To Grow or Not to Grow?

A Multiple-Cases Study on the Growth Dynamics in Medical Software Firms

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Abstract

This study empirically demonstrates that software firms in a niche market with relatively short-life cycle may experience a similar growth pattern of worse-before-better. A system dynamics model is built to capture the essential interactions across industry- and firm-levels. It is found that though activities of market development and service and activities of product development and enhancement are important in pursuing survival and growth, software firms with different attitudes towards growth emphasize differently on the these activities by different human resource management and allocation policies. In this paper, we argue, and show, that entrepreneur's attitude towards growth and his or her adopted growth strategies determine how worse to experience and the extent to grow. This is significant to system dynamists because it shift our attention from traditional growth dynamics exploration to the observation and explanation of why firms experience growth or failure differently. The difference of growth among software firms and its implications is deliberately discussed.

1. Introduction

Recent years have witnessed the rapid development of software industry. The software industry is generally characterized as a turbulent industry with a high rate of entry, exit, product innovation and imitation. In software industry, the low entry and exit barriers spur firm birth and death more dynamically compared to other industries (Nirjar, 2008; Giarratana, 2004; Dunne et al., 1988). Nowadays, software industry is fiercely contested with ever shortening life cycles and more segmented niche markets.

In such an industry, entry into the software market is only the first step. To grow or even to survive is a more challenging task (Dunne et al., 1988). For example, according to Giarratana (2004), the survival rate of firms that entered the segmented market of encryption software is low, especially in the first periods; the survival post-entry average rate is 19% after a year and 10% setting the 2000 as the final year. Software firm survival and growth involve not only project-level issues such as costs, resources, scheduling, and final completion of single/multiple software development projects and client projects (Keil, 1995; Tiwana, et al., 2006; Abdel-Hamid and Madnick, 1989; Rahmandad and Weiss, 2009), but more deliberate strategies to manage the firm as a whole (Honjo, 2000; Hilmola et al., 2002; Ethiraj et al. 2005; Latham, 2009; Hätönen, 2010). However, research about the complex survival and growth process challenging managers is still limited (Achtenhagen et al., 2010).

The amount of literature on firm growth is vast (Delmar et al., 2003; Moreno and Casillas, 2007). Despite the substantial interest and massive empirical research, growth studies have been dominated by analysis of variance using cross-sectional measures to explain differences in growth across firms (Kumar, 1985; Evans, 1987; Wagner, 1992; Dunne and Hughes 1994; Smallbone et al., 1995; Wing et al., 1996; Moreno and Cassilas, 2007) and various models of business growth and growth life cycles (Filley and House, 1969; Greiner, 1972; 1998; Churchill and Lewis, 1983). The simplistic view of growth and the neglect of numerous nonlinear pathways to growth have led to inconsistent findings across studies causing a fragmented theory base (Storey, 1997; Delmar, 1997; Weinzimmer et al., 1998; Kirwood, 2009; Gansey et al., 2006; McKelvie and Wiklund, 2010; Delmar et al., 2003; Achtenhagen et al., 2010). As what Achtenhagen et al.(2010) claimed after their comprehensive review of growth studies and empirical investigation of what entrepreneurs thought about growth: "A crucial challenge for the future study of growth lies in how to capture this complexity and multidimensionality (of growth), e.g., by not treating growth as dependent variable but as intermediary variables while studying other outcomes, such as the improvement of performance." (Achtenhagen et al., 2010)

In contrast to growth studies in entrepreneurship, strategy, economics, and organization fields, findings in system dynamics literature contribute more on growth

dynamics understandings from an endogenous view to facilitate the design of growth policies and strategies. Questions like how imbalanced demand and supply combined with embedded time lags (Lyneis, 1980; Forrester, 1961; Ford, 2001), market saturation and competition (Hall, 1976; Paich and Sterman, 1993), insufficient capacity, and eroded service quality (Forrester, 1968; Sterman, 1988; Oliva et al., 2003), etc. may lead to growth stagnation and even collapse are explored and discussed. Since little is known about the growth dynamics of software firms, this paper aims to explore possible general structures underlying the success and failure across software firms. A study of four medical software firms enabled this paper to makes two principal contributions to the extant literature on growth. First, this study empirically demonstrates that software firms in a niche market with relatively short-life cycle may commonly experience a period of performance deficit before growth occurs. The distinguishing feature of this work is that the system dynamics model built captures the essential interactions across industry- and firm-levels and the growth trajectory of worse-before-better to explain the high exit rate in software industry in which small and medium enterprises are the majority.

Second, we argue, and show, that entrepreneur's attitude towards growth and his or her adopted growth strategies determine how worse to experience and the extent to grow. This is significant to system dynamists because it shifts our attentions from traditional growth dynamics exploration to the observation and explanation of why firms experience growth or failure differently. The difference of growth among software firms is deliberately discussed to stimulate managerial reflections on attitude towards growth.

