A System Dynamics Case Study of Veterinary Telemedicine

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Abstract

Veterinary telemedicine has existed since the late 1990s. Various scholars have predicted its growth, others its decline. We constructed a system dynamics model of a veterinary telemedicine company providing services in one specialty in the industry. The model showed that growth in that specialty would be limited by severe shortages of specialists, even with extensive marketing efforts. This limitation is likely to hold in other aspects of veterinary telemedicine. The paper concludes with recommendations for the company and the industry.

Introduction:

Industry Overview

Telemedicine uses medical information exchanged between distant sites for diagnosis, consultation, and treatment, and transfer of medical data, of patients (Meher et al., 2008). Telemedicine is as widespread in veterinary medicine as it is in human medicine (Devi et al., 2015; Papageorges and Hebert, 2001). As far back as 2001, the journal *Clinical Techniques in Small Animal Practice* devoted an entire issue to telemedicine in veterinary practice (Papageorges M, 2001a) with Papageorges (2001b) predicting widespread use by 2010. Some (for example, Devi et al., 2015) assert that veterinary telemedicine will alleviate the shortage of veterinary specialists, while others (Poteet, 2008) caution that technological barriers might prevent either widespread use or increased efficiency.

The present paper will examine a case study of a company trying to start a veterinary telemedicine business. Unlike the telemonitoring described in Warren et al. (2003), this company has veterinary specialists examine test materials, sent to them remotely in discrete packets, for interpretation. Our goal is to examine whether there is growth potential in this industry, and, coincidentally, to examine if Papageorges's (2001b) prediction has been fulfilled. To maintain confidentiality, the firm requests anonymity and even requests that we disguise its current particular specialty. However, the company shared all the data used in the present paper, and we believe them to be accurate.

The question is whether the veterinary telemedicine field can keep up with demand and its growth potential, or if a lack of specialists will force its incumbent firms to scale back. The industry is severely restricted in its growth by its available tangible assets, which include a limited amount of available specialists in the company's current subfield, which currently total around 500 specialists, worldwide. The growth rate of specialists is slow; universities can currently produce about 40 per year. The company currently experiences specialist turnover of 7 percent. Hiring and retaining staff are important objectives for the company if it hopes to achieve growth and service existing clients well. If the company wants stay on its current trajectory then it will need to maintain an adequate hiring level above its current leakage rate. It will have to hire and retain enough of the available specialists entering and currently in the market, while also being aware that rivals are hiring from the same pool. The company's potential clients currently total the 24,000 clinics in the U.S. and North America. Currently about 9,000 of these clinics use telemedicine services, although this number is expected to grow rapidly over the next five to ten years. Potential clients are veterinary hospitals and clinics, which by themselves send many cases each year. Therefore, the ratio of clients won to cases served is much larger than one to one.

Opportunity:

The company currently serves approximately 4,100 clients and has a 45% share of this specialty veterinary telemedicine market. The company has some control over tangible resources such as specialists, sales reps, and equipment. Resources also include intangibles, such as brand reputation and service quality.

Our goal is to show how the company can capture as much of the potential growth in this specialty telemedicine market as possible. This company's growth opportunity is clear: to improve its current position, and win a greater market share of the available pool of clinics as telemedicine services grow over time. The company expects this market to quadruple in size over the next 5 - 10 years.

To increase contacts with more clients the company is using direct marketing, conferences, “lunch and learns” and is using key opinion leaders who can influence their peers' veterinary practices to get the word out. This creates a self-reinforcing feedback for the company as veterinarians use word of mouth and conferences to reinforce their growth. The company has a sales force of approximately 150 individuals, and plans on using direct selling from this inside sales force. The company geographically distributes its sales representatives based on number of clinics in an area. Management is aware that the quantity of resources can affect the rate at which customers stay with the company, and so it realigns the size of the regions to make them more manageable. This allows sales people to call more frequently on the prospective clinics. It seems the company believes that clinics require a certain level of service to maintain a level of quality. If the quality of service diminishes, companies risk losing clinics. The company has the ability to win more clients but cannot win too many, as this will put too much pressure on the current specialists and reduce service quality.

This company hires three types of veterinary specialists:

- Full time specialists who examine and interpret test materials for the company and have no other veterinary practice.
- Scheduled specialists who examine and interpret test materials for the company on a scheduled basis, but who have their own veterinary practice.
- Non-scheduled specialists, who examine and interpret test materials for the company on an *ad hoc* basis, but who have their own veterinary practice.

The company pays the specialists in each category on a per-case basis, even though the full time specialists are employees and the other two categories are contractors. It charges an additional fee for “stat” cases (i.e. cases where the customer demands fast turnaround) and splits that fee with the relevant specialist.

