups should be collected and plotted against simulation results. This could also be used to perform post-mortem's on failed startups.
- Further research on the used assumptions is needed to find better ways to model these assumed variables
- As the model was calibrated to a B2B business model, other data from B2C companies need to be used and check the impact on the change of the business model on the behavior of the model
- The model needs to be used for other industries other than Web/IT, and see the impact of the changing of the industry, and any needed modifications on the structure of the model
- The ecosystem or external factors were modeled as exogenous variables, while in reality they are a complex system that influences itself. Therefore, a detailed model of the ecosystem and the interlinked loops between these variables could

- be elaborated and added to the model. It was assumed in the developed model that the external environment is constant or static. A detailed model of the ecosystem will closely emulate the dynamic nature of entrepreneurial ecosystems.
- Competitors' behavior was assumed to be constant during the entire model duration. This assumption needs to be elaborated to reflect competitors' dynamic behavior.
 - Further testing needs to be done to verify that this model could be used in different countries with the change of only the ecosystem external factors. Sample startups from different countries need to be used to calibrate and test the model in their respective geographies.

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