



WPI

Implementation of a Rural Diabetes Model

A Major Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Abstract

Diabetes affects millions of Americans; those living in rural areas face unique challenges including transportation and food deserts. Organizations like Stability Health have created virtual care models to reach these patients and improve disease management. Partnering with Stability Health and HealthInfoNet, we conducted case studies of Maine to analyze demand and supply to determine areas that were the best fit for Stability Health's model. By repeating our methodology in other areas, Stability Health can identify new markets with the most opportunity.

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Introduction

Diabetes is an extremely prevalent disease in the United States. It affects about 1 in 10 people, totaling to more than 30 million cases. Approximately 1 in 3 US citizens have prediabetes, and 9 out of 10 people with prediabetes do not even know they have it. The diabetes epidemic continues to grow. Every 19 seconds someone is diagnosed with the disease. With diagnosis comes the possibility of developing major complications that can progress. One of those complications is retinopathy (Cleveland Clinic, 2015). As a result, diabetes is the leading cause of blindness in adults. The disease can also have macrovascular complications which can lead to cardiovascular events like stroke and heart attack. In addition, diabetes is the leading cause of end-stage renal disease in adults through a condition called diabetic nephropathy. This can cause them to have to go on dialysis, negatively impacting their quality of life.

While not all diabetic patients face major complications, they all must take daily steps to manage and treat the disease. This treatment can require insulin injections multiple times a day and medications patients must remember to take. People with diabetes need to monitor and keep reliable records of their blood glucose levels, watch their diet, and try to fit exercise into their everyday routines (American Diabetes Association). Regular doctor's visits and lab tests are recommended based on a person's treatment method. Though there are common treatments that work for many patients, the way to treat diabetes is not a one size fits all model. The most effective treatment can be unique to every patient (University of Utah Health, 2020).

One of the most powerful preventions to reduce diabetes complications is proper patient education. Because diabetes is a disease that is mainly managed by the patient, it is imperative for health professionals to ensure patients know exactly how to manage their conditions. In the 1970s, health professionals established more educational opportunities for diabetes education (Turnbull, 2015). These opportunities included training in self-monitoring, insulin regulation, nutrition education, and other important topics. Although these resources are available, many people are not offered education specific to their condition upon being diagnosed. There is a lack of diabetes education offered to patients, especially in more rural areas where there are fewer endocrinologists (Rosenberg, 2019).

Rural areas have a 17% higher diabetes rate than urban areas (RHlhub), largely due to the fact that rural areas are associated with lifestyle behaviors that can lead to diabetes and obesity. It is also inherently harder for those living in rural settings to manage their diabetes. Access to care is hindered by lack of transportation and ability to take time off from work and food deserts are more common in rural areas making it difficult to eat right to manage the disease.

In order to better serve rural communities, telehealth has emerged as a possible alternative. Stability Health (SH) is a digital diabetes care management company that improves diabetes care through online interactions with the participant. SH attempts to remedy the shortage of endocrinologists by using their own endocrinologists as advisors and health coaches. This allows their participants to access care without leaving home. This scalability can address

demand for care in rural areas where visiting an in-person endocrinologist may not be an option. SH currently partners with payers in order to enroll participants eligible for the program.

The primary objective of this project was to analyze the potential opportunity for implementing SH's current model and system into rural areas, specifically in the state of Maine. We accomplished this by focusing our project in four unique areas: understanding demand, understanding supply, understanding how SH can fill gaps in matching demand for diabetes care with service, and analyzing opportunities for entry. By accomplishing these objectives, our group was able to assess the opportunity regarding implementing SH's model in Maine, including making recommendations and identifying barriers to entry.

According to the 2010 US Census Maine is the most rural state in the country with 62% of its residents living in rural areas. In general, Maine's most rural counties are the counties that are struggling with diabetes care the most according to data gathered by the Maine CDC. The most rural areas of Maine have the most diabetes-related deaths, inpatient hospitalizations and ER visits. The rural areas in Maine also have the lowest primary care provider representation and are the least insured. Although the rural areas in Maine struggle the most with diabetes care, the incidence of diabetes is consistent throughout the state. Maine has a number of endocrinology and diabetes care center locations across the state, but the majority of these centers are located in the most populated part of the state. This suggests diabetes care in the rural areas of Maine can be improved, which is one reason Maine was a focus for the project. In addition, HealthInfoNet (HIN) is a health information technology company that serves Maine's healthcare communities. Their data is fully integrated into the systems' EMRs and updates in real time. The data and relationships HIN possesses is integral to the ability to scale SH's model.

This report is organized into 7 additional chapters; Introduction, Background, Literature Review, Methods, Findings and Discussion, and Analyzing Opportunity and Recommendations. The report begins by giving a detailed description of what diabetes is, how diabetes should be treated, relevant factors that are important in analyzing the issue of treating diabetes in Maine, and the sponsors of the project. Next, four separate topics of diabetes care are discussed in the literature review to examine how the sponsor fills care gaps with their model and how they can help reduce costs in diabetes care. After this, the methods we used to analyze the problem are described followed by the findings and discussion of these methods. Lastly, we predict what the opportunity is for the sponsor to serve rural markets and provide them with a recommendation on how they should proceed with implementing their model into the rural areas of Maine.

Chapter 1: Background

In order to fully understand the implementation of Stability Health's model into the rural areas of Maine, one must have a background on what diabetes is, what the diabetes standard of care is, and specifically how diabetes affects the state of Maine. In doing so, Stability Health's goal is revealed along with how HealthInfoNet provides support using their information technology. Lastly, it is crucial to see how rural health plays a role in how patients receive health care and how living in these areas can be detrimental to how patients stay in control of their diabetes.

I. Diabetes

Diabetes Mellitus (DM) is a chronic condition that occurs when a person has a relative or absolute insulin deficiency, causing them to have high blood sugar. An absolute insulin deficiency is classified as Type 1 diabetes. Type 1 diabetes occurs in only about 5% of diabetes cases and is an autoimmune condition that mainly affects children. The most common type of Diabetes Mellitus, however, is Type 2 diabetes. A patient's condition is classified as Type 2 when they have a relative insulin deficiency. This occurs in approximately 95% of diabetes cases. A relative deficiency in insulin means the patient produces insulin but cannot get it to the necessary receptors (Stability Health Internal Document, 2020). Though, currently, there is no definite known cause for Type 2 diabetes, it has been found that certain environmental influences such as pesticides and plastics could play a role in its development (Diabetes UK).

In addition to Type 1 and Type 2 diabetes, there are other rare types of the disease. One rare classification of diabetes is Maturity Onset Diabetes of the Young or MODY. MODY occurs genetically and is caused by a single mutation in a specific gene. Those with the particular gene develop MODY by age 25. Another rare form is Neonatal diabetes. Neonatal Diabetes is typically diagnosed in children under the age of 6 months. Wolfram Syndrome, also called DIDMOAD, is a rare genetic disorder and another rare form of diabetes as well. It is known as DIDMOAD because of the combination of its four main features (in order) of Diabetes Insipidus, Diabetes Mellitus, Optic Atrophy, and Deafness (Diabetes UK).

Alström Syndrome is another rare form of Diabetes Mellitus is a syndrome that is carried down through a person's genes. The rare condition, LADA or Latent Autoimmune Diabetes in Adults, is what seems to be a combination of Type 1 and Type 2 diabetes. Because of this, LADA is also referred to as Type 1.5 diabetes. In addition, Type 3c diabetes is a rare form of diabetes that takes place when a person's pancreas is damaged by a separate disease. Often, pancreatitis, pancreatic cancer, haemochromatosis, and cystic fibrosis are the diseases that can ultimately result in 3c diabetes. Finally, those who consume steroids are at risk for the rare condition of Steroid-Induced diabetes (Diabetes UK).

Approximately thirty-four million people have diabetes in the United States, and 1 in 4 people with diabetes are not even aware they have it. 84.1 million people have prediabetes, and 9 out of 10 do not know they have it. Numerous complications that negatively impact people and their quality of life. In America, diabetes causes more death each year than AIDS and breast

cancer combined. Every year, 50,000 Americans develop kidney failure due to their diabetes. Every 2 minutes, diabetes causes an adult to have a stroke and become hospitalized, and every 80 seconds, an adult must be hospitalized for heart failure due to diabetes as well (Stability Health Internal Document, 2020).

Severe microvascular complications can occur and progress due to diabetes include: retinopathy, nephropathy, and neuropathy. Retinopathy, also known as eye disease, is the main reason diabetes patients should see an eye doctor or ophthalmologist on a routine basis. Symptoms in a diabetic person that can be a reason for alarm in regard to developing retinopathy are blind spots, blurry vision, or any known eye disease. Because of the complication of retinopathy, diabetes is the leading cause of blindness in adults. Diabetic women who are pregnant should take extra precautions in protecting themselves from this complication by having eye examinations throughout their pregnancy. Another major concern, diabetic nephropathy, known as kidney disease, is the leading cause of end stage renal disease. The nephropathy complication is monitored through annual urine tests. Routine blood pressure checks are also important for diabetes patients to complete to control any hypertension and slow down the development of kidney disease. Diabetes patients should watch out for the symptoms of consistent foot or leg swelling. Lastly, is the microvascular complication of diabetic neuropathy. Neuropathy is nerve disease and is the leading cause of lower extremity amputations that are non-traumatic. To help protect themselves, diabetes patients should look out for burning, tingling, or numbness feelings in their feet. This can also be monitored by observing their feet for signs of unusual calluses, redness, or cracks in their skin. The common macrovascular complications for diabetes patients include stroke and cardiovascular disease as previously mentioned before as well (Stability Health Internal Document, 2020 & Diabetes UK).

One component to treating Diabetes Mellitus is through the patient's intake of insulin. Insulin was first discovered by Sir Frederick G. Banting, MD, in 1920. A patient can receive their necessary daily dose of insulin several ways. This includes insulin injections, through an insulin pump, or even through the consumption of pills. Oral medications can help the body to increase their own production of Insulin or even help decrease the amount of insulin needed. As technology advances, new ways to receive insulin and treat diabetes in general advances as well (Stability Health Internal Document, 2020). Though technological advances in the medical and healthcare industries are often positive breakthroughs, with new technology comes new complications. Patients must adapt to learn how to use the tools they need on a daily basis to survive and remain in good health.

Though insulin plays a major role in diabetes treatment and controlling the disease, it is hardly ever that simple. Often, an entire team of people can be necessary for a patient to receive the best care possible for them and to truly tackle diabetes from all aspects. A diabetes care team could consist of a primary care provider, an endocrinologist, an ophthalmologist, a podiatrist, a pharmacist, a dentist, a registered nurse, a registered dietitian, a certified diabetes educator, a fitness professional, and a mental health professional. The necessary personnel a diabetes care team consists of, however, is specific to every patient (American Diabetes Association).