Model:

The reader will find a shared version of the model at the following link:
https://app.sysdea.com/shared/zVlQ3R1orwjtY5q_Gr0nKQ

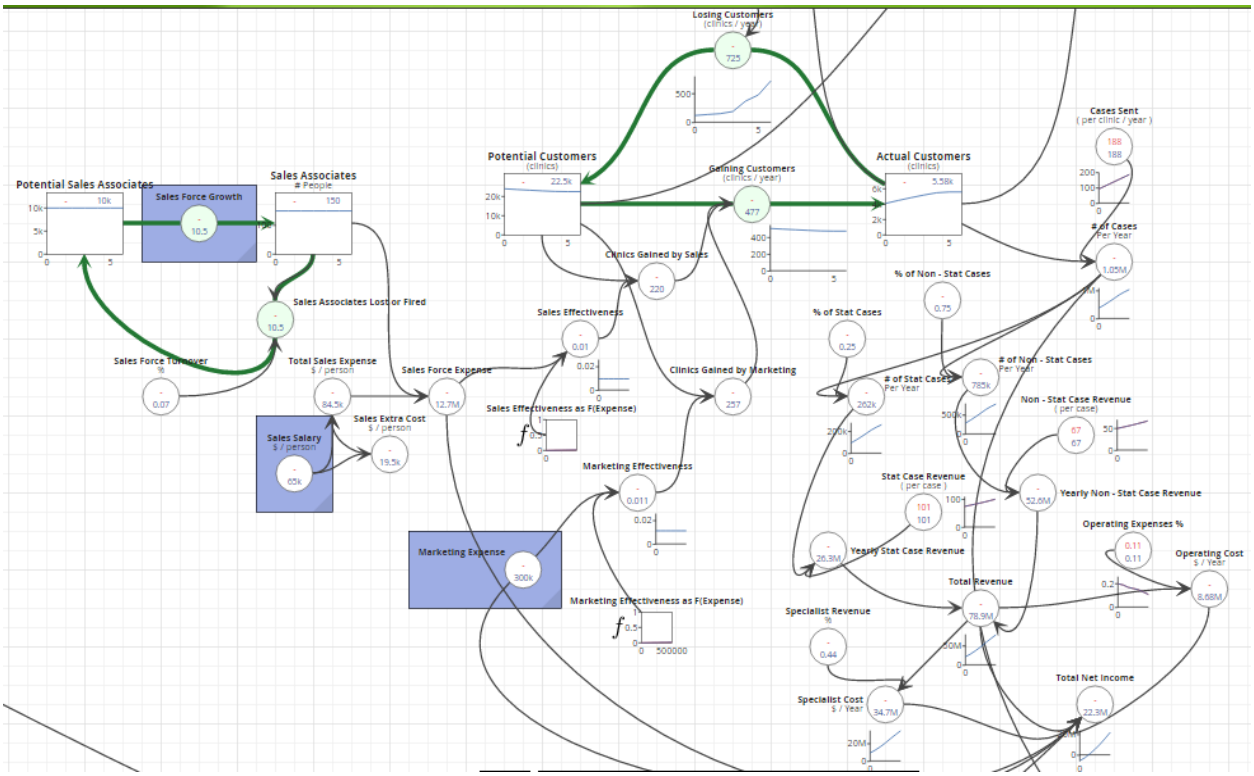


Figure 1 Full Model of a Veterinary Telemedicine Business

Model Overview

We designed the model to mirror the strategic architecture of the focal veterinary telemedicine company. In the model, we mapped out each facet of the business, to facilitate understanding of the relationships among different tangible and intangible factors. We explain each part of the model in detail in the following sections, and we conclude with a complete view of the model.

Market Opportunity

The first part of the model relates to the market opportunity that this company has in the telemedicine market. At the top center of the model is the familiar structure of the Bass Diffusion Model. This shows how the company converts its potential customers of 24,000 clinics into actual customers through sales and marketing efforts. The variables highlighted with blue boxes are the decision variables that the company can make. The company can choose how many sales associates to hire per year, the yearly salary of sales associates, and how much to spend on marketing per year. Marketing expense and sales expense drive marketing and sales effectiveness, which increase or decrease the flow rate of potential customers to actual customers. Although it is off the screen, pressure on staff and service quality drive the flow rate of actual customers back to potential customers (losing customers). Towards the right side of the model, the number of actual customers this company has dictates the caseload (which breaks down into stat and non-stat cases). This caseload in turn affects revenues, specialist costs, operating costs, and net income.

