

Dynamic Modeling of Systems and Enterprises

SYS 681 - Midterm Exam

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Question 1: Identifying variables, feedback loops.

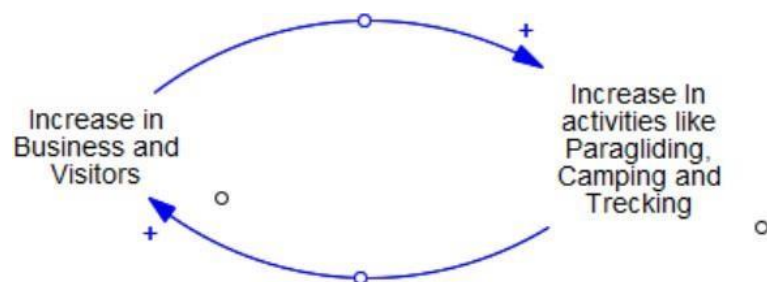
A1- List the major variables that are drivers in growth and expansion of the size and visitors and the business in this mountain. Identify minimum of 5 variables

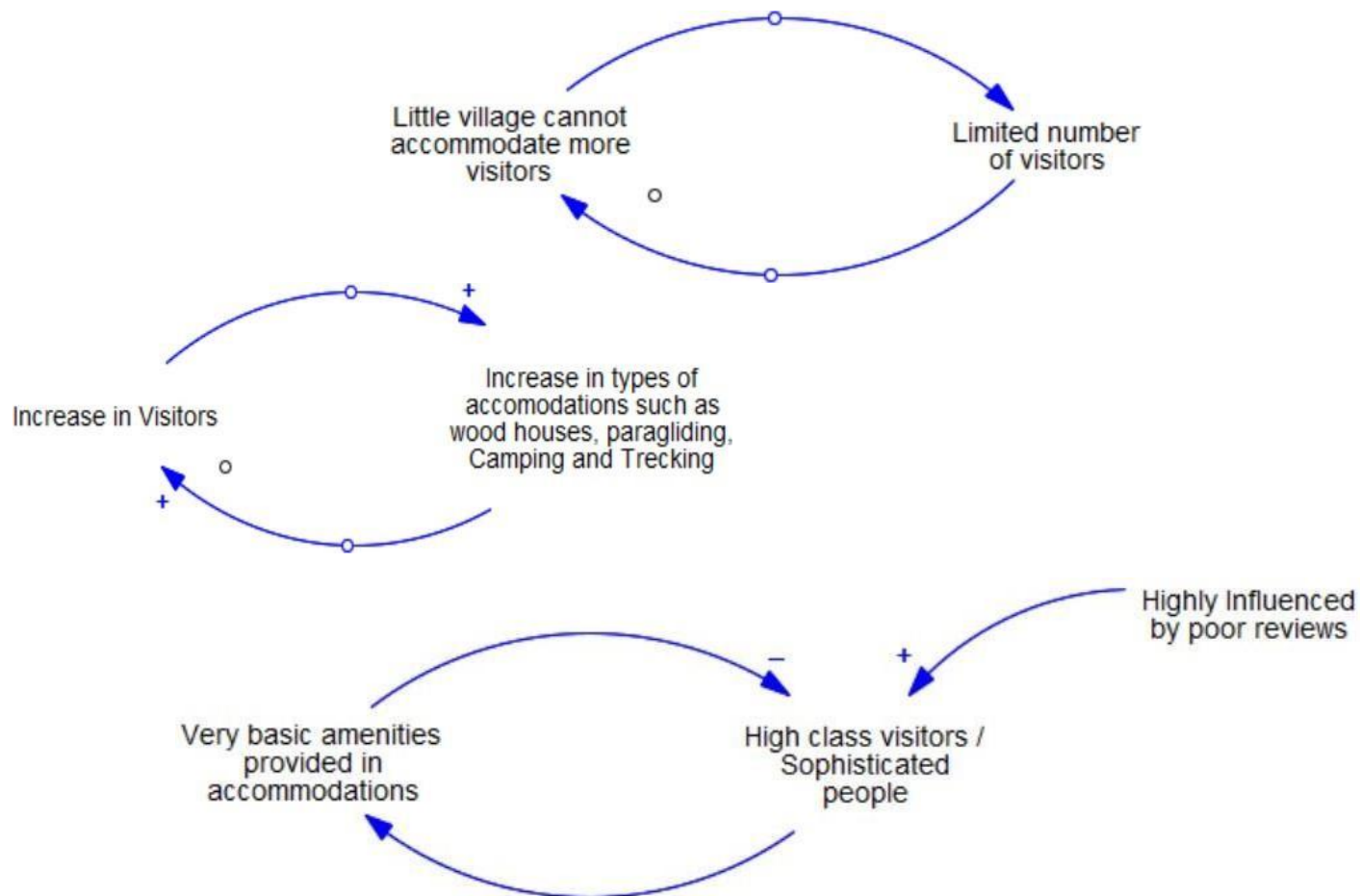
- Visitors can find dining establishments, apartments, hotels, and rental properties.
- Vermont, specifically, is a major lure for the mountain's location.
- The resort's season, which runs from December to April, is another factor that draws lots of visitors.
- The area's surroundings could also be regarded as a driver because they attract lots of tourists.
- There is also the medium-sized mountain, which draws lots of tourists.