This paper is organized as follows. In the Second Section, research design and data collection is explained. Then, in the Third Section, the development of medical software market and the market dynamics is briefly introduced and discussed. In the Fourth Section, a general model of basic operations and management of medical software firms is further discussed and in the Fifth Section, how different growth strategies matter in software firm growth is discussed with multi-cases simulations. Findings are summarized and concluded in the Sixth Section.

2. Research Design

To this paper, in-depth longitudinal case studies of different growth experiences of software firms would be particularly valuable in order to enhance understandings of how and why firms achieve or fail to sustain growth. This study used data from four medical care software firms to develop a system dynamics model to capture essential components and interactions general to software firm growth. Table 1 indicates basic information about the four interviewed medical care software firms. The rationale in choosing the medical care software firms to study is because the medical care software market in Taiwan has experienced growth and got saturated during the period of year 1995 to 2005. The fast growing and then saturated characteristics of market is suitable for implied not only the opportunity for software firms to grow but also the challenges for survival. With the quantitative system dynamics model, this paper shows how and why the general growth model with different pervasively adopted growth strategies lead to different performance result.

The model building and analysis process was consisted of three phases. Phase 1 began by focusing on a software firm in the medical care software market to develop a quantitative model to reproduce what the firm under study had experienced in its growth process. In investigating firms' willingness to collaborate with this study, Company C, as shown in Table 1, actively showed its willingness for further quantitative modeling. Hence, Company C was chosen as the starting point in Phase 1 to develop the general growth model of software firms. In Phase 1, twenty semi-structured (approximately two hours each) interviews with the chief executive officer were conducted and available secondary sources as company materials were collected. Model validations were conducted according to Forrester and Senge (1980) and Sterman(2000). The developed system dynamics model captured the growth dynamics of company C and the market characteristics of the medical care software market to serve as a basis for studying other software firms' growths.

Table 1 Descriptive Statistics on Case under Study

Company	Market Position	Product Focus	Number of Employees		Number of Healthcare Institution Served
			startup	2010	
A	Top	Western	7(1998)	100	4500

		medical clinics			
B	Middle	Dental clinics	5(1993)	70	2000
C	Middle	Chinese medical clinics	3(1992)	36	1500
D	Exited	Western medical clinics	3(1992)	0	200(history)

In Phase 2, we interviewed three other software firms that were also in the medical care software market. As indicated in Table 1, one of the three was a leading firm in the market, another had a market position similar to the firm Company C, and still another firm exited the medical care software market after a long period of financial deficit. The purpose of interviewing with the three firms was twofold. First, we clarified a general operational model of software firms and identified common market and competition characteristics based on the quantitative model developed in the prior phase. It is also notified that the four firms under study did not received external financial support even in tough times, just as the majority of firms in medical software market. Second, we deliberately examined how these firms differed in entrepreneurs' attitude towards growth, i.e. growth strategies, resources allocation polices, performance control and management and further modeled these differences in the quantitative model. By contrasting the different growth performance of the four studied firms after a series of simulation and experiments, we extracted a general growth model to summarize the most important insights of software firm growth in medical care software market in Taiwan.

In Phase 3, a second series of interviewed (approximately one hours each) was conducted to all the four interviewed firms to validate the developed model. In each firm, the firm's specific growth strategies and management policies was communicated on the basis of the general growth model. Model structures and simulation results were all examined and discussed to ensure the model's validity.

3. Demand and Supply of Medical Care Software Market in Taiwan

Model overview of medical software firms is shown in Figure 1. The quantitative model is comprised of two major parts. One describes the market or industrial development process, and the other is a firm-level analysis about the dynamics of operations and management. In this section, how the medical software market as a whole grew and got saturated is discussed first and then, in the following section, the firm-level operations and management is described.