Specialists and Hiring

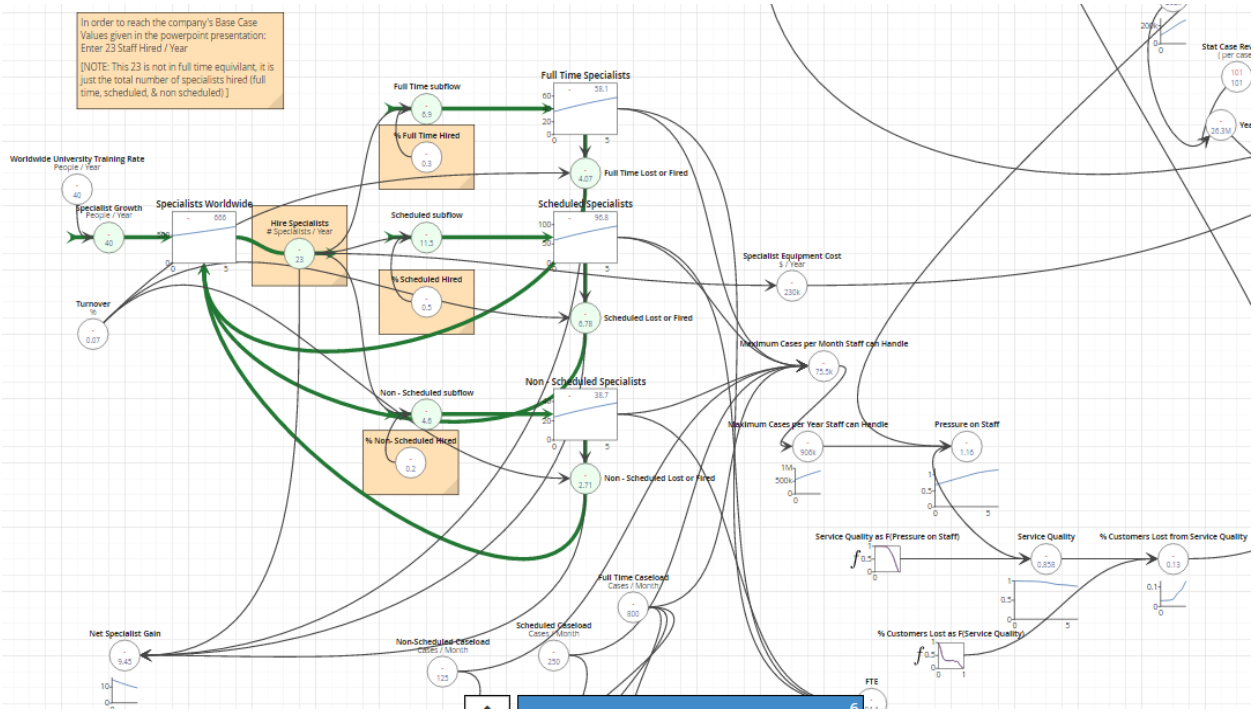


Figure 2 Specialist Hiring Practices

The second part of the model relates to specialists in this field of veterinary medicine and the company's hiring process. In the starting year of 2015, there are around 500 specialists worldwide for this field of medicine. At the left side of the model, a flow of specialist growth enters the specialists' worldwide stock at a rate of 40 specialists per year, which is the company's estimated value of specialist growth. The company's hiring draws out of this stock, with multiple split flows into stocks of full time, scheduled, and non-scheduled specialists. We highlight the decision variables in this part of the model using tan boxes. The company determines how many specialists to hire per year, and the target percentages of each type of specialist that it hires. Please note that these are decisions for viewing strategic outcomes; however, in real life it is harder to get full time hires (the company currently has 30% full time staff, but wants to get to 50%). Once specialists are hired, a turnover rate of 7% annually draws out of the specialist boxes back into the worldwide specialists' pool. Towards the right side of the model, the numbers of specialists dictate the maximum caseload staff can handle per year, which relates with the actual cases sent by clients; this creates a pressure on staff ratio, and a service quality level. The service quality level drives customer retention and losses.

Simulation 1 - Base Case:

Assumptions

The company provided information for the base case of the model. The model runs for 6 years, from 2015 - 2021. Some basic assumptions of the model based on information the company gave include:

- There are 24,000 potential clients in the U.S. and North America

- At the start of year 2015, the company has approximately 4,100 clients. Marketing and sales force expense drive the rate of client growth. Pressure on staff and service quality drive the rate of client loss.

- The company starts in 2015 with 36 full time specialists (30%), 60 scheduled specialists (50%), and 24 non-scheduled specialists (20%). This equals approximately 60 Full Time Equivalent (FTE) specialists. The model keeps hiring of specialists at a constant level of 23 specialists / year to meet the company's projected FTE growth to 95 by year 2021. It assigns $10,000 of equipment to each new specialist hired.