A2- List the major variables that cause lower number of visitors to the mountain. Identify minimum of 5 variables

- The mountain is only drawing tourists from the nearby districts because those who have already been there won't come back, which reduces the overall number of visitors.
- Covid-19 has posed a threat, which is one of the main causes.
- The modest size of the ski village is another influencing element.
- The number of thrilling activities that draw visitors to the area is quite small.
- The ski hamlet, which is enclosed by the mountain, is the only place to visit.

A3- Create major reinforcing loops that contribute to the growth of business and more visitors. Create at least 2 reinforcing loops.





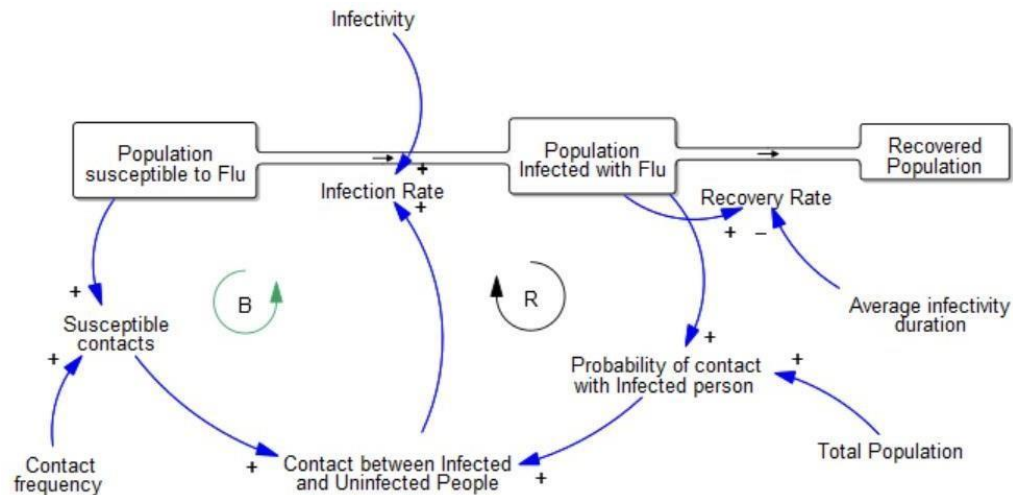
A4- what are some of the balancing loops that contribute to limited visitors to the ski resort? Create at least two balancing loops

A5-Explore the effect of weather on how many visitors snowflake mountain will receive. For example, a of a warm winter with limited snowfall, or a winter with unusually large amount of snowfall