There are several reasons why a diabetes patient may want to stray from seeing their primary care provider for managing their diabetes and switch to an endocrinologist. Sometimes, a primary care provider may directly recommend a patient switch to an endocrinologist to receive specialized care. Other times, a primary care doctor may have limited experience treating diabetes and not feel they are the best fit because of that lack of experience. From a patient's perspective, they may feel their primary care provider is difficult to communicate with concerning their diabetes care, or the patient may feel like they are not receiving the proper educational material to help self-manage their diabetes. Other reasons to switch to an endocrinologist could be diabetic complications for a patient, their treatment is too complex, or their treatment is not working. Sometimes patients would like to participate in research and new studies for diabetic treatments and an endocrinologist could be the best person to see regarding those opportunities as well (University of Utah Health, 2020).

With diabetes comes a significant cost. The economic impact diabetes has is even greater in cases where it is poorly managed. In total, diabetes costs \$237 billion directly through doctor's office visits (13%), medications (30%), supplies (15%), hospital care (30%), and other factors (12%). There is a great cost for the reduced productivity that results from the current diabetes care that exists. In total, a loss in productivity from diabetes costs \$89.9 billion. Factors that play into this are reduced productivity days (\$2.3 billion), workdays absent (\$3.3 billion), mortality (\$19.9 billion), reduced work performance (\$26.9 billion), and reduced labor force (\$37.5 billion) (Stability Health Internal Document, 2020).

II. Diabetes Standard of Care

The Diabetes Standard of Care documents the American Diabetes Association's (ADA) recommendations for clinical practice, necessary components for diabetes care, treatment guidelines and goals to adhere to, as well as ways to determine the quality of a patient's care. The Diabetes Standard of Care is typically revised and updated on a yearly basis, making changes where see fit based on new advances in technology and a better understanding of the disease; however, updates to the standards of care can be made at times where revisions are necessary. The members of the ADA's Professional Practice Committee are the ones responsible for making these changes.

Diabetes can be categorized into four main groups. Type 1 diabetes is an autoimmune disease that affects between 5-10% of all people with diabetes. Type 2 diabetes occurs when a person's body does not use insulin correctly and cannot control blood sugar levels. Gestational diabetes happens during pregnancy for some women who have not been previously diagnosed with diabetes. The fourth and final group is diabetes by alternative causes which can result due to several different reasons.

In addition, prediabetes is another factor to the disease. Though it does not qualify as diabetes, prediabetes affects more than 1 in 3 adults in the United States. Prediabetes means a person has abnormally high blood sugar levels, putting them at an increased risk for stroke, type 2 diabetes, and heart disease. (CDC, 2020)

With different types of diabetes comes a plethora of different methods for managing them. According to the American Diabetes Association, managing diabetes should include a healthy diet, proper exercise, and emotional and medical support when needed. For type 1 diabetes specifically, living with and managing the disease requires insulin injections to supplement the fact that insulin is not being produced by the pancreas. Insulin can be administered through a pen, a pump, or a syringe. Essential management and treatment options for people with type 1 diabetes are:

- Insulin
- Monitoring of blood glucose levels
- Exercise
- Healthy diet
- Work with a diabetes care team (if needed)

For type 2 diabetes, a person's body either makes inadequate amounts of insulin or does not use its insulin properly. This makes a person's body unable to use glucose for energy and that can result in the major problem of glucose staying in that person's blood. Care for type 2 diabetes includes:

- Healthy diet
- Exercise
- Medicine

Medicines may consist of pills and insulin, or just insulin alone, depending on what the patient's doctor prescribes and feels will work best for the individual. (American Diabetes Association)

For gestational diabetes, screening and testing for the disease typically occur during the second trimester (between weeks 24 and 28) of a woman's pregnancy. High risk patients can be classified as women who are obese or overweight before pregnancy, as well as women who have a family history of diabetes. This may cause a doctor to test for gestational diabetes earlier on in the pregnancy to help better manage it. Women at risk of gestational diabetes also have a higher risk of developing type 2 diabetes post pregnancy and could require additional PCP monitoring. The screening for gestational diabetes consists of an initial glucose challenge test, followed by a follow-up glucose tolerance test. If it is concluded that a patient does have gestational diabetes, treatment for the disease can consist of:

- Medicine
- Lifestyle changes
- Healthy diet
- Monitoring of blood glucose levels

In order to better ensure the baby's health, it is critical women with gestational diabetes pay close attention to monitoring it and controlling it. Doing so, can help prevent further complications during the pregnancy all together. (Mayo Clinic, 2020)

III. Maine Healthcare

According to the 2010 US census report Maine is the most rural state in the country with 61.3% of the population living in rural areas. Maine only has three areas that are considered urban, specifically Portland, Bangor and Augusta. The most rural counties in Maine are currently the counties that are struggling with healthcare and in particular diabetes care. These areas in Maine also have most diabetes related deaths, inpatient hospitalizations and ER visits. There are a number of reasons for why the rural counties in Maine struggle with diabetes care but one of the most glaring is the lack of endocrinology and diabetes care centers available in these rural areas.

There are two large hospital systems that operate in Maine, Northern Light Health and MaineHealth. There are also a number of smaller independent hospitals that are scattered throughout Maine. The hospitals and healthcare centers in Maine are in the urban areas and the areas with the highest concentration of rural population. Of these hospitals and healthcare centers, fewer than 30 of them offer designated endocrinology and diabetes care programs. The lack of endocrinology and diabetes care centers in rural areas makes it harder for the rural population to get the diabetes care they need. Figure 1 shows where endocrinology centers are located across Maine and where the most rural areas in Maine are (US Census, 2010). Figure 2 shows data from the Maine CDC that highlights which counties have the highest percentages of population with diabetes and prediabetes (Maine CDC, 2016).

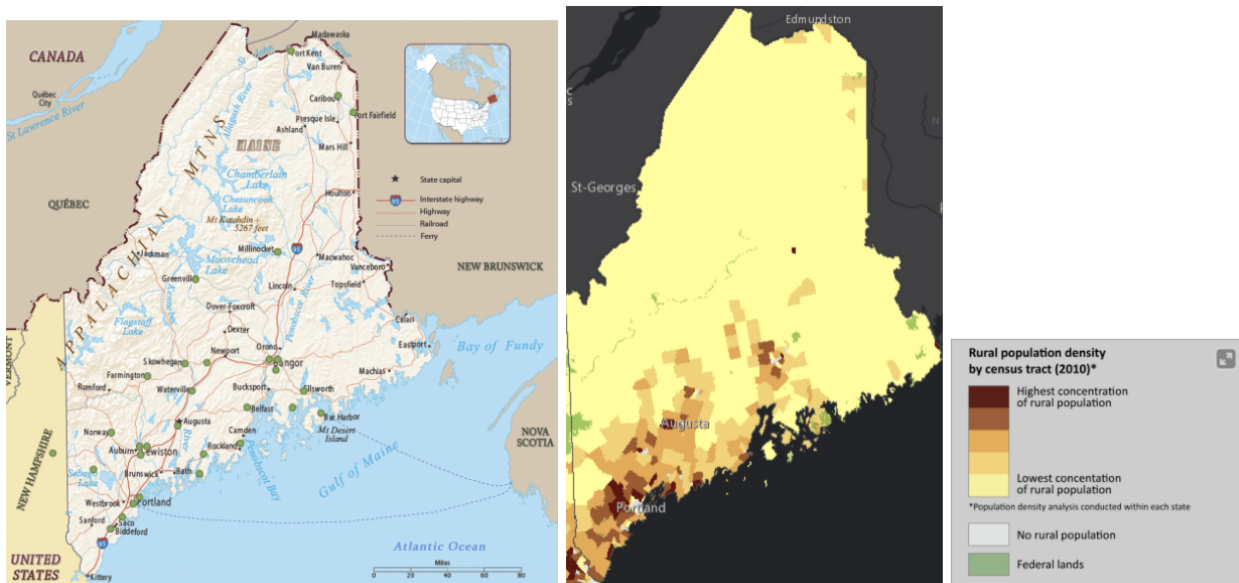


Figure 1: The locations of endocrinologist centers in Maine and the population density of Maine

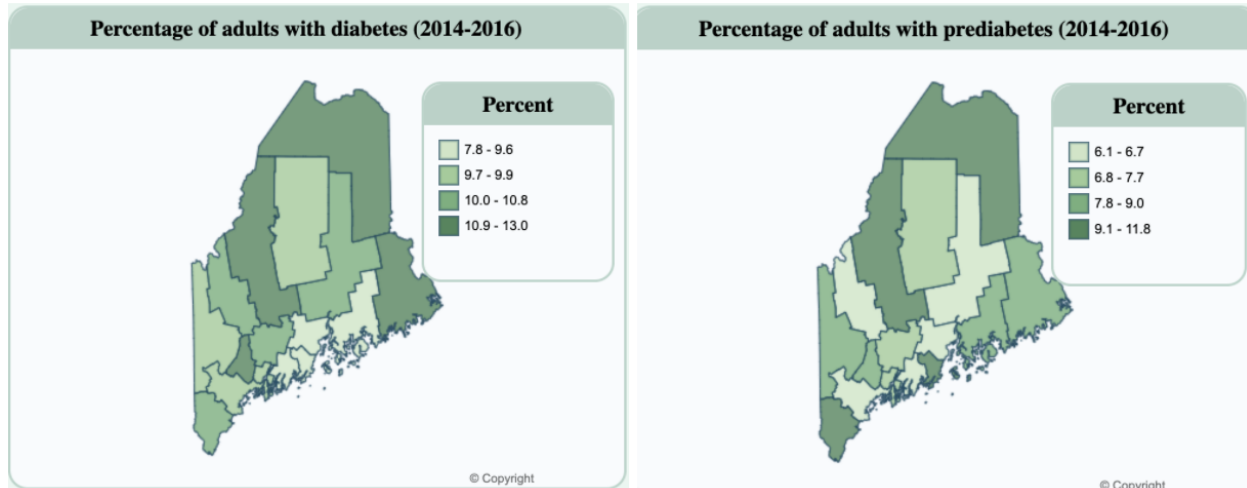


Figure 2: The percentage of adults with diabetes and percentage of adults with prediabetes by county in Maine

IV. Stability Health

Stability Health (SH) is a telehealth diabetes care management company whose mission is to “improve the lives of people with diabetes.” Their unique model fills the gaps of the current diabetes care system. SH currently partners with employers and recruits participants using claims data. Their entirely virtual model makes scaling to all geographies realistic, including rural areas. The company employees include endocrinologists, certified diabetes care educators, a director of administration, a chief development officer, and a chief executive officer. The Medical Advisory Board consists of globally recognized leaders in the field of diabetes care and delivery (Stability Health Internal Document, 2020).