- Specialist turnover is 7% for all categories of specialist.

- Full time specialists can handle 800 cases per month, scheduled specialists can handle 250 cases per month, and non-scheduled specialists can handle 125 cases per month.

- The company has a salesforce of 150, with salaries of 65,000 annually. The model assigns an extra 30% of the salary to each sales person for extra costs. Sales force turnover is at 7%, hiring will be kept at a rate of 10.5 to keep the salesforce at a constant level of 150.

- The company spends approximately $300,000 annually on marketing.

- Twenty-five percent of cases are stat cases; 75% are non-stat cases. Stat cases charge $75 / case, and non - stat charge $50 / cases. Forty-four percent of case revenues go to the specialist for their labor cost. Twenty percent of case revenues are operating expenses for the company. Based on company projections, these operating expenses reduce to 11% by 2021.

- Prices for all cases increase by 5% per year.

Results

Table 1 shows the decision variables for the base case, results for key factors at year-end 2021 after we ran the base case. Figure 3 shows supplemental charts.

Table 1 Base Case Decisions

Decisions		Results (Year End 2021)	
Marketing Expenditure	$300,000	**# of Cases**	1.02 Million
Hire Specialists	23	**Revenue**	$76.6 Million
% Full Time Hired	0.3	**Total Net Income**	$21.3 Million
% Scheduled Hired	0.5	**FTE Employees**	94.4
% Non-Scheduled Hired	0.2	**Pressure on Staff**	1.12
Sales Salary	$65,000	**Service Quality**	0.889
Sales Force Growth	10.5	**Customers Lost**	484 (8.9% of actual)
		Market Share (% of NA clinics)	23.90%

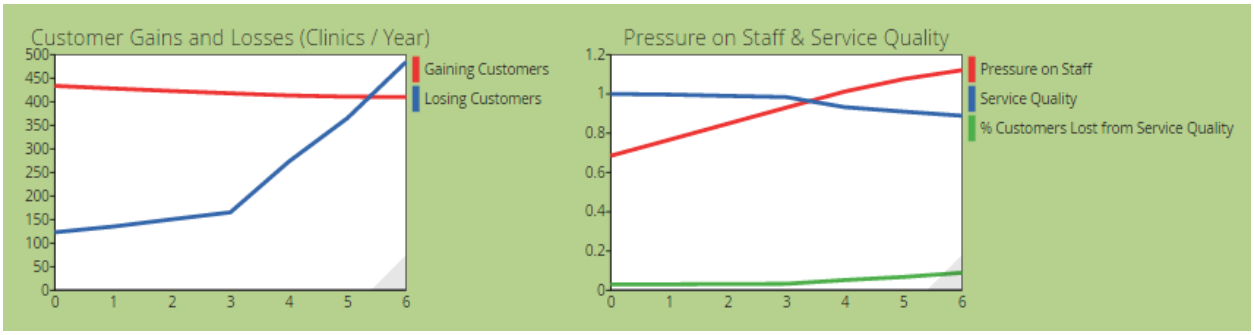


Figure 3 Base Case: Service Quality and Customer Gains and Losses (2015 - 2021)

In the base case of the model (based on projections the company supplied), by year-end 2021 the company receives 1.02 million cases, and surpasses $20 million in net income. They end the year with 94.4 FTE employees, barely under their target of 95. However, the charts of customer gains and losses and service quality above indicate a problem for the company. Because of the increase in cases, pressure on staff reaches a level after year 3 where it causes service quality to drop significantly. These factors cause the percentage of customers lost from service quality to rise above a steady rate of 3% to a rate of 8.9%. By the end of year 6, the company is losing more customers than it is gaining. For these reasons, it is clear that because of the specialists' numbers, the company is not able to handle the growth in number of cases clients send. Following simulations will explore in detail this relationship between different hiring scenarios and performance.

Simulation 2 - Pessimistic Hiring:

We prepared a simulation of a realistic yet pessimistic outcome for the firm, through adjustments to the decision variables used for the base case. These changes reflect the possibility the firm would be unable to meet its goals of hiring in both total specialists as well as the percentage of full time specialists in the coming years. The company's stated goal for the mix of specialists on staff was 50% full time, an increase of 20% from the firm's current situation, so the percentage of full time employees hired in the pessimistic case was conversely

reduced to 10%. We reduced the overall number of hires to 17 from 23, were overall hiring to be more difficult.