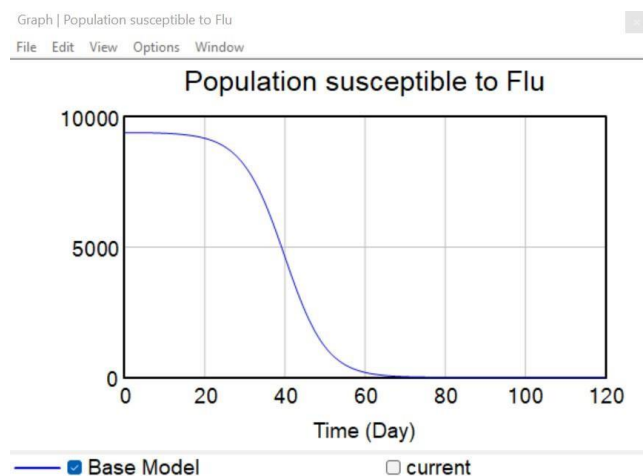
- The Snowflake Mountain receives 3–4 million visitors annually on average.
- If the weather is favorable all winter, there will be a spike in tourists from December to the third week of January, after which there will be a fall because the weather won't be good for skiing.
- If there is an abnormally large quantity of snowfall, visitors will be few to nonexistent from December to the second week of January, and then there will be a small increase in visitors as the winter break will be finished, impacting the significant number of visitors by roughly 40 to 50%.

A6- Explore the effect of Covid-19 on winter sports for winter 2022-2023. How could Covid-19 affect this mountain in this ski season?

- The business of winter sports has been significantly impacted by Covid-19 since 2020. Experts surveyed in November 2020 said that it will take two to three



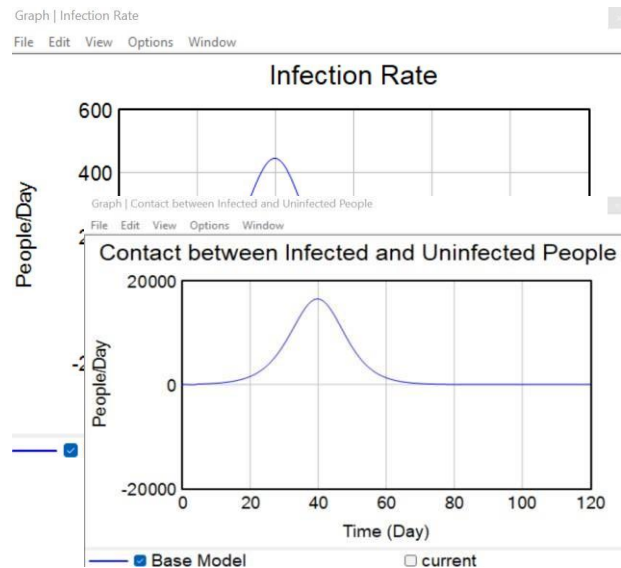
years for winter sports to return to their pre-COVID-19 levels. Starting this year, there will be a dramatic rise in the number of tourists. Yet, Covid-19's impact is still very much felt in the present. Some will therefore want to stay safe as a result.



Question 2: Susceptible, Infected, Recovered (SIR) Model- A hypothetical case of flu for Stevens faculty and student population Winter 2021-2022

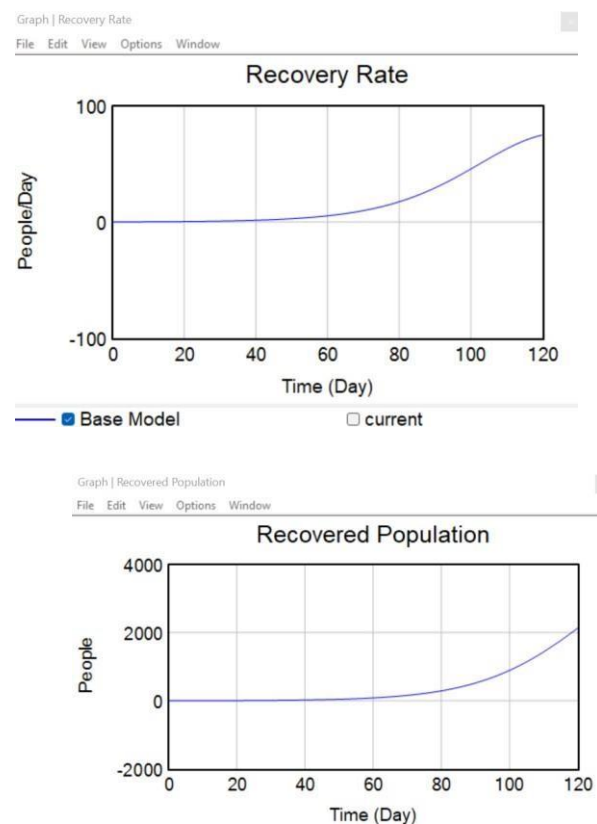
B1-Rebuild and complete the model in Figure 9.5. Run the model and present the major stock and flow results (graphs) and discuss the results you observe for the baseline case model. **Run the model and present the graphs for major variables and discuss their behavior.**