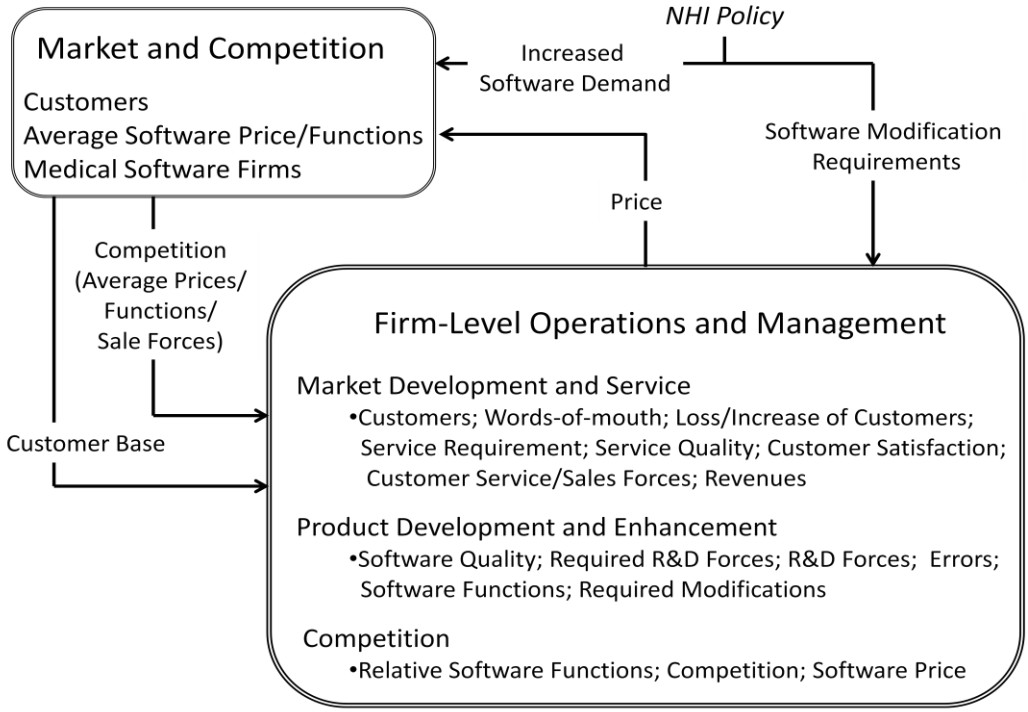

Figure 1 Model overview of medical software firms

The National Health Insurance Program in Taiwan was first launched in 1995 on the idea of marshaling the resources of the majority to relieve the difficulties less fortunate people have in paying for health care. The Bureau of National Health Insurance (BNHI) collects premiums from the insured and contracts with qualified medical care institutions to provide medical services to the insured. The medical providers make claims to BNHI for reimbursement of the services they have provided. By the end of 2010, more than 99% of the population was enrolled in the program and

about 92.13% of the medical care institutions in Taiwan had entered contracts with the BNHI.

The rapid development of NHI implies a quickly expansion of medical care software market. In accordance to the Regulations Governing the Review of the Medical Services, the BNHI needs to review reimbursement claims filed by contracted medical institutions and to screen the type, volume, quality and appropriateness of medical services provided under the NHI program. To cope with the heavy loading of claims reviewing, the BNHI has encouraged contracted health care institutions to file their expense reimbursement claims electronically (via the Internet, electronic media or the VPN). Efforts have been put into for software that allows all contracted health care institutions in 2001 to report their expense claims electronically through one window, the IC Card Data Center (IDC), to streamline the process even further, in turn, stimulating the surge of contracted health care institutions' demand for software that supported the online claims.

In Figure 2, it shows the developments of supply and demand in medical software market in Taiwan. The feedback loop denoted as *Growth of Adoption 1* illustrates the increase of contracted medical institutions that adopted medical software *via* diffusion effect. The more medical institutions adopted the medical software, the stronger the diffusion effect was to stimulate more adoptions. NHI policies and the rapid development of NHI brought the medical software market a great number of prospect customers to support the software adoption growth, in turn, increasing the average revenues of software firms. High revenues, low entry barriers, and high medical software demand, attracted more software firms and further stimulated greater software adoptions.

The supply and demand of medical software market grew so fast that it soon confronted with the limit of the market, as illustrated by the balancing feedback loop, *Market Saturation*, in Figure 2. Severe competitions among software firms occurred and triggered software firms to compete with each other by offering software with more functions and greater price reductions. Compared to the time-consuming of software function design, price reduction was adopted more frequently because of the negligible production cost of additional copies of software (Arthur, 1994). Viewing the

market as a whole, the fewer the average revenues were, the greater software price reduction, causing a further falling average revenues. Consequently, merges occurred