SH prides themselves on filling the gaps of diabetes care by providing support to both patients and providers. “Our comprehensive and personalized digital solution enhances the current system of care bringing more expertise to clinicians and empowering patients with the tools and support they need to better manage their disease.” (Stability Health Internal Document). SH provides a tech-enabled support system model that provides analytics, diabetes expertise, a patient support mobile app, registry care plans, and patient monitoring. SH uses what is known as StablePath Analytics, or their “rules engine”, in order to claim data analysis and stratify risk. The platform links important elements of care delivery together to create consistency and scalability. SH’s platform provides care standards supported by the rules engine and an expert care team. Furthermore, they provide a registry of care plan automation and communication systems to improve utilization of their system. Patients that use SH have access to a mobile app that provides support as well as engagement. Overall, SH’s services provide a deeper dive on comprehensive connection using personalized enrollment, metabolic care perspectives, and empathetic understanding. They also provide relevant engagement with a personal coach, guided goal setting, continuous communication, and lifelong skills development. SH uses a comprehensive assessment, an individualized care plan, impactful education, and adaptive support to provide expert solutions for their consumers. They practice proactive

monitoring with their connected devices, social determinants, and analytics. Lastly, they use clinical collaboration with the help of clinician team partnering, delivery of interim care information, and intervention management. Figure 3 shows how SH operationalizes their model using specific processes from enrollment to intervention management (Stability Health Internal Document, 2020).

1. Comprehensive Assessment

The first step of SH's model is the comprehensive assessment. This takes place after a patient is enrolled, and consists of a phone conversation between the patient and a SH health coach. The patient's vitals are explored and analyzed by both their health coach to get a better understanding of the patient and by the patient to get a better understanding of the program. The assessment also serves as a means to develop rapport between the patient and the health coach. The assessment is used as the basis of the creation of the Care Plan.

2. Personalized Care Plan

Each Stability Health participant is given a custom care plan to follow. The care plan is developed from the outcome of the assessment. The patient's information is uploaded into SH's proprietary rules engine. The rules engine provides recommendations for the care plan including diet and exercise goals. The care plan is then reviewed and approved by both the SH health coach and SH endocrinologist. It is sent to the patient's diabetes care practitioner (DCP) as well, so they are aware of patient progress.

3. Care Support and Engagement

From our literature review, we identified patient engagement as a powerful predictor in the success rate of patient outcomes. SH's ongoing care support and engagement through check-ins with health coaches is the backbone of the model. By keeping patients engaged between DCP appointments, SH health coaches are able to motivate patients as well as track their successes and struggles.

4. Intervention Management

If patients experience vitals such as blood pressure or A1c out of control, alerts are sent to their DCP so they can be managed immediately. Device tracking and a mobile app are still in developing phases but will soon make it so SH can provide even more immediate assistance. Intervention can help patients achieve better outcomes and quality of life.

How We Operationalize Our Model

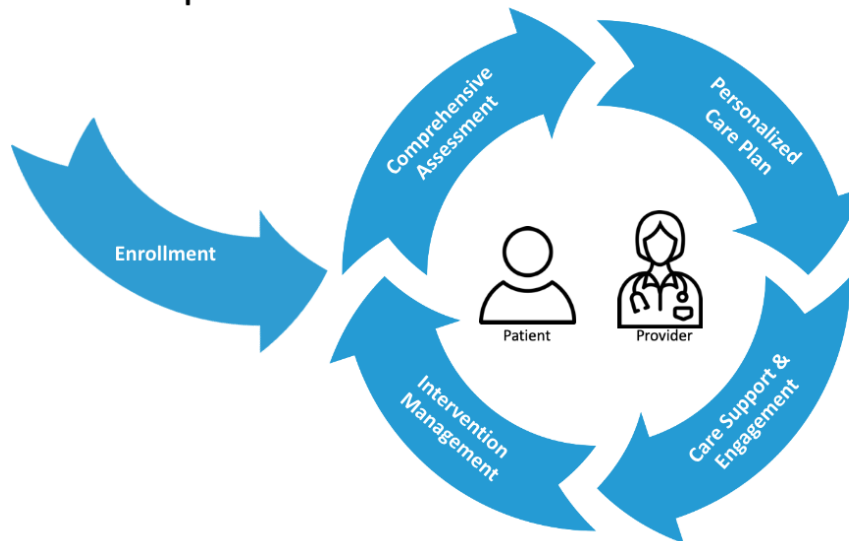


Figure 3: Stability Health's operationalization of their care model

V. HealthInfoNet

Our other project sponsor, HealthInfoNet (HIN), is the sole health information exchange for the state of Maine. HIN is integrated into more than 800 facilities in the state of Maine, and they have the capacity to run real time analytics for all of their clients. HIN processes, validates, standardizes, and optimizes incoming data. The first step they take when they receive data is to verify the completeness and consistency of data sets. They then turn to their data engine which translates local coding norms into industry standard values while blocking and censoring sensitive data. HIN then constructs probabilistic and deterministic matching measures to ID records that belong together. Algorithms are then created and attributed to match patients with specific providers and facilities. This is also where performance measures, predictive risk models, and other analytics are executed. Finally, linkage procedures are created that link participating providers' clinical-based repositories with MaineCare, social determinant information, transportation codes, and more (HealthInfoNet).

SH and HIN are planning to partner up to explore providing diabetes care in the rural areas of Maine. In doing so they hope to complete the following:

1. Innovate and adapt to a different population from the ones that they are currently serving.
2. Measure how effective the revised model is at improving diabetes health outcomes and cost of care.
3. Analyze barriers such as limited internet access, transportation, cost barriers that limit healthcare for patients. Use these barriers to help identify solutions
4. Identify opportunities for financial alignment with payers of all types and having data to support cost-savings in the rural population will help design new payment models for this population.

5. Integrate Platform with HealthInfoNet to be able to use the digital infrastructure to enhance participant/provider info needs. This will allow stability and HealthInfoNet to expand respective services within the state of Maine (Stability Health Internal Document Grant, 2020).

VI. Rural Health

Rural areas experience unique challenges when it comes to receiving care. These challenges are so drastic that the mortality rate in rural areas is 18% higher than in urban areas (Rosenberg, 2019). Rural areas also experience a higher rate of preventable deaths and have higher rates of Medicare and Medicaid. Much research has been conducted on how to solve the issues faced by rural areas, however communities continue to struggle. Much of the problem has to do with resources and access to care. Between 2012 and 2019 388 rural health clinics (RHCs) closed. The unique needs of rural communities include the ability to receive care, food security, and health literacy, which all factor into the difficulty of getting rural citizens the care they need.

A distinct difference between rural citizens and urban citizens regarding healthcare is the ability to access care. Reliable transportation is essential to reach appointments. This transportation can be much harder to find in rural areas. According to RHIhub in 2021, 20% of the US population lives in rural areas, but only 11% of transportation grants are allotted to rural areas. While cities often have multiple, well-funded modes of transportation such as subways and buses, rural areas often have underdeveloped public transportation. In fact, only 60% of rural communities have any form of public transportation at all. Of the 60% that do have it, 28% have “limited service”. This means the majority of rural areas have limited public transportation, or no public transportation at all. Furthermore, 32% of rural bus systems have fixed routes, which often do not meet the needs of people who live off main roads. Alternative modes of transportation such as ride hailing apps are also not well developed in rural areas. Only 19% of rural residents report using ride hailing apps, and the majority of rural citizens (54%) had never heard of ride hailing apps. Road conditions are another concern for rural areas. Approximately 40% of roads are “inadequate for travel” and 54% of fatalities occur on rural roads. The dangers of rural roads serve as another barrier for rural residents to get to their health appointments. Finally, the average trip for medical/dental services is 9 minutes longer for rural residents than urban residents (RHIhub 2021). This is largely due to the fact that there are fewer medical professionals/facilities in rural areas. According to NRHA, there are 39.8 physicians per 100,000 people in rural areas, compared to 53.3 physicians per 100,000 people in urban areas (NHRA 2021).

Another factor in the ability to receive care is the ability to take time off from work. According to a study conducted by the University of New Hampshire, 44% of rural workers lack access to sick days, 10% more than suburban workers. For part time rural workers, that number increases to 76%. Of rural workers who lack sick days, 74% also have no vacation days, compared to 64% of suburban workers. Without sick days or vacation days, it is difficult for rural workers to take time off from work to go to see their doctor. Not only will they lose pay for

the day but taking days off could affect their standing at their place of work. In addition, 54% of rural workers surveyed said the “ability to take leave for personal matters” was “very or somewhat difficult” compared to 40% of suburban workers and 50% of central city workers. Rural workers’ struggle to take time off from work is a significant roadblock in addressing health concerns (Smith and Schaefer, 2011).

The nature of jobs in rural areas also play a role in accessing care. Rural jobs were hit hard by the Great Recession, and according to US News, by 2015 were still 4.26% below 2008 levels. Urban jobs jumped over 4% in the same time period (US News, 2017). Rural jobs also pay less than urban jobs. According to the 2016 census, rural household income was 4% lower than urban household income. Less income and limited availability of jobs means each paycheck means more, making it harder to leave work (US Census, 2016).

Rural health literacy is another concern. Health literacy is defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.” (RHlhub) Health information in general is harder to find, use and understand in rural areas, especially when taking into account the lower education levels in rural areas. According to the US Census, 84% of the counties in the bottom 10% of degree attainment are partially or completely rural. Using basic terms and repeating information are measures health professionals can take to lessen the impact of low health literacy in rural communities.

Finally, food security is a unique challenge faced by rural citizens that can affect their health. Someone who is food insecure “cannot rely on access to sufficient, affordable, and nutritious food at all times.” About 12.7% of rural households are food insecure, higher than the overall percentage of US households that are food insecure, 11.1%. Rural areas are often food deserts, or areas with limited supplies of fresh, affordable foods. According to RHlhub, “Rural shoppers may rely on more expensive and less nutritious food, such as the types available at gas station convenience stores or face a long drive to a town with a supermarket or grocery store that stocks fresh produce, milk, eggs, and other staples.” Food can have a large effect on health, especially diabetes, which makes food insecurity a large issue regarding rural health.

Chapter 2: Literature Review on Diabetes Care

This section provides our literature review on diabetes care. We focused on four separate topics of diabetes care to investigate how Stability Health fills the gaps with their care model and how they can help reduce costs in diabetes care. The first topic we focused on was medication adherence and how improving medication adherence can lower diabetes costs and improve patient lives. The next topic we looked at was increased engagement in diabetes care and how more communication with the patient leads to better care. The third topic we looked at was diabetes education and how when patients are better educated about their diabetes, they get better care. The final section we focused on was reducing readmission rates, as that is one of the largest avoidable costs in diabetes care and something Stability Health can help reduce.

I. Medication Adherence

Medication adherence is defined as “the extent to which patients take medication as prescribed by their doctors.” (FDA 2019) Medication adherence in diabetes patients has been researched extensively to identify the effect it has on patients, the cost analysis of adherence, and factors that may cause patients to not adhere. While medication adherence is usually relatively low (50%-60%), there is data that suggests increased adherence can lower costs and improve the lives of diabetes patients. In order to gain perspective on the value proposition of Stability Health, understanding the value of medication adherence in both monetary and nonmonetary ways is paramount.