As time, the population that is susceptible to infection declines. We can see from the graph that there were 9400 persons who were at risk for the flu, and that risk gradually declines over time.



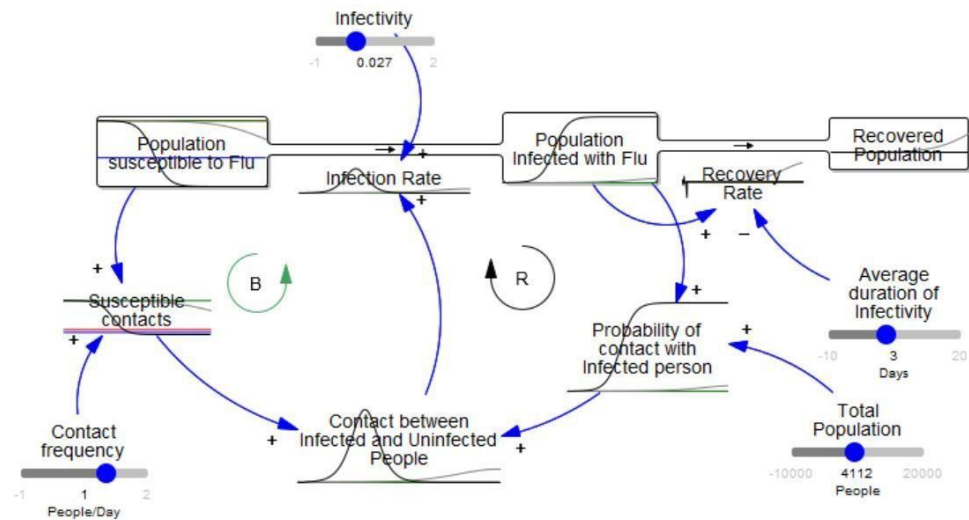
Between 20 and 60 days, the infection rate peaks and then steadily declines. At day forty, the apex is reached.

The surge in interaction between infected and uninfected people for 20 to 60 days is depicted in the graph above.

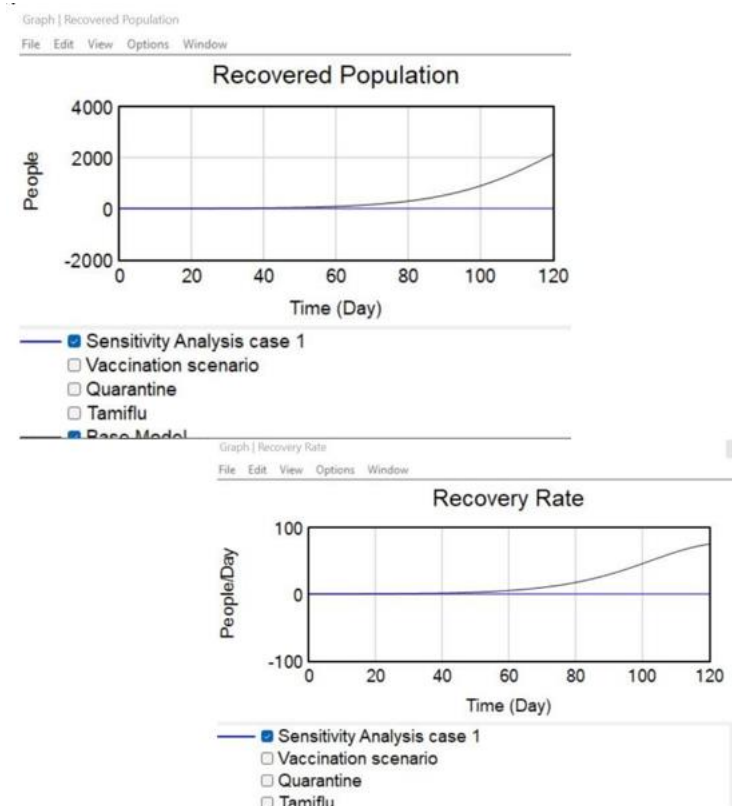


According to the graph above, recovery rates started to rise after 40 days and will continue to do so until the entire population has recovered.