Table 2 Pessimistic Simulation Decisions

Pessimistic Simulation #1	Reduced hires	Pessimistic Simulation #2	Hires Constant
Marketing Expense	300000	Marketing Expense	300000
Hire Specialists	17	Hire Specialists	23
% Full Time Hired	0.1	% Full Time Hired	0.1
% Scheduled Hired	0.6	% Scheduled Hired	0.6
% Non-Scheduled Hired	0.3	% Non-Scheduled Hired	0.3
Sales Salary	65,000	Sales Salary	65,000
Sales Force Growth	10.5	Sales Force Growth	10.5

Pessimistic Simulation #1:

The reduction of both overall Specialists hired and the percentage of Full Time Specialists hired resulted in a staff with a significantly lower number of Full Time Equivalent employees from the base case, 66.5 compared to 94.4. This results in a smaller staff that overall is less efficient. This directly affected the firm's growth of cases completed, which led to a drop in total revenue to $58 million, and net income of $13 million. As there was a decrease in hires, in this run, we reduced the costs associated with specialists but it had very little effect on overall operating costs. We show these results in the charts in Figure 4 below.

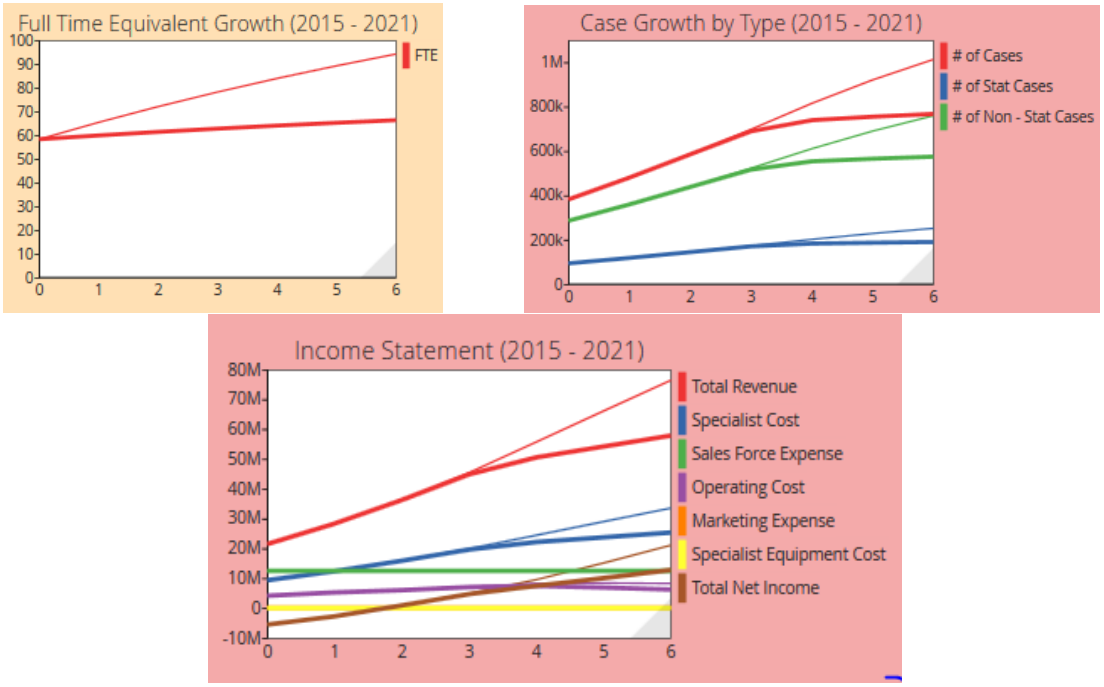


Figure 4 Results of Pessimistic Simulation #1

Pessimistic simulation #2:

In this simulation, new hires were held constant at 23/year while the percentages of hired specialists were reduced. Even though the final staff total was equal to the base case with 192 Specialists employed, there were still significant differences in performance due to the lower percentage of Full Time Equivalent employees hired. The FTE employees totaled 76.6 at year-end of 2021 in simulation #2. This is better than simulation # 1's FTE value of 66.5, but still worse than the base case's 94.4 FTE employees are. The following table shows specific measures of performance in the two pessimistic cases compared with the base case values.

Comparing Pessimistic Outcomes to the Base Case			
	17 Hires with % changes	**Hires Held Constant with % Change**	**Base Case**
Specialists Employed	163	192	192
Full Time Equivalent Employees	66.5	76.6	94.4
Total Cases Handled by Staff / Year	639,000	736,000	906,000
Actual Customers	4,104	4,590	5,420
Total Net Income	$13 Million	$16 Million	$21.3 Million

Table 3 Comparison of Simulation Runs

These findings show that a decrease in the overall number of hires/year would have a large effect on total net income; however, the outcome on performance is more significant if management reduces the percentage of full time specialists hired. This is because the staff as a whole is able to handle fewer cases, which raises pressure on staff, reduces service quality, and increases the number of customers lost.