In 2018, the University Diabetes Centre at King Saud University in Riyadh, Saudi Arabia conducted a study of 395 type 2 diabetes patients. The study focused on barriers to adherence, the effect of adherence, and costs associated with adherence. Subjects cited multiple reasons for not adhering. One significant social factor was family gatherings. One subject cited not liking when “people start asking what medication I’m taking or what is wrong with me.” A large group of patients cited not having proper education of the medication. Some were confused on why they had to take it, what the medication did, and what the consequences of stopping were (Aloudah, 2018). These findings were consistent with those by Washington State University professor Joshua J. Neumiller. Neumiller cited the two most common reasons for nonadherence as forgetfulness and “lack of perceived benefit.” Neumiller also notes the barrier of cost, as some diabetes patients cannot afford to get their prescriptions filled. Among his suggestions was providing an app to patients to remind them to take their medications, as Neumiller claimed doing so could “play a major role in improving adherence.” (Neumiller, 2018) The King Saud University study concluded that low adherence is affected by physicians, social factors, and organizational factors. The study found that for every 25% increase in adherence, the patient’s A1c dropped 0.34% and concluded that low adherence may contribute to the rates of morbidity and mortality observed amongst patients. Regarding costs, the study finds an inverse relationship between adherence and total direct cost. Hospitalization costs especially had a negative correlation, suggesting total direct costs over time are driven by expensive hospitalizations by patients with type 2 diabetes. However, total costs for patients with high adherence were slightly

higher than patients with low adherence due to increased medication costs that canceled out the savings in inpatient, outpatient, and emergency visit costs.

A study conducted at Pennsylvania State University yielded similar cost results. High levels of medication adherence were associated with lower disease-related medical costs, but those savings were offset by rising medication costs. Similar to the prior study, direct healthcare costs were lowest for the highest adhering (80%-100%) patients, and hospitalization rates were inversely correlated with adherence (Sokol, et. al, 2005). Finally, a study conducted by AJMC concluded while medical costs dropped, there may be a threshold effect, where costs do not drop until 20%-39% adherence. Increased adherence was associated with decreased inpatient and emergency visits, suggesting “improved disease control and well-being.” Increased well-being, fewer hospitalizations, and control of diabetes without an increase in total costs suggests that medical adherence is a worthwhile investment by diabetes patients (Caffrey 2017).

II. Increased Engagement in Diabetes Care

Increasing patient engagement in diabetes care is critical to improving diabetes care in general and making care more personalized to each individual patient and their needs. A type 2 diabetes mellitus research study published by the U.S. National Library of Medicine National Institutes of Health in 2018 was conducted around the idea that patients are the ultimate stakeholders in their health (Simacek et al., 2018). The study focused on engaging patients in their own diabetes care to understand what areas those living with diabetes want to see more research done in. The study also focused on the patient perspective of how they would like to be involved in the design of future research studies, the execution of the studies, and the interpretation of the results. This study, titled “Patient Engagement in Type 2 Diabetes Mellitus Research: What Patients Want,” utilized the patient community forum, “PatientsLikeMe,” to hold two discussions. From these discussions and the specific questions asked, the themes of managing type 2 diabetes with comorbidities, finding a cure, managing blood sugar levels, and better understanding what causes type 2 diabetes were concluded to be of the most importance to the 88 participants. In general, the participants also hope to see more research that directly applies to their lives and hope to contribute their personal skills, education, and experience with diabetes to different aspects of the research processes. In addition, the study came to the result that online platforms can be beneficial and should be encouraged in gaining patient insight and obtaining qualitative data (Simacek et al., 2018).

Another research study published by JMIR Publications in 2017 focused on investigating the effectiveness of different digital prompts in improving patient engagement. The study is titled, “Promoting Engagement with a Digital Health Intervention (HeLP-Diabetes) Using Email and Text Message Prompts: Mixed Methods Study.” HeLP-Diabetes stands for Healthy Living for People with type 2 Diabetes; it is a digital health intervention driven to encourage and promote self-management amongst type 2 diabetes patients (Alkhaldi et al., 2017). The study directed research towards investigating how the content of a message and a message’s delivery method impacts the way a patient behaves in response to it.

The results were measured through how frequently a patient visited the digital health intervention tool. Different text messages and emails were sent out to patients registered with HeLP-Diabetes and the results suggested email was the most effective communication method for engaging patients. 39 email prompts were sent out and 19 (49%) of them indicated more visits to the digital health intervention tool. None of the text messages correlated with more visits to the digital health intervention. It was thus concluded by the study that emails with brief, encouraging messages were most effective in engaging patients (Alkhaldi et al., 2017).

III. Diabetes Education

Because diabetes is primarily a self-managed disease, being well-educated about diabetes is the best way for patients to help manage the disease and prevent diabetes-related conditions. The United States Centers for Disease Control and Prevention (CDC) offers a program called Diabetes Self-Management Education and Support (DSMES) that offers services to help diabetes patients learn how to take the best care of themselves. The DSMES focuses on making better decisions about issues that affect the individual's needs including eating healthy, staying active, checking blood sugar levels, taking medicine, and reducing risks of other health problems (CDC, 2020).

Most insurance plans, including Medicare and Medicaid, cover up to 10 hours of diabetes education the first year of diagnosis. This makes it easier for patients to learn about and adjust to all of the new things they need to do to care for their diabetes. However, many insurances do not provide as much or any coverage for diabetes education after the first year of diagnosis. The Association of Diabetes Care and Education Specialists (ADCES) states that there are 4 critical times a patient with diabetes needs to see a diabetes care and educational specialist; these times are: when being diagnosed with diabetes for a specific self-management care plan, annual check-ins to see what is working or what is not working, when new challenges occur such as new medical issues, and when there are changes to life stages or health care plans (ADCES, 2020). But, because insurance mostly only covers education up to the first year, it can be harder for patients to stay up to date with their health care professionals about their self-managing of their diabetes.

In a conducted study from 2016 in the United Kingdom, a team researched the role of knowledge and awareness of diabetes in fighting against diabetes and also to interpret to which extent is diabetes education successful. There is a Child and Adolescent Structured Competencies Approach to Diabetes Education (CASCADE) program in the UK for children and young people who are diagnosed during childhood that helps decrease long-term complications. Because the patient is receiving education of their diagnosis young, they are more likely to take better care of themselves long-term as compared to someone who receives the same education much later in life. Most people in the UK with Type 2 diabetes are over 60 years old and their levels of knowledge of diabetes self-management tends to be poorer than younger patients. This is especially true for patients that are residents of care homes because most care homes do not have the resources for diabetes special education. The study found that the relation between

health literacy, complication awareness, and diabetic control, among patients with Type 2 diabetes, patient awareness scores and their health literacy was negatively related to their diabetes control (Junaid Nazar, et. al, 2015). Overall, educating the patients regarding diabetes plays a key role in supporting patients to take active responsibility to control their diabetes. Most importantly, proper diabetes education can help lower the number of patients who develop long-term complications and new medical conditions.

IV. Reducing Readmission

Reducing readmissions for diabetes patients is a key health care quality measure and focus for reducing the total cost of care. The biggest driver of costs in hospital readmission is a 30-day readmission, also known as an early readmission. Being able to reduce these early readmissions can greatly decrease the costs in diabetes care.

Patients with diabetes in the US represent 9% of the population and account for about 25% of hospitalizations (Rubin, 2015). The overall early readmission rate for hospitalized patients is 8.5%-13.5% and the early readmission rate for patients with diabetes is 14.2%-22.7%. After the 30-day period for early readmissions, the readmission rate for diabetes patients within three months is 26% and within a year is 30%. In 2012 in the US the costs associated with diabetic patient hospitalizations was \$124 billion with \$25 billion of that being attributed to 30-day readmissions. Being able to reduce the readmission of diabetes patients would greatly reduce the total cost of diabetes care.

Based on a number of studies looking at factors of diabetes patient readmissions, Rubin (2015) identified five themes that contribute to readmission risk. The first theme was poor health literacy, such as a lack of knowledge about diabetes and discharge instructions. The second theme was health system failure of the discharge process and discharge support. The third theme was failure of factors that were supposed to be protective, including following discharge instructions, being aware of medication changes, and having support at home. The fourth theme was social determinants of health impeding healthcare. The fifth theme was loss of control over illness. Another common theme for diabetes patient readmissions were lack of transportation, medications, or food.

There are many barriers to reducing the readmission of diabetes patients, these barriers come from both the hospital's side and the patient's side. One barrier on the hospital's side is competing medical priorities may take precedence over diabetes care. One study at a teaching hospital found that 60% of discharge notes included diabetes, but only 20% of these notes gave a follow-up plan for diabetes (Rubin, 2015). Also, when diabetes is mentioned in discharge notes the only instructions for follow-up are about medications. Another issue is the difference between inpatient and outpatient settings, these differ greatly and cause more readmissions. A barrier for reducing readmissions on the patient's side is poor health literacy. Diabetes is a chronic condition that requires more engagement than other conditions and because of this people with poor health literacy may not understand their discharge instructions. Lack of

financial resources also serves as a barrier as some patients do not have access to transportation or health insurance and are not able to follow their discharge instructions.

There are several strategies that are being studied to see if diabetes patient readmissions can be reduced. One study found that having a nurse diabetes educator and an endocrinologist in the inpatient setting reduced 3-month readmission rates from 32% to 15% (Rubin, 2015). Another study found similar results but did not reduce readmission rates past one year. One study that included inpatient diabetes education and a post-discharge phone follow up found that the 180-day readmission rate went from 28.3% to 3.2%. Other studies have found that intensifying diabetes therapy has greatly lowered the 90-day and longer readmission rates but did not have as much of an effect on the 30-day readmission rates. One study that had patients have four clinic visits annually, monthly phone calls, and 24-hour access to a diabetes coach lowered the readmission rates for diabetes patients while also lowering the costs of diabetes care. Other strategies for lowering readmission rates include better communication of discharge instructions, involving patients in appointment scheduling, assessing barriers of following discharge plans, and keeping communication with diabetes patients.

Chapter 3: Methodology

To help us achieve our goal of providing Stability Health with tools for evaluating the Maine market and other states in the future we broke our methodology into four main objectives: understanding demand, understanding supply, understanding how Stability Health might fill the gaps in care between supply and demand, and analyzing opportunities for entry. Accomplishing these objectives put our group in a good position to make reasonable and attainable recommendations to Stability Health about implementing their model. In order to understand demand, we had two primary goals: HealthInfoNet database discovery and interviewing those affected by diabetes. To understand supply, we conducted research on SH competitors as well as the Maine health system. To understand how SH might fill the gaps, we interviewed SH team members and reviewed the literature to identify common gaps. Finally, we analyzed 5 specific counties in Maine and developed different decision-making techniques that show where there is the most opportunity for Stability Health to integrate based on factors obtained from HealthInfoNet's data. Each of these steps is described more specifically in the sections that follow. For any technical term in this section, refer to the glossary of terms in Appendix A.