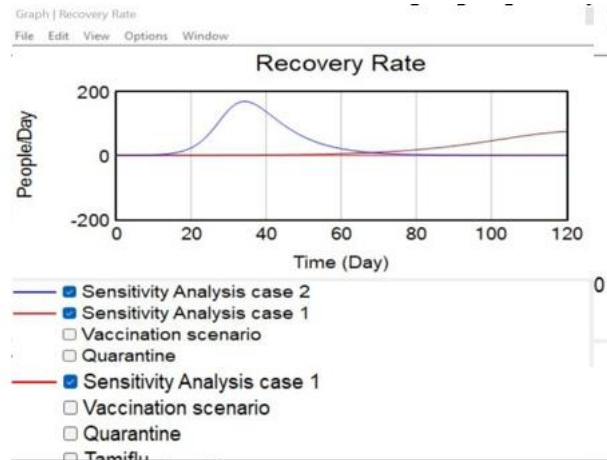
B2- Perform a **sensitivity analysis** on relevant variables by changing the variables based on your chosen granularity, run the model a few times again and **present your graphs in your response**. Don't forget to label the resulting graphs. **Discuss what variables have the highest impact on new strain epidemic.**



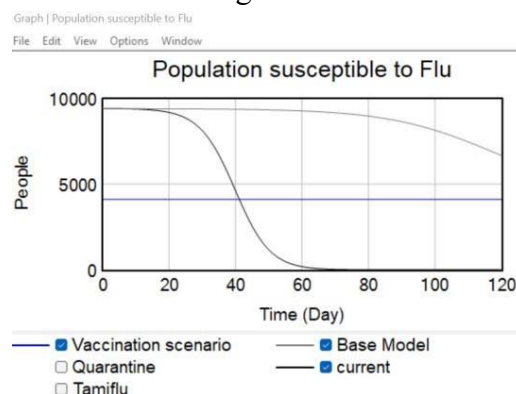
To carry out the sensitivity analysis, variables like contact rate and infectivity can be used. Graphs depicting the changes in the first scenario's infectivity, which is increased from 0.027 to 0.04.



In the second case, the infectivity is kept at 0.04, the contact rate is raised to 10 persons per day, and the results are apparent.



B3- Vaccination scenario: Assuming **75%** of the students, faculty and staff have

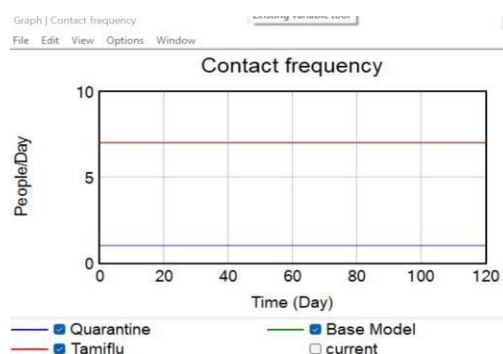


received full bivalent vaccination by October 1st. However, we assume that the bivalent vaccine only protects people against **80%** of the new BF.7, calculate how many people are still vulnerable on campus? Run the model based on this assumption and compare it against the base scenario that no one is vaccinated, and everyone is susceptible.

Although 75% of people have received their vaccinations, there are still 2350 people who are at danger of contracting the flu, but since vaccinations only offer 80% protection, we can say that 75% of those who have had their shots are safe. The remaining 4112 people are therefore still in danger. Run the simulation after setting the population total to 4112.