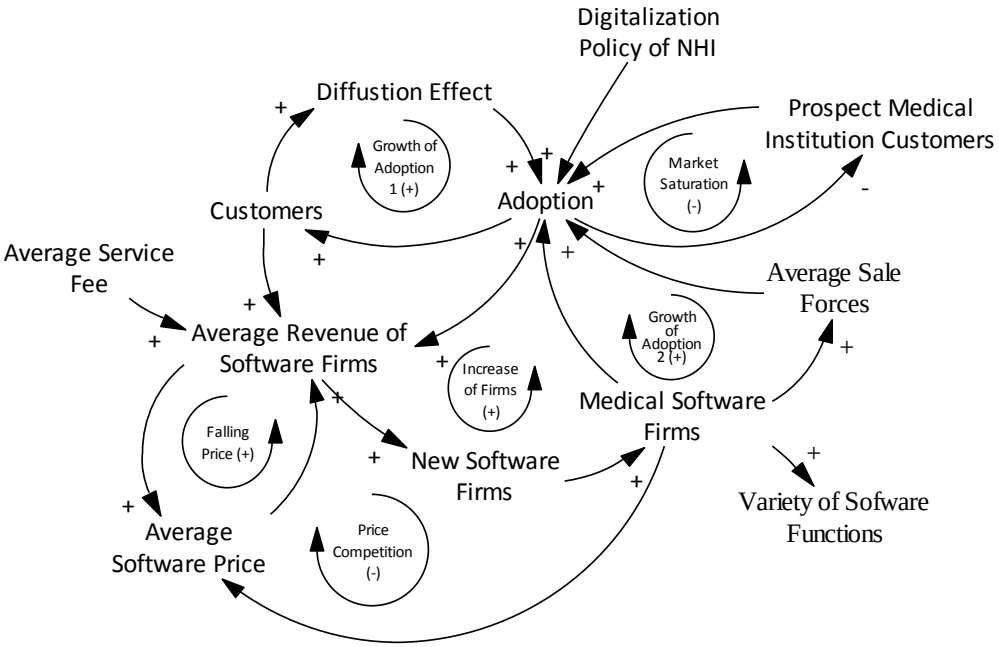

Figure 2 Development of the overall medical software market

and software firms that failed to get enough revenues exited the market. In ten years, the rapid growing number of medical care software firms dropped from one hundred and twenty, at its peak, to forty. Top four software firms accounted for more than sixty percent market share in 2010.

4. A General Operation Dynamics of Medical Software Firms

In the rapidly developed medical software market, the four software firms under study had operated in a similar way. As illustrated in Figure 3, two distinguishing categories of activities that constituted the general operations and management of medical software firms were extracted from the four cases under study: activities of market development and service and activities of product development and enhancement.