Simulation 3 - Optimistic Hiring:

In this scenario, we focused on the supply side of customer service. This means that we are trying to have enough specialists on staff so that we can minimize the number of customers leaving. This will allow the company to increase sales through increasing cases from existing customers, rather than focusing primarily on acquiring new customers. To do this we focus on hiring enough specialists to keep service at a constant level. If the service level is constant, clinics will be happy with the service they are receiving, and be more likely to stay. This is especially important in industries like veterinary medicine where the quality of service is very important.

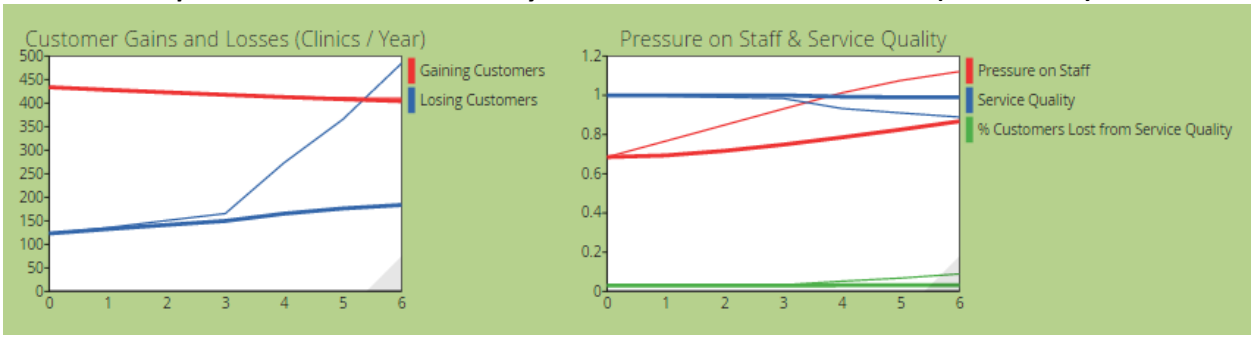
In this scenario, hiring 29 specialists per year results in a more-constant level of service quality. This assumes that the company holds its marketing expense constant at $300,000, and its sales force constant at 150 individuals. Based on communications from the company, these assumptions are realistic, because it does not seem like it is focusing on marketing or sales growth. For this case, we raised the percentage of full time employees hired to 50%, which the company reported is a level of full time employees that would make it ecstatic.

Table 4 shows the decision variables for the optimal hiring case, results for key factors at year-end 2021 (after we ran the optimal hiring case) and supplemental charts.

Decisions		Results (Year End 2021)	
Marketing Expenditure	$300,000	# of Cases	1.08 Million
Hire Specialists	29	Revenue	$81.1 Million
% Full Time Hired	0.5	Total Net Income	$23.2 Million
% Scheduled Hired	0.3	FTE Employees	129
% Non-Scheduled Hired	0.2	Pressure on Staff	0.867
Sales Salary	$65,000	Service Quality	0.99
Sales Force Growth	10.5	Customers Lost	184 (3.2% of actual)
		Market Share (% of NA clinics)	25.70%

Table 4 Decisions for Optimistic Case

Optimistic Case: Service Quality and Customer Gains and Losses (2015 - 2021)



Optimistic Case: Income Statement (2015 - 2021)

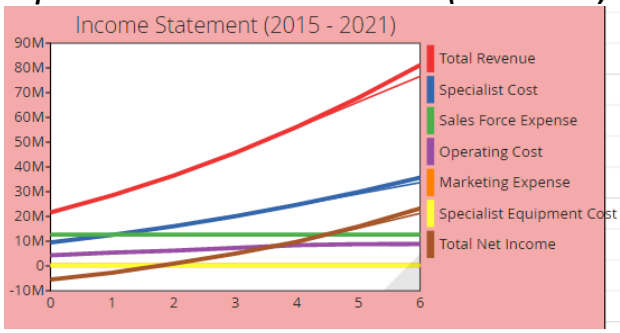


Figure 5 Results of Optimistic Case

The charts in Figure 5 show that by year three the pressure on staff starts increasing due to the increased cases sent by clients. This means that the service quality decrease at the same time.

However, because the company has more specialists on staff, these rates increase and decrease at much lower rates than the base case. Both factors lead to a lower percentage of customers lost from the base case. This helps increase revenues in the last two periods by almost $5 million, which is a significant increase from the base case revenue. However, these decisions do not significantly increase the expenses relative to total revenue. In the long term, these decisions would require increasing the hiring rates of more specialists, which would be hard because there is a limited pool of specialists worldwide. Therefore, the company should focus efforts on its retention and recruiting policies. If the company could improve its retention, it would make hiring more efficient, and slightly reduce the risk of the limited talent pool.