The graph up top shows how, after the population as a whole changed, the population that was susceptible to the flu changed from the original

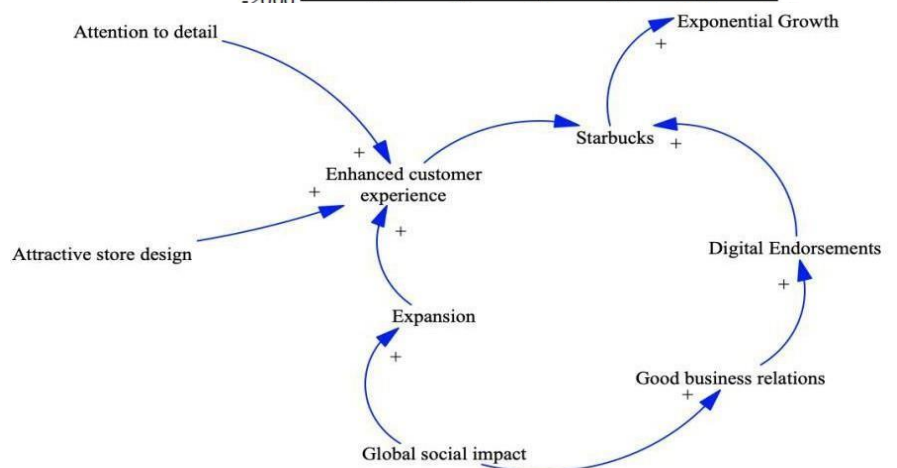
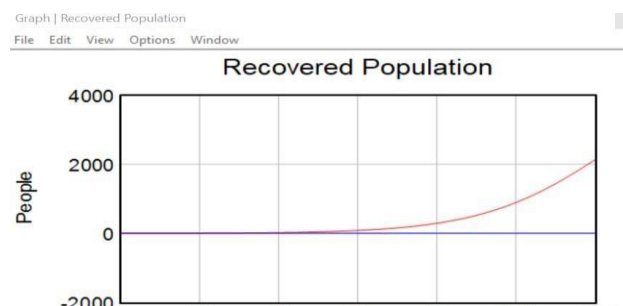
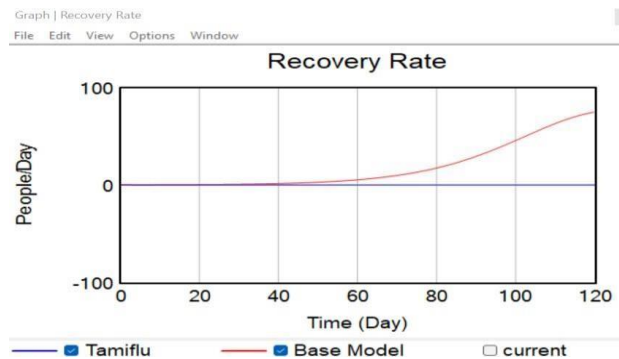
B4- Quarantine scenario: Assume that as soon as the flu is positive, an individual quarantine at home and will have contact rate with **one more person** only. Run the model with this new assumption and compare it against the baseline.



Given that the contact rate is adjusted to one person, the contact frequency in the graph above has been changed from 7 to 1.

B5- Paxlovid Scenario: Assume that upon identification of covid, the students, faculty and staff are prescribed Paxlovid that shortens the duration of infectivity/recovery to 4 days only. How does that affect the model? Present the graphs and discuss the results.

The Paxlovid vaccine helps patients heal more faster and reduces their risk of contracting an infection. The recovery rates and population in the event of the Paxlovid vaccine are shown in the graphs below.