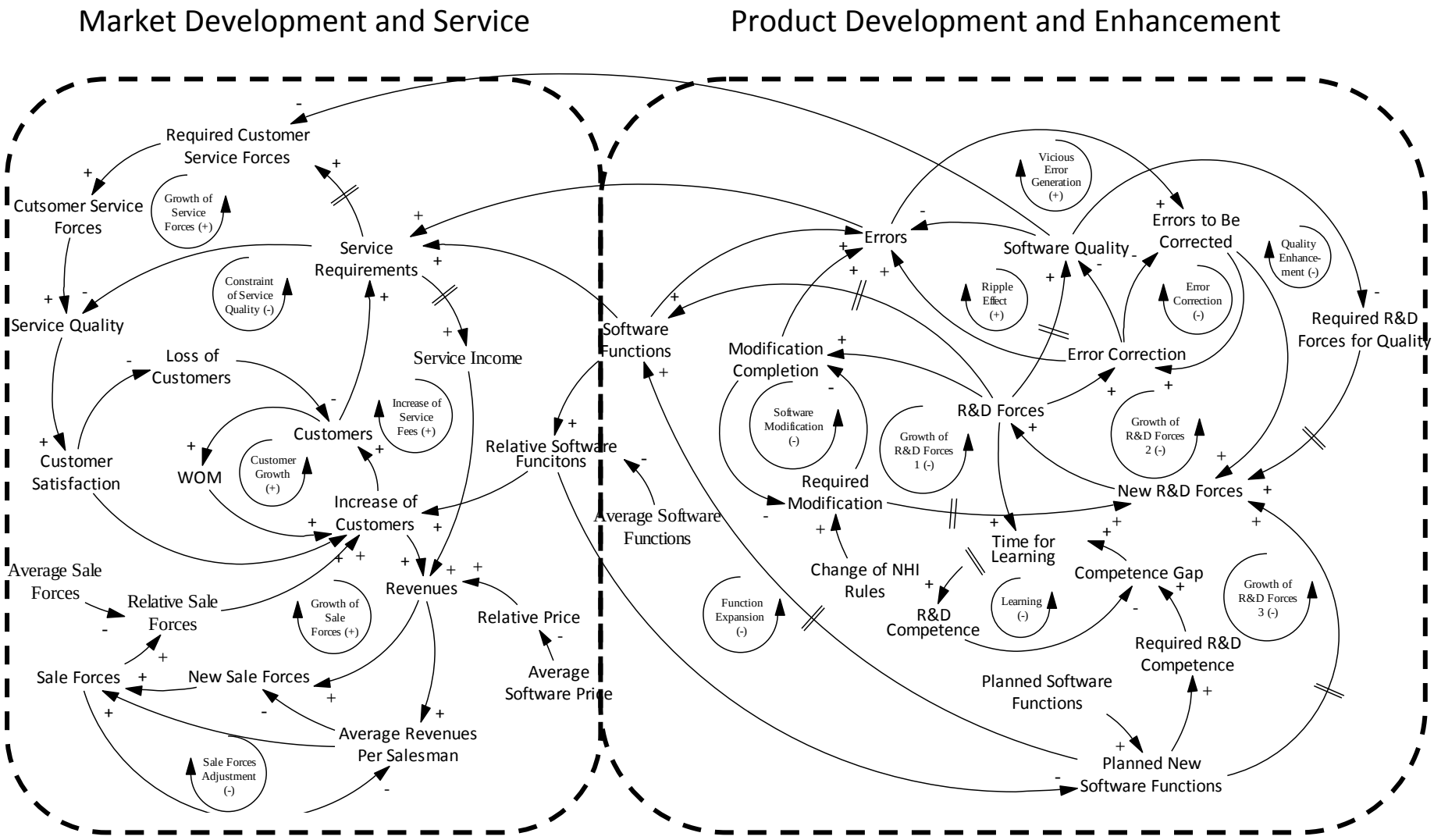

Figure 3 Operation and management structure of medical software firm

Market development and service

In medical software firms, short-term growth was majorly driven by words-of-mouth and growth of sale forces. To medical care institutions considering to adopt medical software, words-of-mouth from colleagues and medical associations were the most influential factor. In addition to words-of-mouth, the more sale forces a software firm owned, the more prospect customers that the firm could contact with and bring in more revenues to expand the sale forces. The two reinforcing feedback loops were illustrated in Figure 3 as the loops denoted as *Customer Growth* and *Growth of Sale Forces*.

Another critical revenue stream of a medical software firm was customer service fee that was usually charged after the first year. In consideration of high switching costs including data transfer, software, and learning cost, medical care institutions rarely changed software supplier unless the quality of service was too poor. That is to say, as long as a certain degree of customer service quality was kept, the amount of service fees increased by time when the number of customers accumulated. To software firms, customer service forces are critical resources to fulfill customer service requirements and the loss of customers from insufficient service forces should be avoided. However, when revenue was not good as expected, a software firm might shrink its sale forces or slow down of necessary service forces expansion.

Product development and enhancement

Different from sale and service forces that were customer-oriented, R&D forces focused their attentions on product development and enhancement. As illustrated by the three goal-seeking feedback loops in Figure 3, R&D tasks can be categorized as *Software Modification*, *Error Correction*, and *Function Expansion*. Among the three categories of tasks, software modification in accordance with NHI policy changes in time was of the essence. However, frequent reforms of NHI policies constantly asked for expansions of R&D forces to carry out the heavy software modification tasks.

Error correction was another critical task for R&D forces. In most occasions, errors that occurred in software development and modification processes were not recognized until software clients called for defects fix. In Figure 3, the two arrowed

links from *Errors* to *Service Requirements* and *Errors to Be Corrected* represent a co-flow structure involving the two flows of customer services and errors. Error correction might generate two kinds of adverse effects. One was the commonly known ripple effect that contaminated more new tasks and generated more errors (Taylor and Ford, 2006; Rahmandad and Weiss, 2009; Repenning, 2000; Lyneis andFord, 2007). The other was the phenomena that the loop, *Vicious Error Generation*, shown in the Figure 3, describes: error correction unavoidably affected software quality and increased the possibility of error generation, especially when limited time was available for a specific defect fix. To avoid the escalation of errors, investment in R&D forces might be needed to enhance software quality by adoption of new software languages and tools and deliberate re-examination of software and system architecture. However, for most medical software firms of small or medium size, long delays often existed for system quality enhancement.

The third category of R&D tasks was about new software function development. In consideration of competitions and the digitalization policy of NHI, a medical software firm might activate the upgrade activities of their software products to attract customers. However, software upgrade was time-consuming and might ask for new R&D skill and competence. R&D forces had to allocate their time for learning new skill and enhancing R&D competence and time for product development and enhancement. Without sufficient R&D forces, a software firm might need to decide to expand R&D forces or to adjust its growth strategy or competition plan in the market.

As the aforementioned introduction and discussion illustrates, a medical software firm had to offer not only the front end activities to acquire and new customers and maintain customer loyalty but also necessary back end activities to develop and enhance software products to support the front-end market development. Though both the front-end and back-end activities were important in pursuing survival and growth, software firms with different attitudes towards growth emphasized differently on the these activities by different human resource management and allocation policies. In this study, we classified the four medical software firms under study into three categories based on their attitude and growth policies: *aggressive*, *moderate*, and

conservative ones. How different growth strategies impacted on the growth pattern of each case is further illustrated and discussed.