Simulation 4 - Marketing Case

Assumptions

For the marketing case, we decided to delve further into what drives inflows and outflows of clients, and how decisions by the company can affect these flows. The company currently has 4,100 clients, which is the result of investments made in its resources in the past. The company is acutely aware that the overall number of specialists has been growing at a small but steady rate every year. It can only grow as fast as the universities can produce specialists. Without gaining new specialists or entering different telemedicine fields it will be difficult for the company to increase its growth strategy and retain clients.

The company currently invests about $300,000 yearly in marketing, and demonstrates small increases in this budget annually. The company only increases marketing by a small amount of every year because it wants to win customers at a reasonable rate. It seems that the company uses marketing to make the industry aware of their presence, and to teach them about telemedicine and its benefits. The company also uses the sales force to help keep relationships with current and prospective clients. The sales force services different regions where clinics are located and management realigns the regions to make them smaller, so it can more effectively serve the clients. The sales reps have a base salary of $40,000 plus commissions.

If the clients are not satisfied with their service, they could potentially switch to a competitor. These switching costs for the clients are probably low, because the clients do not have to invest in the equipment to perform telemedicine. The monetary loss of a client is probably high to this company, as they invest about $10,000 in training and equipment for each specialist hired to consult for clients. Therefore, client and specialist retention is important.

Marketing simulation #1:

For this simulation, we use the strategic architecture to show how the flow rates depend on management decisions. One of management's decisions we made was to increase the marketing expense, which should increase awareness of the company. To increase the sales staff to win these customers who are now aware of the company from the marketing increase and to increase the sales staff salaries to retain them and keep morale up. Why would the

company do this? Perhaps they want to increase their clients and their market share at a faster rate. Other external factors such as competition could increase, and the company may want to change its growth strategy to match the competition. The goal of this simulation is to show what happens when the company tries to gain more customers without being able to increase specialists.

Decisions	2016	2021	Yearly Increase	Results (Year End 2021)		
Marketing Expense	$325,000	$475,000	$25,000		Base Case	Marketing Run
Hire Specialists	23	23	0	Total Revenue	$76.6m	$81.4m
% Full Time Hired	0.3	0.3	0	Total Net Income	$21.3m	$16.2m
% Scheduled Hired	0.5	0.5	0	Customers Lost	484	889
% Non-Scheduled Hired	0.2	0.2	0	Clinics Gained by Marketing	204	404
Sales Salary	$68,575	$90,025	5.5% or $3,575	Clinics Gained by Sales	206	349
Sales Force Growth	11.5	17.5	1	Pressure on Staff	1.12	1.19
				Operating Cost	$8.42m	$8.95m

Table 5 Marketing Case Decisions and Results

Table 5 shows what happens when the firm increases marketing expenses, sales salary and sales force numbers. The company did not give any figures on increasing sales force salaries but we assume that it will increase these figures as it increases what it charges clients every year.

Total revenue increased and the company gained a larger number of clinics over the base case. This makes sense as the larger investments in resources such as marketing and sales force help drive growth. However, while these figures increased, it was not a good scenario. The amount of clients gained created too much pressure on the staff, which in turn caused the service to clients to decrease. This resulted in clients' being poorly serviced as the specialists could not handle the increase in caseload, and the customers lost increased more than the customers gained did. The increased spending on marketing, sales salaries and hires resulted in significantly increased operating costs. This caused the net income for the company to decrease. To keep up with this growth, management would have to obtain more specialists so that service quality would not suffer. The charts below show various results in pressure on staff, customer gains and losses, revenues, and costs

Figure 6 Results of Marketing Case #1: Service Quality and Customer Gains and Losses (2015 - 2021)