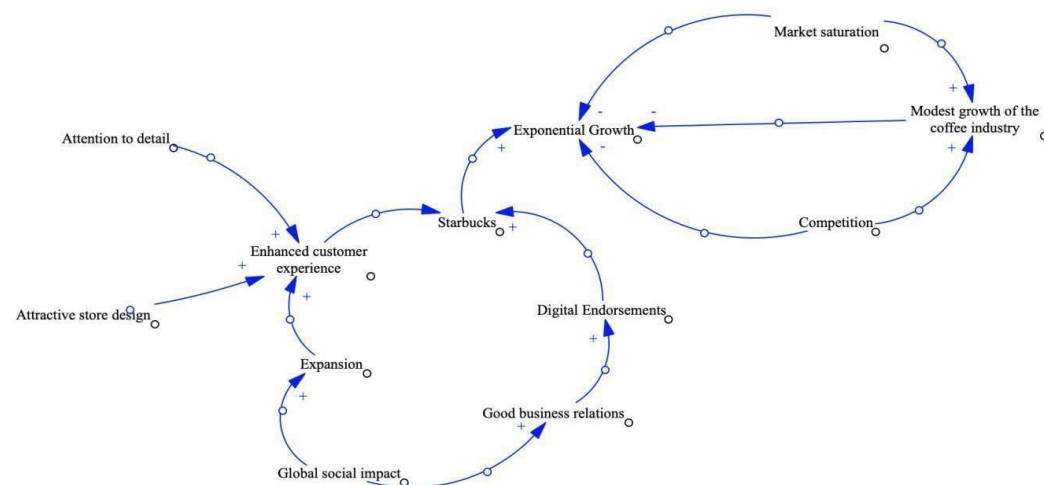


Question 3: Causal links and feedback loops

Identifying the Feedback Structure of Growth and its Limits- Starbucks Company

C1. Identify the positive feedback loops responsible for the exponential growth of Starbucks in general in past two decades (see figure above). Develop a causal loop diagram capturing the positive feedback that you identify. Provide a very short explanation of the meaning or operation of each loop.

- **Attractive store design** - a rise in customer happiness brought on by enticing establishments that mimic the style of the hit movie Charlie and the Chocolate Factory (Willy Wonka's candy factory).
- **Expansion** - The company has experienced its quickest growth in the previous ten years as a result of Starbucks expanding its location network. Due to the brand's growth in China, which boasts the world's largest population of coffee drinkers, consumer interest in the product has increased.
- **Global social impact** - One of the primary factors fueling Starbucks' exponential growth is the company's social impact on the world at large. For instance, they banned plastic straws as a "green" measure. They recently disclosed that they are developing a greener cup and have allocated \$10



million to the effort.

- **Good business relations with farmers** - Starbucks takes pride in developing close relationships with farmers who provide its customers with the highest-quality arabica coffee. To do this, they provide farmers with distinctive training in coffee farming, as well as up to \$50 million in low-interest loans for growers and support for farmers who are impacted by climate change.

C2. No real quantity can grow forever. Identify some of the negative feedbacks that might eventually stop and slow down the growth. Add them to your causal diagram. Limit yourself to 3 negative feedback loops. Provide a very short explanation of the meaning or operation of each loop.

Market Saturation – As it has grown so significantly in such a short amount of time, Starbucks has had trouble becoming a significant brand. Thus, it has become difficult to keep the brand relevant.

Competition - To give customers authentic experiences, creative coffee shops are coming up with novel ideas. Starbucks' public image has changed. Like it came from McDonald's.

The other new coffee businesses capitalize on Starbucks' ubiquity.

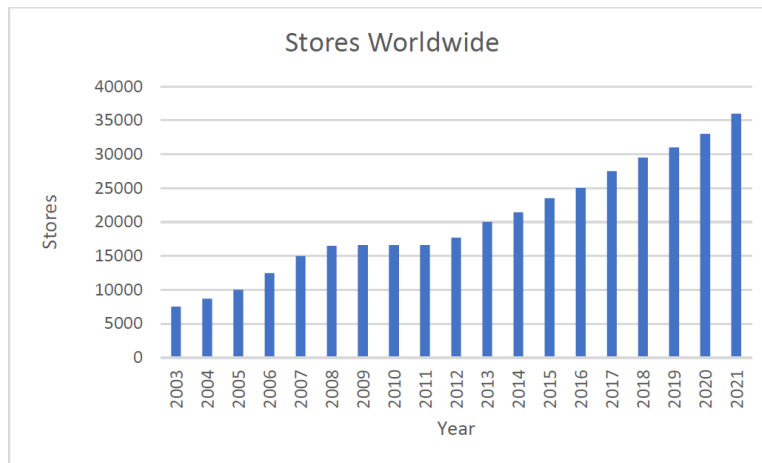
Modest growth of the coffee industry- The coffee industry has only had very slight growth in recent years. Due to this, Starbucks' company has also progressively expanded.