5. How Growth Strategies Matter in Medical Care Software Firms

In Table 2, medical software firm cases and their strategy focuses of the three growth policies are listed. In the case of Company A that adopted an *aggressive* growth policy, market share was of the first priority. Company A aggressively invested in sale forces to expand its market and maintained a high service quality by having enough service forces to fulfill customer requirements. To keep software products attractive and competitive, Company A also invested in R&D forces to stay in the position of market leader. Compared to the case of Company A, Company D was much more conservative. To Company D, survival was more important than growth. Deficit was not acceptable and human resource investment occurred only when profit was seen. Product leadership was not a major management goal in a *conservative* growth policy. Software functions expansion to catch up with competitors might even be quitted if cash flow was insufficient to support the cost of R&D forces.

Table 2 Growth strategies adopted by medical software firms

Growth Strategy	Cases	Focus
Aggressive	A	Customer acquisition, service quality, and product leadership
Moderate	B, C	Customer acquisition, service quality, aggressive market follower, HR investment taken into account deficit
Conservative	D	Profit conditioned HR investment, passive market follower

Different from Company A and Company D, the other two software firms, B and C, adopted a *moderate* growth strategy. In these two firms, though market expansion was the focus of firm strategy, the pace of investment was not as aggressive as Company A. The two medical software firms did not invest so much in R&D activities as Company A did. In *moderate* growth strategy, being a product follower was good enough. Shrink in sale forces might even occur if market development was

not as expected. In this paper, the quantitative model that is built on the case of Company C describes the *moderate* growth policy. The *moderate* growth policy was tested and confirmed in the other firm, Company B, that also adopted the *moderate* growth policy. Based on the quantitative model, *aggressive* and *conservative* growth policies were also modeled and simulated, respectively. Model structure and simulation results of each growth policy were demonstrated, discussed, modified with each company by conducting after-model interviews. In Figure 4-1 to Figure 4-3, the essential feedback structure of the three growth strategies that were simplified from the quantitative simulation model are illustrated. Simulation was set to be eight years, measured by month, to cover the growth patterns of all cases under study. Simulation results of the *aggressive*, *moderate*, and *conservative* growth strategies are shown in Figure 5.