I. Understanding Demand

In order to understand demand for diabetes care in Maine, our group focused on addressing the 3 Ws of demand-who, where, and why. To assess these factors, our group used HIN databases, CDC data, and interviews. Analyzing our results helped us pinpoint who the demand is coming from, where the demand occurs, and why the demand exists.

A. HIN Databases Discovery

HealthInfoNet (HIN) has access to multiple databases which we used to assess the “who” and “where” regarding demand. It is important to note that HIN shared only de-identified patient information for all data sources provided for this project. The first database, the HBI Database, places patients into buckets regarding their risk for developing diabetes: low, moderate, high, very high. The database includes data on how many people in each bucket developed diabetes within the last two years. This allows the user to check the predictive analyses to see how accurate they were. An individual patient can be broken down into how likely they are to develop diabetes within the next 12 months, as well as, how much more likely they are than others in their bucket to develop diabetes. Patient encounters and costs can also be analyzed by bucket. This tool was exceptionally powerful in understanding the demand for diabetes care. Our team dissected where the highest concentration of high and very high-risk patients are located, what their comorbidities are, what their encounters have been, and the costs associated with their care. These four factors gave a more holistic picture of where demand is prevalent, and the factors that are associated with these areas. The second tool encompasses similar data, where A1c metrics can be tracked based on county. These figures helped us estimate where the most out of control patients are, and how SH can open channels of care to them.

After analyzing these first two databases, we realized a significant gap in data was hospital performance by county. HIN was able to provide us with a database including county data on readmissions, emergency room visits, and more hospital-level data. From this data we analyzed which counties had the highest number of incidents and the poorest performing hospitals. Since hospitals are penalized for poor performance, our group identified which county's hospitals could benefit the most from an increase in performance via Stability Health's services.

To better understand the who and where of demand, our group also analyzed the population of Maine in general. We explored the demographics of the state, using resources like the Census, CDC, and interactive maps in addition to the HIN databases to assess socio-economic and healthcare data. Determining populations who fail to meet the diabetes standard of care was instrumental in identifying communities that struggle obtaining diabetes care, especially rural areas. We also used these databases to outline where challenges unique to rural areas, outlined in the background, such as access to reliable transportation and WiFi are present. Understanding where these challenges occur was instrumental to understanding the region as a whole and allowed us to identify where the SH model is beneficial to implement. The list of databases we used, and their descriptions and sources can be seen in Table 1.

Table 1: Descriptions and Sources for each Database Used

Database Name	Database Description	Database Source
Diabetes Population Risk Scores	Risk scores for several diseases for patients in Maine that have diabetes	HealthInfoNet
Comprehensive Diabetes Care	The measure of diabetes control for patients in Maine based off their A1C	HealthInfoNet
Encounter Flags	The measure of diabetes control for patients in Maine and details on the hospital encounters	HealthInfoNet
MaineHealth Locations	The locations of MaineHealth’s hospitals and endocrinologists	MaineHealth (https://www.mainehealth.org/Locations)
North Light Locations	The locations of Northern Light’s hospitals and endocrinologists	Northern Light (https://northernlighthealth.org/Locations)
Endocrinologists in Maine	The locations of other endocrinologists in Maine	US News and World Report (https://health.usnews.com/doctors/endocrinologists/maine)
Population and demographics	Population and demographic information on counties in Maine	HomeTownLocator (https://maine.hometownlocator.com/)
US Census	Population and demographic information on counties in Maine	United State Census (https://www.census.gov/quickfacts/table/ME/INC110219)
Northern Light Care	Types of care given to diabetes patients for each county in Maine	Northern Light (https://northernlighthealth.org/Community-Health-Needs-Assessment/2019-CHNA-Reports)

Common tools we used to analyze the data we were given included Microsoft Excel regressions as well as Python “heat maps”. Regressions gave us a unique look at which factors were closely related to others. We compared which county characteristics were correlated with poor A1c, how geographic factors affected hospital performance, and more, as detailed in Chapter 4.

B. County Analysis

In order to further evaluate the five counties our group chose to focus on and dive deeper into the data we used the Analytical Hierarchy Process (AHP), the Technique for Order of Preference by Similarity (TOPSIS), and Decision Tree analyses. These analytical techniques gave our group quantitative evidence of which of the counties were the most in need of diabetes

care management services. All three techniques allowed us to rank the counties, and from comparing the results of the three analyses we determined how each county performed relative to the others.

a) AHP Analysis

AHP is a way to evaluate alternatives based on certain criteria. Each criterion is weighted based on its relative importance compared to the rest of the criteria, and each alternative has a score for each criterion based on its performance in that area. In this use case, each county was an alternative and we chose seven criteria to evaluate: percentage of poor control A1c, hospital per capita, diabetes death rate, diabetes emergency rate, diabetes readmission rate, percentage of the county living in a rural county, and percentage of households with access to broadband. We used AHP to create our own Weighted Demand Average (WDA), or the demand a certain region needs for diabetes management assistance. When using a decision-making tool, it is important to conduct a sensitivity analysis as well. The weights in the tool are critical to the results and are determined by the user. If the weights of the criteria were to change for AHP, that could alter the entire outcome. If the scores for each item were to change, this could also heavily impact the results. In addition to performing the sensitivity analysis, it was also important to consider data limitations. We were unable to obtain data on important criteria such as where people are receiving their care opposed to just where they reside, the level of that care, and how often people get foot or eye exams. Though we are confident that the data we did use in our analysis to make our final recommendations is beneficial and telling of the current areas of opportunity for improvement in Maine, it is critical to keep these data limitations in mind.

b) TOPSIS Analysis

In order to provide another way of analyzing which county provides the most opportunity in terms of having the most negative performance, we evaluated the five counties using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Like AHP analysis, TOPSIS is a multi-attribute decision making technique for ranking alternatives using several externally determined criteria through distance measures. This is done by identifying weights for each criterion, normalizing scores for the criterion, and calculating the geometric distance between each alternative and the ideal alternative, the best score in each criterion.

To keep consistency with the AHP model constructed, the same seven criteria were used and the weights for the criteria were kept the same (Pergamon, 2006).

c) Decision Tree Analysis

A decision tree is a decision support tool that allows the user to visually understand a decision and identify best alternatives by seeing payoffs and consequences along with the probability of different paths in a tree like model. They are most used in operational research in order to support decision analysis. Decision trees contain three types of nodes which are decision nodes represented by green squares, chance nodes represented by red circles, and end nodes

represented by black triangles (Decision Tree, 2021). We used the same criteria in the Decision Tree as the AHP and TOPSIS. The purpose of this Decision Tree was to make a decision on which of the five counties had the most opportunity for SH to integrate their model into.

C. Interviewing Diabetes Patients

The last step in understanding demand was interviewing diabetes patients to better understand their predicaments and experiences regarding their diabetes. After the Institutional Review Board (IRB) approved our process, we set out on contacting patients for interviews. While we reached out to over a dozen patients who were largely referred to us by Stability Health, we only were able to connect with and interview three patients. Interviews took place over Zoom with at least two group members present with the interviewee. The list of questions used in the interviews is provided in Appendix B, and includes questions such as “Do you have difficulty in managing your diabetes?” and “What about your environment makes managing your diabetes difficult?” In order to better understand the experiences of people affected by diabetes, we also interviewed family members of diabetes patients. We then collected, grouped, and analyzed interview answers to make conclusions on common problems faced. From our understanding of SH and our analysis of these interviews, our group crafted recommendations for SH as they look to scale their model into these markets. These interviews also introduced personal and qualitative data that often cannot be captured in raw data.

II. Understanding Supply

Once our group understood the demand for diabetes care in rural Maine, we shifted our focus to the supply of diabetes care. To get a better understanding of the supply side of diabetes care we completed research on SH competitors. Once we understood the different competitors offering diabetes care in Maine, we shifted our focus to where in Maine people can get diabetes care.

A. Maine Health System

The first step in getting an understanding of the supply of diabetes care was looking at where in Maine people get diabetes care. This was completed with the help of HIN’s databases. Through our research in our literature review, consulting the ADA’s Diabetes Standard of Care, and speaking with Stability Health, our group gathered the major elements of good diabetes care. Good diabetes care can be expressed by regular foot and eye exams, A1c in control, and several other data points. This data was available in the HIN databases and could be analyzed as we assessed where in Maine the best diabetes care was present in. These databases detailed hospital performance standards by county. The counties that are having the most patient readmissions show us which places are having difficulty supplying the proper diabetes care to their patients. The databases provided by HIN also highlighted what areas in rural Maine do not have the proper amount of diabetes care options. The information supplied by HIN helped show us where the largest gaps are in diabetes care in Maine. The information we found on the supply of

diabetes care in Maine helped us move into our next goal of understanding how SH can help fill the gaps in diabetes care in rural Maine.

B. Interviewing Healthcare Professionals

To further understand the supply of diabetes care, our second step was to interview healthcare professionals both from Stability Health and across the county. In order to better understand how SH operates, our group met with company employees who explained specific processes. This allowed us to understand how the company fulfills some of the required demand that comes with treating diabetes. Additionally, our group interviewed physicians, endocrinologists, or hospitals to determine the best plan of action for the patients, using questions from Appendix C and Appendix D. Meeting with both the patients and the caregivers allowed the group to understand the advantages and disadvantages of SH's model for diabetes. Furthermore, it was important that the group specifically looked at the rural areas that companies are currently serving in order to try to replicate the thoughts of consumers in the rural areas of Maine. In these interviews, the group formed a firm grasp on how Stability Health and HealthInfoNet helps caregivers and consumers while also understanding where there is room to improve primarily in Rural Areas.

C. Competitor Research

Our final step in understanding the supply of diabetes care involved doing competitor research. We did research on companies that offer similar services to that of SH. The purpose of completing this research was to understand what options people with diabetes currently have. While SH has a unique model for how they provide diabetes care there are several other companies that are similar. It was important for us to understand what sets SH apart from other diabetes care providers. SH provided us information on several different companies that provide diabetes care in a similar manner to SH. We used that competitor information to understand how these companies provide care and what their similarities and differences are from SH. We also investigated whether any of these other diabetes care companies have entered a rural market or entered a market in Maine. Performing competitor research gave us insight into the type of care that is available for people in rural Maine.

III. Understanding how SH “Fills the Gaps”

In order to understand how SH can fill the gaps in diabetes care, our team integrated the data we collected through interviews with our data from the literature review and county analysis. This analysis was driven by questions about the feasibility of integrating the Stability Health model while remaining profitable. By accomplishing these tasks, we gained knowledge on where healthcare professionals see gaps in care as well as what gaps exist to see where SH can provide value. We developed a process flow map that details how Stability Health can integrate into the current diabetes care model positively for patients and providers.