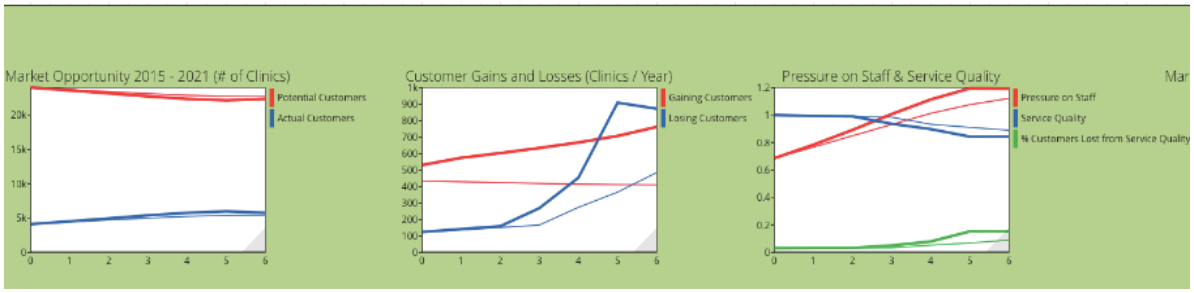
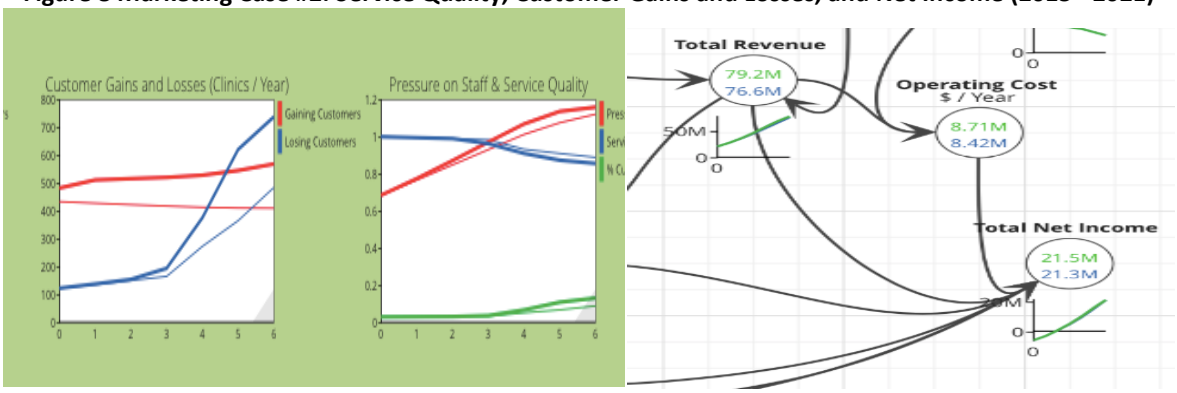


Figure 7 *Marketing Case #1: Revenues, Costs,* and *Income Statement (2015 - 2021)*

In marketing simulation #2, we wanted to use a less aggressive approach towards growth. We decided to not increase the sales salaries, and only increase marketing and the amount of hires to the sales staff. Instead of $25,000 added per year to marketing, we decreased it to $15,000. We decreased the hiring of staff from one to .5 per year. By implementing a less aggressive approach, the company was able to end 2021 with a net profit over the base case. We do not believe that would continue, as the net income should continue to decrease. At first, the company was winning more clients than it was losing, but as in the first case, the pressure on the staff increased enough to cause the customers lost to surpass the customers gained. The company could take this approach if it knew it would have to hire more specialists in the future, so that it could well service the clients gained. This would be tricky and management would have to do it before the clients losses increased too much. Overall, these simulations show that the company would be ill advised to grow too quickly using sales or marketing without investing in more specialists. The following charts show the results of this less aggressive approach to growth through sales and marketing.

Figure 8 Marketing Case #2: Service Quality, Customer Gains and Losses, and Net Income (2015 - 2021)



Conclusions and Recommendations:

The main conclusion we reach from these simulations is that, similar to what Senge (1990) called a “Limits to Growth” systems archetype, the restricted pool of specialists makes this resource the most important factor that relates to performance in the short and long term. The company may be able to find success through incentivizing current scheduled and non-scheduled specialists to transition to full time workloads. The company could achieve this using

incentive programs, better pay and benefits, or striving to create a desirable work culture and environment for these specialists. Additionally, as specialists often work for multiple firms, converting to full time specialists or even from unscheduled to scheduled specialists may result in a decrease in a specialist's desire to take on cases from rival firms. This would be beneficial because it would increase the company's annual case capacity, and decrease competitor's ability to have access to the firm's specialists.

If the company has not already done so, it would be beneficial to reach out to the universities producing specialists to develop relationships with both the programs and students. This could lead to easier hiring, and create a competitive advantage over rivals through the development of a new capability—being able to access and recruit new hires more easily.

It is clear that the veterinary telemedicine industry is limited by the number of specialists who become available every year in this field. This company has a healthy outlook as the industry is expected to continue to grow, and its competitors face the same issues in the available supply of specialists to the market. From the insights gained through the process of modeling the company, we recommend the following actions:

- Focus on creating relationships with universities that produce specialists.
- Try to improve the hiring rate of current specialists through incentive programs.
- Develop incentive programs to persuade scheduled and non-scheduled specialists to switch to full time.
- Pursue greater investments in marketing and sales force only if the company can hire specialists to keep up with the growth.
- Scale this telemedicine model to other specialties in veterinary medicine, to reduce the unique risks created by the lack of specialists in this one specialty.

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