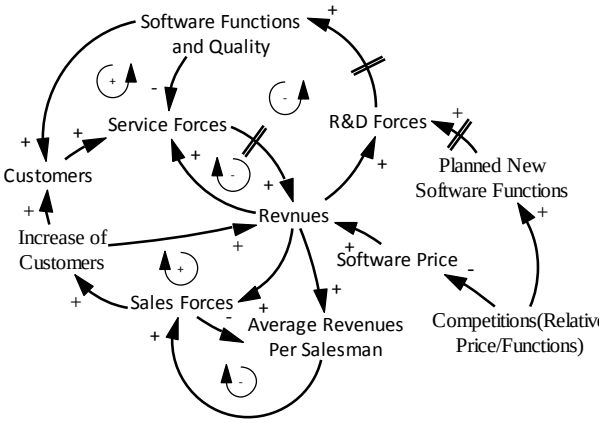

Figure 4-1 Software firm growth strategy(1)-Moderate

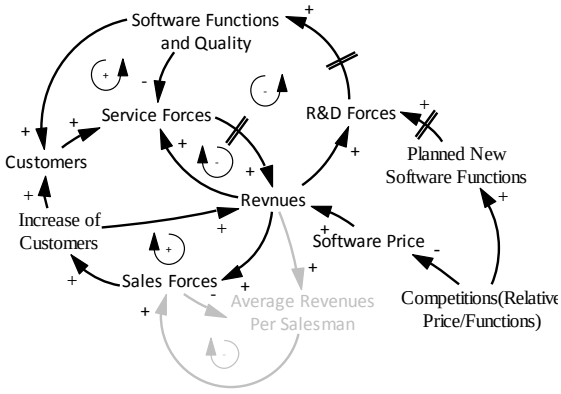

Figure 4-2 Software firm growth strategy(2)-Aggressive

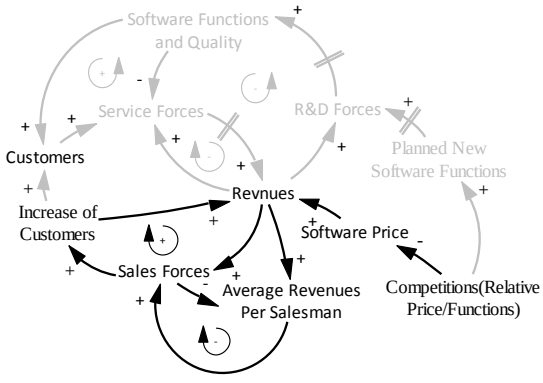

Figure 4-3 Software firm growth strategy(3) -Conservative

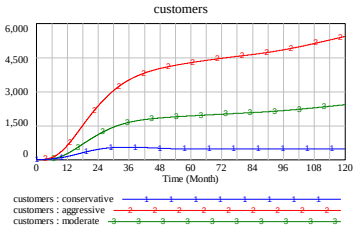

Figure 5-1 Simulated results(1)-Customers

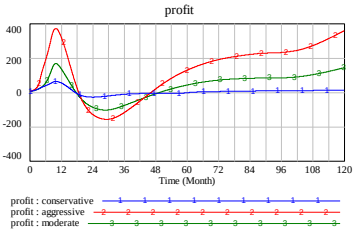

Figure 5-2 Simulated results(2)-Profit

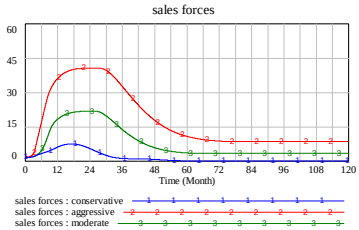

Figure 5-3 Simulated results(3)-Sale Forces

Figure 5-4 Simulated results(4)-Service Forces

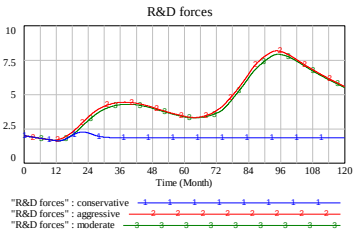

Figure 5-5 Simulated results(5)-R&D Forces

In Figure 5, it shows that growth patterns of the three growth policies have some behavioral characteristics in common. First, an S-shape pattern is seen in the simulated *Customers*. Second, while the simulated *Customers* is growing, the simulated *Profit* that is calculated from *Revenues* minus operational costs and HR salaries grows rapidly but soon falls down to its valley. However, after a period of deficit, *Profit* stops falling and even grow again. Third, simulated *Sale Forces* as shown in Figure 5-3 increases at first and then drops. Differently, simulated *Service Forces* and *R&D Forces*, that are shown in Figure 5-4 and Figure 5-5, grow gradually again after a period of downturn. Based on a structure-behavior analysis, these common behavioral characteristics illuminate a general growth model of the four medical software firms in the rapidly developed medical software market.

A general growth model of medical software firms

The simplified general growth model of medical software firm is as illustrated in Figure 6. In the early stage of the medical market as a whole, few medical software firms shared the huge unexplored market. High medical software prices and a great

number of customers resulted in great incomes and revenues that were further invested in sales forces to bring in more customers to the software firm. However, as the number of customers grew, customer service requirements unavoidably increased and asked for more service forces to maintain service quality. Meanwhile, the explosively growing number of medical software firms intensified competitions in software price and software functions. R&D forces were further burdened by the aforementioned frequent NHI policy changes that asked for software modifications in time and cascading error and software quality problems. Namely, more R&D forces were required while revenue was falling. Consequently, profit deficit unavoidably occurred because of falling revenues and increasing human resources cost.

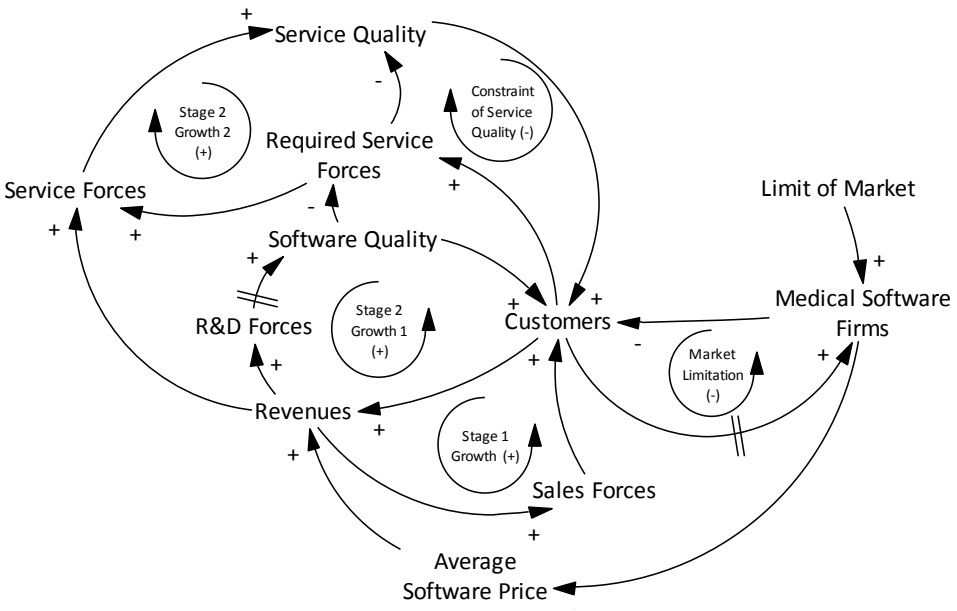

Figure 6 A generic structure of software growth in a rapidly developed market

Afterwards, since the overall medical software market almost reached its market limit, medical software firms gradually reduced its sales forces in response to the saturated market. Though in the absence of new customers as before, profit deficit was improved because of the increasing after-first-year service income. Prior R&D investment in software quality improvement and product enhancement started to reveal its impacts on required service forces cost. Major revenue stream of software firms shifted from software adoption to service fees. Those medical software firms with more customers activated the *stage 2 growth*, as shown in Figure 6, because of