IV. Analyzing Operational and Financial Opportunity

SH's model operates by combining technology and clinical expertise to create a program that is attractive to participants to encourage enrollment. After enrollment, patients are given a comprehensive assessment to take. The assessment results help SH develop the best personalized care plan for them. Patients are constantly supported through care support and engagement within the SH model and intervention management when it is needed. This is all designed to ensure patients remain healthy and that their diabetes remains controlled. To determine operation opportunity, we analyzed this model of care and paired it with the general cycle of events a diabetes patient experiences.

Before SH can integrate their model into any part of Maine, the decision to expand must be evaluated as economically and financially feasible. This means that SH must be able to afford the integration or expansion and that the expansion will create profit or opportunities for profit soon. Currently, SH is considering three broad types of fee structures and revenue models that describe how provider organizations might pay for SH's services and an option for these organizations to provide incentives.

Once the cost input for SH was understood, our group analyzed the value of expanding into the rural parts of Maine and the opportunity it creates by developing a cost benefit analysis (CBA) template. We created a template of a CBA that could be used by SH in the future to measure the different benefits and costs associated with expanding their operations. We found that a CBA was an important tool because it allowed us to include intangible benefits and costs such as customer satisfaction. Not only was the amount of value in terms of revenue analyzed, but also how many patients, physicians, and other people in these areas will receive the benefits of having SH's model available to them. The goal of this project was to analyze if SH's model will help people in rural areas of Maine receive access to diabetes care. In order to achieve this goal, our group needed to figure out how many people could use SH's model to help with their diabetes care control and if in fact, these people have the ability and want to obtain SH's model.

Chapter 4: Findings and Discussion

Following our methodology, we were able to accomplish two major tasks understanding the demand for diabetes care and understanding the supply for diabetes care. To understand the demand for diabetes care, we looked at HIN data including A1c and risk stratification data. This painted a picture of where the demand was greatest, geographically. From these preliminary findings, we identified five counties to focus on. These five counties formed our “case study” approach that SH can repeat in other areas. We used heat maps to analyze these counties, and interviewed diabetes patients to gather qualitative data to supplement our quantitative findings. Using HIN data, we were able to understand where Maine healthcare facilities exist, and how well they service the surrounding population. We also interviewed providers, which gave us a better idea of how they provide diabetes care, and where some gaps may exist. Finally, we researched competitors of Stability Health in the region, including value-based care companies, chronic care companies, and diabetes care companies. For any technical term in this section, refer to the glossary of terms in Appendix A.

I. Understanding the Demand for Diabetes Care

This next section describes our results and findings for our analysis on demand of diabetes care in Maine. The first subsection highlights the databases we looked at and our analysis on the data. The second subsection discusses how we selected five counties to focus on. The third subsection is further data analysis through the use of heat maps based on the chosen counties. The final subsection discusses the results from the patient interviews we completed.

A. Data Description and Analysis

To better understand the demand for diabetes care in Maine we gathered data on several different attributes that included population, disease state, type of care received, and demographic data. HealthInfoNet gave us the data that included disease states and hospital admissions and readmissions. The data provided by HIN were all de-identified to ensure protection of patient privacy. To gather data on population and demographics we used the U.S. Census. The data that we had gathered on types of care received was from Northern Health’s website. Because this data was supplied by Northern Health, we only have data on counties with Northern Light hospitals. The full data dictionary for the data on a per county basis can be seen in Table 2. The full data dictionary for the data on a per patient basis can be seen in Table 3.

Table 2: Data dictionary for population data per county

Name	Description
County	Name of county
Ppl/Household	Average number of people per household of each county in Maine
CPU	Percent of households with computer access for each county in Maine
Broadband	Percent of households with access to broadband for each county in Maine
Insurance o65	Percent of people over the age of 65 without insurance for each county in Maine
Commute	Average person's commute time for each county in Maine
Pop/Sq mi	Population per square mile for each county in Maine
A1C	Percent of patients who have at least 2 A1C tests per year
Education	Percent of patients who have had formal diabetes education
Foot	Percent of patients who have an annual foot exam
Eye	Percent of patients who have an annual eye exam

Table 3: Data dictionary for care data per patient

Name	Description
ID	ID number for the patient
Age	Age of the patient
Gender	Gender of the patient
County	County that the patient is from
Result Type	The type of test that was run on the patient (A1C or FPG)
Result Value	The value of the patient's test
Control	The control of the patient's diabetes (Normal, Good, Prediabetes, Poor)
Control	The control of the patient's diabetes (Normal, Good, Prediabetes, Poor)
Inpatient	Count if hospital inpatient visits
Readmission	Count of patient readmissions within 30 days
LOS	Length of stay of patient visit in hours
ED	Count of emergency department admissions
EDReturn	Count of emergency department readmissions within 30 days

To help visualize the demand for diabetes care in Maine, we examined the percentages of patients in normal control, prediabetes, good control, and poor control. Figure 4 shows a bar graph for these four attributes for each county. The counties are ordered by highest population to lowest population on the graph. This graph shows that the values for all the controls in each of the counties are fairly like each other. This graph shows that both highly and lowly populated counties need to improve the quality of their diabetes care as all counties have around 20% of their diabetes patients in poor control.

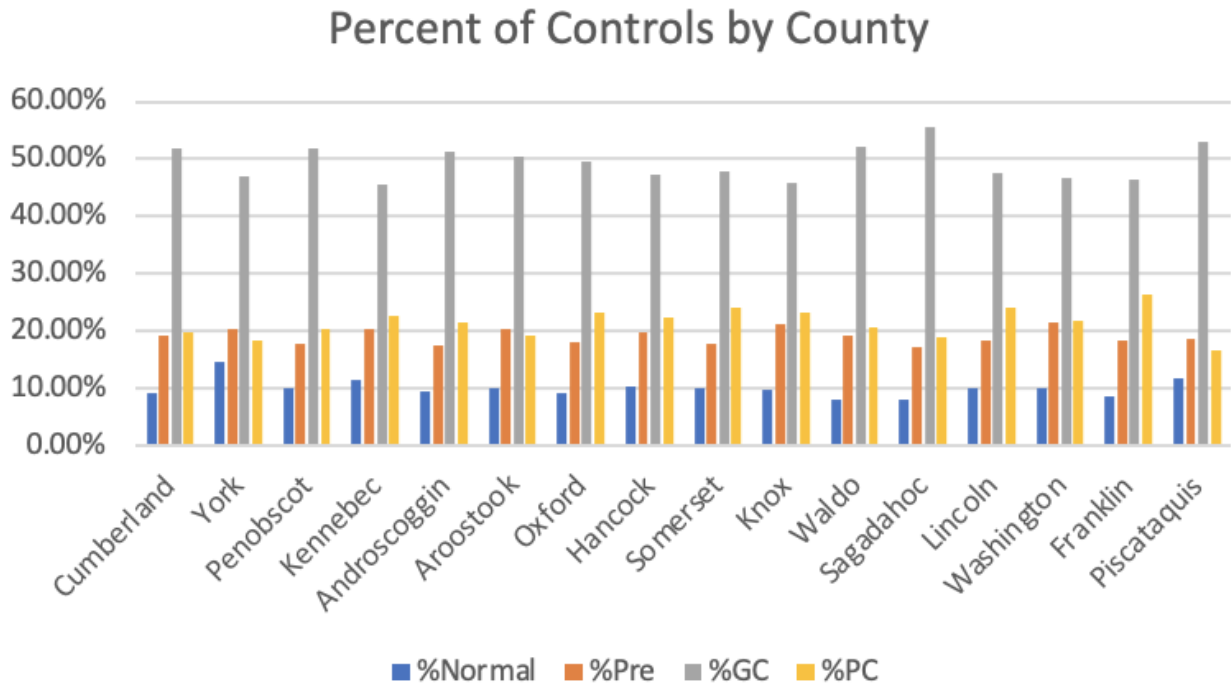


Figure 4: Percent of normal control, prediabetes, good control and poor control for each diabetes patient in Maine

We also wanted to highlight demographic data, mainly the percentages of households with a computer and percentage of households with access to broadband. In Figure 5 these two attributes are shown per county. The counties are ordered by highest population to lowest population. The most populated counties in Maine are also the counties with the greatest access to computers and broadbands. Households that do not have access to these technologies currently have difficulty reaching all the resources they need to manage their diabetes and in turn can result in poorer control of their diabetes. As Stability Health continues to consider areas to integrate, they must consider rural areas that may need special programs or partnerships with local facilities where participants can get WiFi to attend virtual appointments and speak with their health coaches.

Demographic Statistics by County

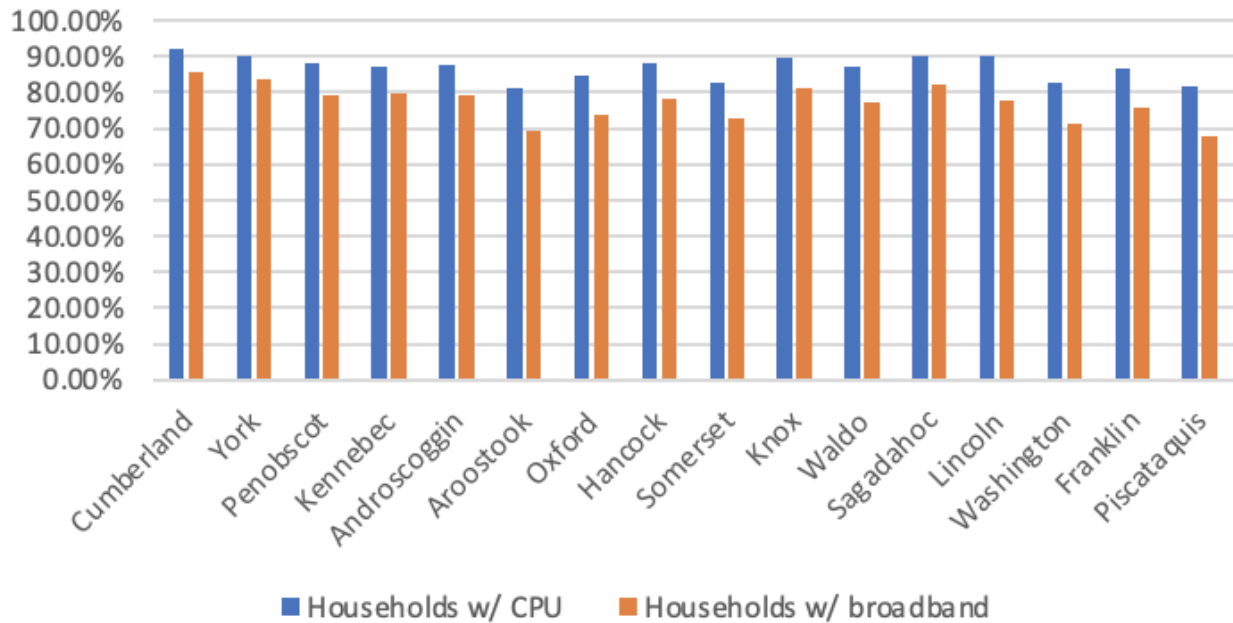


Figure 5: Percentage of households with computer and broadband for each county

Another aspect we wanted to look at was the other types of care that diabetes patients receive. In Figure 6 we show the percentage of patients with at least 2 A1C tests per year, the percentage of patients with formal diabetes education, the percentage of patients with an annual foot exam, and the percentage of patients with an annual eye exam. The counties are ordered by highest population to lowest population. We did not have all this information for every county, which is why some of the counties have blank bars. Almost every county does a good job with A1C tests and foot exams, but they seem to lack eye exams and diabetes education. This table demonstrates that not all patients are receiving all the care that they should be receiving. What is most alarming about this graph is that almost all counties are around 60% or lower for diabetes education. All the diabetes care providers we interviewed emphasized the importance of diabetes education. The lack of diabetes education is something that Stability Health can provide in Maine.