C3. Now given the base conceptual model you built, what could happen to the growth of Starbucks, given the Starbucks reserve concept? Specifically, what patterns of development are likely (optimistic and pessimistic scenarios)? Draw a graph showing possible trajectories for the number of stores or market share. Select an appropriate time horizon and explain your choice briefly.

The Roastery and Reserve locations, in contrast to normal Starbucks shops, are meant to provide a much more immersive experience. They're not just a brief pit stop on your way to work, nor are they just a drive-through place you pass by when your kid nods out in the backseat. They are a goal in theory, and Starbucks acknowledges the significance of this differentiation in a nation with so many locations. As opposed to regular Starbucks shops, these cutting-edge designs will also approach food differently. Crisp pastries and bread will be made nearby. Because of this, it will be necessary to have a specialized staff that only works on these kinds of meals, which means the renowned baristas will work alongside a team of chefs. Additionally, the New York Roastery, for instance, will include a 45-foot bar where patrons can purchase wine, lager, and mixed drinks, suggesting that these cafes will be more than just meeting places for morning or evening shots in the arm. The business intends to open 12,000 more locations by 2021, the majority of which will be in its two biggest countries, the US and China. In any case, you might find traces of this new system even in your favorite local Starbucks. During the next five years, it wants to introduce "Reserve Bars" to 20% of its conventional cafés, bringing some of the opulence associated with the Reserve brand to those locations.

Although the Starbucks Reserve location may seem more premium, it is also more expensive than the city's normal stores. The conventional shop is preferred by regular folks who only want a cup of coffee because it is less expensive. On the other side, Reserve outlets offer a full restaurant or bar experience in addition to coffee. Young people would be drawn to this novel idea, and it might eventually develop into a new party location where the production process is displayed for entertainment.

Starbucks kept adding additional outlets even though the market was fully developed. In 2007, Starbucks had 15,000 outlets worldwide, and by the end of 2019, that number had risen to nearly 30,000. The growth of retailers slowed or reached saturation between 2008 and 2012. The graph below shows that growth has been sharply accelerating since 2013.



Starbucks has a sizable 10.5 percent of the restaurant sector. Starbucks has some impressive statistics:

- Controls 39.8% of the US coffee market and generates \$24,72 billion worldwide.
- There are 29,324 stores in 72 nations.
- The United States has over 14,000 cafés, and there are over 27,000 worldwide.
- Weekly transaction volume exceeds 90 million
- A new location opens up every 15 hours in China due to how well-liked it is.

Optimistic scenario - Starbucks is essentially bringing something new to the table with its strategic choice to enter the premium coffee industry. This should significantly boost Starbucks' growth

since, unlike other Exclusive Coffee Boutiques, Starbucks aims to offer its customers not only delicious coffee but also an entire novel and exciting experience to go along with it. This experience.

informed their approach to design for the new Starbucks Reserve locations, which pay great attention to the smallest details in their décor. Already, interest in this idea is growing.

Pessimistic scenario - Starbucks aims to join the premium coffee industry may face some difficulties. The farmers of these rare coffee beans will be the most challenging obstacle they will encounter. Because the farmers have a long-standing commercial relationship with boutique businesses that have been providing special coffee to their clients for a long time. As a result, these growers may be unable to sell their limited- edition coffee to major retailers such as Starbucks. Another difficulty will be the scarcity of such coffee beans. Because it grows in a set season and is heavily dependent on uncontrollable elements like rainfall, their supply cannot be copious.

C4. Starbucks is planning to phase out its disposable cups by 2025: <https://www.cnn.com/2022/03/15/business-food/starbucks-cup-sustainability/index.html>

The plan is to use reusable cups, bring your own mug, or pay a deposit on store mugs to be more environmentally friendly. From a system dynamics

point of view, how does this company's policy affect the long-term sales and growth?

Because Starbucks historically has a high-cost range due to rising coffee and salary prices, this choice will have an impact on sales. So, this policy may make the clients feel pretty

uncomfortable.

However, Starbucks' market in the USA has already reached saturation, so this new policy won't result in much growth.