stable revenues, fewer costs in sales and service forces, and rich R&D resources to respond to customer requests, NHI policy changes, and develop better software products.

In medical software market as a small niche market with a relatively short life cycle, not every software firm was lucky enough to successfully pass through the performance deficit and enjoy the *stage 2 growth*. Actually, in software industry in which small and medium enterprises are the majority, most medical software firms exited the market regardless of the growth strategy and attitude towards growth was aggressive or conservative one. Let's take a closer look at how growth strategies mattered in medical software firms' survival and growth.

How growth strategies matter in software firm growth

In a comparison of *aggressive* and *conservative* growth strategies that were illustrated in Figure 4-2 and Figure 4-3, both the two growth strategies invested in sale forces. However, *aggressive* growth strategy had a much stronger driving force to accelerate customer growth because of a greater sale forces investment. The stronger *stage 1 growth* momentum as illustrated in Figure 6 explains the difference in the growth speed of simulated *Customers.* In software firms with *conservative* growth strategy, the relatively fewer software adoptions and the smaller customer base led to a fewer service forces investment as shown in Figure 5-4. Without sufficient service forces, service quality was poor. Negative words-of-mouth effect further enlarged the gap of *Customers* between *aggressive* and *conservative* ones. R&D forces investment was another reason for differences. In the *aggressive* growth strategy that aimed at product leadership, R&D forces investment was also more aggressive than the *conservative* growth strategy. R&D investment not only expanded the number of software functions and enhanced software quality to attract customer adoptions but also reduced the number of required service forces to respond to customer claims, in turn, stimulating the *stage 2 growth* momentums as illustrated in Figure 6. In contrast to the *aggressive* growth strategy, the outcome of lacking sufficient R&D investment could be worse than the incapability to attract new customers. Insufficient R&D

forces for error corrections and system modifications resulted in the vicious escalation of errors and poor software quality that asked for more R&D forces and service forces. However, with fewer and fewer new customers in the rapidly saturated market, investments in R&D and service forces became even more unattractive in conservative software firms.

The above analysis illuminates that the archetypes of limit to growth and underinvestment to growth that *conservative* software firms might be entrapped. Insufficient investment could worsen the growth problem they were confronted with. However, the aforementioned analysis does not mean an *aggressive* growth strategy was a better one for those software firms. Aggressive investment in human resources could indeed bring in a firm short-term and long-term growth momentums. However, before the delayed effects of product enhancement and reduced service forces costs appeared, the worse-before-better growth trajectory of profits often led to decisions to exit the market. Actually, as the entrepreneur and the chief executive officer of Company A that adopted an *aggressive* growth strategy said, "The deficit lasted for years. Many competitors exited the market, small and big ones. And I did think about quitting the medical software business for many times. It was a hard time."

6. Conclusion

This study empirically demonstrates that software firms in a niche market with relatively short-life cycle may experience a similar growth pattern that firm grows after a period of performance deficit. The growth trajectory of worse-before-better explains the high exit rate and shows that entrepreneur's attitude towards growth and his or her adopted growth strategies determine how worse to experience and the extent to grow. Taking medical software firms as illustrated examples, in this study, it shows that how to survive or even how to grow is not simply a decision about to grow or not to grow for software firms. Whether a software firm can survive or grow cannot be simply explained or foreseen just based on a few variables such as size, age, entrepreneurship, etc. In the study of the four medical software firms, it is found that the three growth strategies, the attitudes toward growth, and the corresponding management actions in response to external and internal events were rather reasonable.

However, to these software firms especially the one adopted conservative growth strategy, the underestimate of the speed of price dropping and the overlook of rapidly arising customer service requirements intensified the financial stress and tension that profit deficit brought. Namely, the advantage of low entry cost of the software market that attracts small and medium software firms to the market becomes severe difficulties for competitions and survival. The systemic interactions among firms and market as a whole, the vicious and virtuous natures in the management of R&D activities, and the dynamic alignment of short-term and long term profitability is more important and challenging. Managers should pay attentions to the dynamic alignment of trade-offs and risks that conservative and aggressive growth strategies may generate in pursuing survival or growth.

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