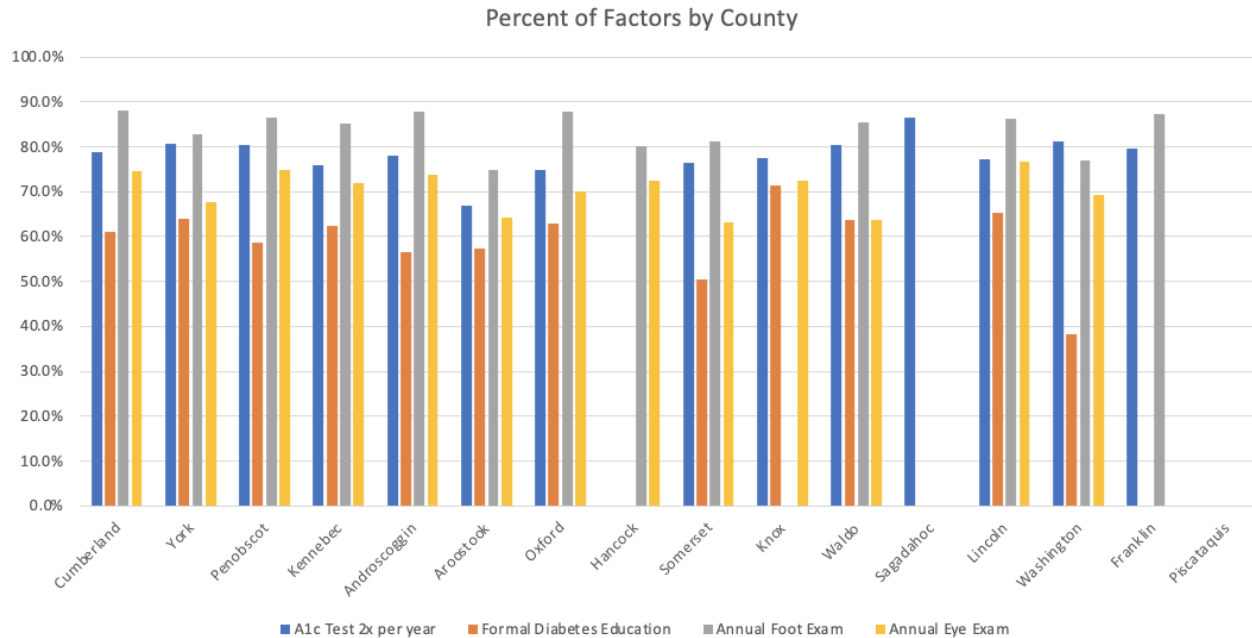


Figure 6: Percent of 2 A1c tests per year, formal diabetes education, annual foot exam, and annual eye exam for each county

B. Selecting Counties for Detailed Analysis

In order to further evaluate the specifics of diabetes care in Maine, our group chose five counties to focus in more detail on. Each county was chosen for a specific reason. Piscataquis County, which is the county with the smallest population in the state was chosen because it also has the lowest percentage of diabetes patients with poor A1c control. Franklin County was chosen because it has the highest percentage of poor A1c control. Washington County was chosen for its unique combination of high rural population and high number of hospitals per resident. Penobscot County and Cumberland County were chosen for their high populations, high urbanization, and wealth of hospitals. These five counties helped our group capture a holistic view of Maine, encompassing small, rural counties and large, urban counties. By using the data from these counties, we were better able to focus our regressions and determine relationships amongst the data. We also used the Analytical Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution model (TOPSIS) to come up with composite scores that considered the demand for assistance in diabetes management in each county. We used these counties as a case study, and our methods to analyze these counties can be repeated elsewhere in Maine in other states to develop similar conclusions. By ranking according to need for managing diabetes, SH can use the results to identify the counties that are most likely to benefit from their services.

a) AHP Results and Analysis

The AHP results can be seen in Appendix F. The first step in AHP after establishing criteria and alternatives is weighing the criteria against each other. We used a 1-9 system for all our weighting. While weighting criteria is a subjective process that directly affects the result, our

basis for our weights lay in our literature review research, data analysis, as well as input from interviews. Percentage of poor control A1c received a 9 (most relative importance) down to households with access to broadband which received a 2 (least relative importance). We then converted the alternative's performance in each criterion to 1-9 weight. Negative performance; for example, high percentages of poor control A1c, were given higher scores. Positive performance; for example, a low hospital per capita, were given lower scores. Once the matrix is complete, calculations are made to determine the weighted sums. Franklin County received the highest WDA, demonstrating the most negative performance, while Cumberland County received the lowest WDA, demonstrating the most positive performance. From the AHP we can analyze the need for services is greatest in Franklin County. The county's high number of residents per hospital and high percentage of poor control A1C led it to having the highest WDA. Cumberland County performed well in every category, giving the county a low WDA reflecting a low need for services. We recommend Stability considers the top three counties that have the best opportunity to try to integrate their services into. As demonstrated by this AHP analysis, these counties, in order, are Franklin, Washington, and Piscataquis counties.

To perform a sensitivity analysis using the AHP method, we reversed the order of the criteria and their corresponding weights. The scores of how well each county met the criteria remained the same. As displayed in the AHP, this changed the weighted sum and final ranks significantly. In this situation, the criterion weights and the scores are the independent variables, while the weighted sum and the ranks are dependent variables. This demonstrates that changing the values of these independent variables affects the outcome and values of the dependent variables.

The rank in this AHP analysis is intended to be used to determine whether it is worthwhile for Stability Health to try to integrate their system into a new county. In the AHP analysis we conducted, a rank of "1" meant it was the most worthwhile county to approach and a rank of "5" meant it was the least worthwhile. After performing this sensitivity analysis and altering the values of the criterion weights, the ranks of the counties based on how worthwhile they are to attempt integration to changed from Franklin (1), Washington (2), Piscataquis (3), Penobscot (4), Cumberland (5) to Piscataquis (1), Washington (2), Franklin (3), Penobscot (4), Cumberland (5). Ultimately, the most significant change in this sensitivity analysis was with originally having Franklin county be the most worthwhile to Piscataquis changing to be the most worthwhile and Franklin reducing to the third ranking spot.

Further altering these criterion weights to be different values would change the final outcomes even more. To use this type of analysis and get the results to be as accurate as possible, it is critical to fully understand which criteria are the most important to the outcome. This would likely change depending on the user or the intended purpose. The sensitivity of this analysis can be beneficial because if the user's values change, the AHP analysis can be altered to reflect that and the results will change accordingly.

b) TOPSIS Results and Analysis

The results of the TOPSIS analysis can be seen in Appendix G. After completing the normalization, the last step in TOPSIS which involves normalizing the alternative closest to the most ideal solution and the alternative farthest away from the worst solution, it was found that Piscataquis is the best alternative, in terms of having the most negative performance using all the different criteria, followed by Washington, Franklin. Penobscot and Cumberland were the last two ranked, meaning that they have the most positive performance when it comes to the criterion used to analyze each alternative. TOPSIS provides Stability with a way to analyze which counties have the most opportunity because it determines which county is closest to the best solution, which in this case is the county which performs the worst in the criteria. From the TOPSIS analysis, the top three counties presenting the greatest opportunity for Stability are Piscataquis, Washington, and Franklin counties, in that order. Because the AHP analysis also got these three counties as presenting the greatest opportunity for improvement but in a different order, we recommend Stability considers integration into all or any of the three.

c) DecisionTree Results and Analysis

The decision tree we created, shown in Appendix H, analyzes the decision of “Where should Stability Integrate their Model” represented by the green square. This decision led to the five counties: Piscataquis, Washington, Franklin, Cumberland, and Penobscot. Each of the counties in the decision tree is then followed by 6 chance nodes which represent six different factors that are important in determining how well the population of these counties do in managing diabetes for their people: percentage of poor control, death rate, emergency rate, diabetes readmission rate, percentage of rural population, and households with broadband. These chance nodes are ordered by what is believed to be most important to least important based on the weights previously assigned in the AHP and TOPSIS analysis. Each of these chance nodes has two outcomes: Yes or No. The outcome chance percentages include the exact percentage of those factors based on the data that was obtained about each county. For example, for the first chance node for Piscataquis County, “Is there opportunity in terms of poor control”, there is a 16.54% that it becomes “Yes”, which is the exact percentage of poor control in Piscataquis. Additionally, the value that is obtained by obtaining “Yes” is the same weight that was used in the AHP and TOPSIS in order to provide a sensible value of obtaining that opportunity.

After implementing the factors for each county, the decision tree determines what the best decision is based on the risk represented and the value of taking that risk is. In the end, the decision tree determined that Stability should integrate into Franklin County as it has the most opportunity in terms of Diabetes management and the value gained by entering this area. This decision is demonstrated by the “True” on the decision branch for Franklin rather than “False” which is shown on the others. This is consistent with our previous decision-making techniques as Franklin was rated 1st in AHP and 3rd in TOPSIS

C. Heat Maps

To further understand relationships between characteristics of the five counties we ran regressions using the data provided to us by HealthInfoNet along with additional county data that we found through our research. To easily understand the results of the regressions we ran, we placed the regressions into heat maps that used colors to show the strongest and weakest correlations in our attributes. The equation we used to find each of these correlation values can be seen in Figure 7 below. In this equation r represents the correlation coefficient value between the x and y variables. The independent variable is represented by x and the dependent variable is represented by y . Both \bar{x} and \bar{y} represent the mean values of the independent and dependent variables.

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

Figure 7: The equation used to find the correlations between different attributes

The first dataset we ran correlations with included attributes such as population, households with CPU, households with broadband, persons without health insurance, mean, commute, population density, number of patients with diabetes, and percentage of patients with diabetes. The data on social determinants of health was found through our own research and the data on the number of diabetes patients and percentage of diabetes patients was provided by HealthInfoNet. Figure 8 shows the results of the regressions in a heatmap. We ran a regression between each attribute and the strength of the correlation is denoted by the color, with lighter colors meaning strong positive correlations and darker colors meaning strong negative correlations. Although many of the attributes showed weaker correlations with each other there were some correlations that stood out. One of these was the negative correlation between the percentage of diabetes patients in poor control and the number of persons that did not have insurance. This means that when a population is not insured, they are more likely to be in poor control of their diabetes. This result is also interesting as there is a much weaker correlation between insurance and patients in good control. Another negative correlation that is worth noting is the population density with the percent of patients in poor control. This negative correlation shows that the more rural areas are the areas that are struggling the most with managing their diabetes care. These regressions help to demonstrate what areas need improvements to their diabetes care and where Stability Health might fit in.

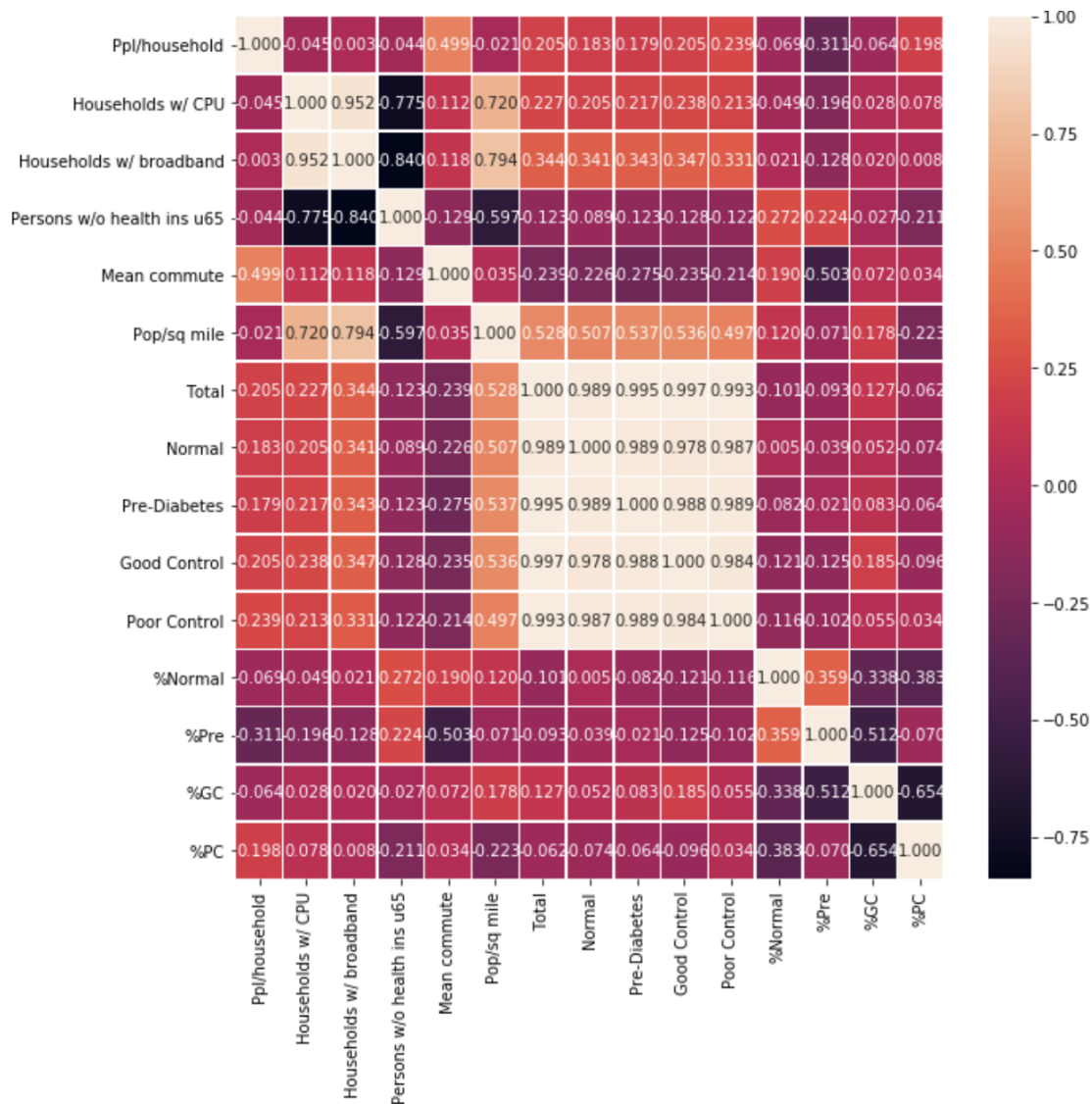


Figure 8: Correlation heat map with social determinants of health attributes

Another dataset we ran regressions on included data on diabetes-related deaths, hospitalizations, ER visits, education, testing, total number of diabetes patients and percentage of diabetes patients. The standard of care data was found through our research and the diabetes data was provided by HealthInfoNet. We had this data for each of the 16 counties in Maine. Figure 9 shows the heat map. This heat map also showed weaker correlations between most of the attributes but there are a couple that are worth diving into. There was a strong correlation between the percentage of poor control patients and the total number of diabetes hospitalizations. There was also a strong negative correlation between the percentage of patients in good control of their diabetes and in diabetes hospitalizations. These two correlations go hand in hand in saying that when patients are in good control there will be fewer hospitalizations and when patients are in poor control there will be more hospitalizations. This shows the demand for

keeping patients in better control of their diabetes so they do not have to be hospitalized as often; this also points to an opportunity that Stability Health can help address.

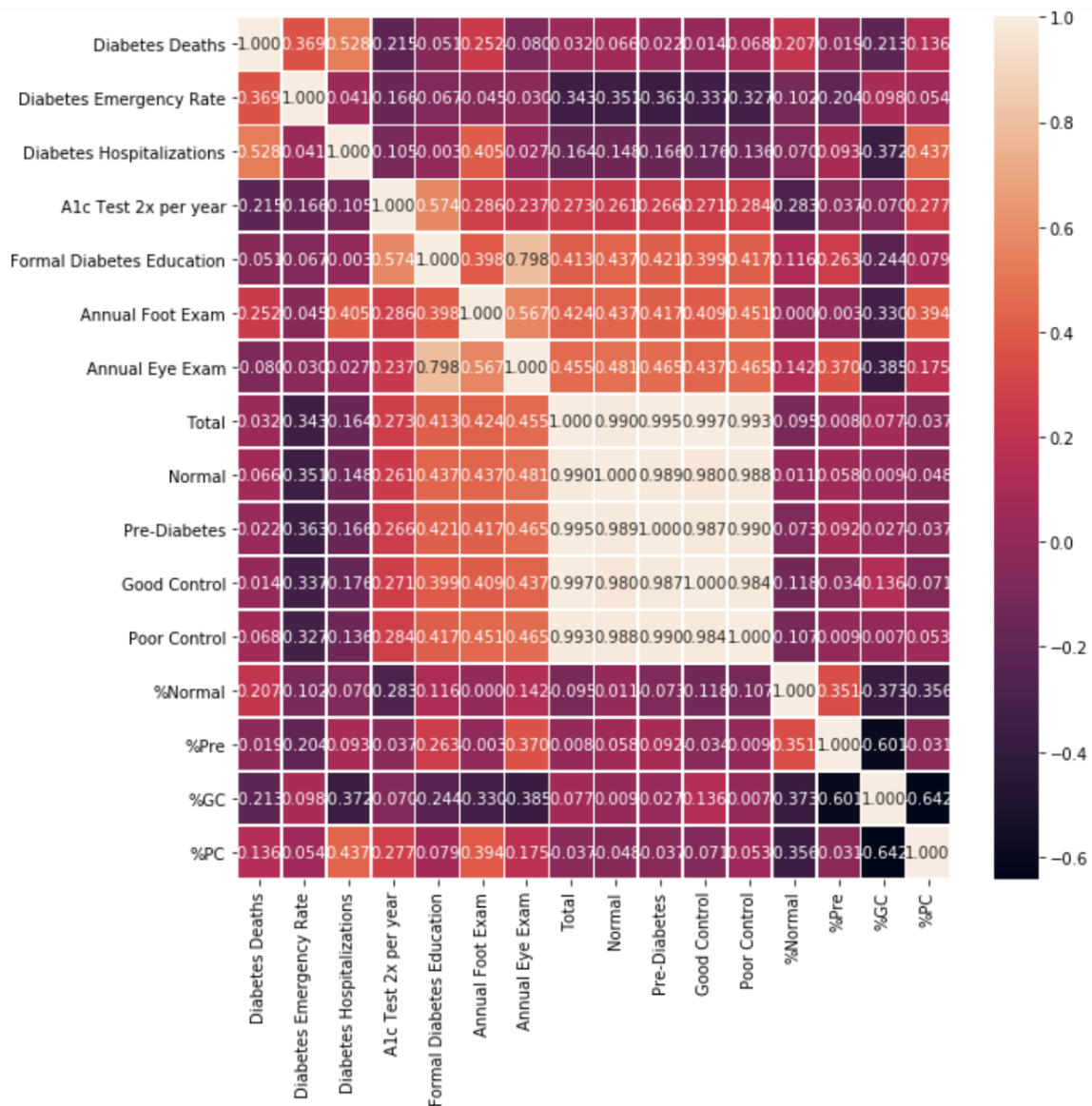


Figure 9: Correlation heat map with standards of care attributes

D. Patient Interviews

To get a better glimpse into the demand for diabetes care and where Stability Health could potentially fill that gap, we interviewed diabetes patients. In total, we interviewed three diabetes patients. One patient is living with type 1 diabetes, one patient is currently a Stability Health patient, and one patient is interning with Stability Health. Interviewing these patients allowed us to gain a well-rounded perspective on diabetes care.

From interviewing the Stability patient, we learned using SH’s services helped get his blood sugar under control. He said he uses SH services daily, including speaking with his health

coach and using the SH app. He was first introduced to SH through a family connection. This patient said, “he chose it [SH] because they chose him.” We also discovered that this patient greatly enjoyed using a health coach to manage their diabetes specifically because it gave them someone to contact quickly with any questions or concerns while also providing them a contact who specifically tracks their individual progress. A suggestion that this patient had was to be able to implement comments into the SH system. Overall, this patient loves virtual diabetes care and finds it helpful in managing his diabetes by saving him time and keeping him accountable.

The type 1 diabetes patient we interviewed offered similar insight in his response in that he also enjoys using telehealth and virtual care services for managing his diabetes. He enjoys telehealth because it allows him to easily ask questions to someone he trusts and who is readily available to answer them. Even with these services, he still sees the importance of in-person visits to the doctors and other care facilities. He thought the health coach was helpful as well. The health coach motivates him to stay on track with the idea of not wanting to let his “team” down. Ultimately, this patient expressed that ideal healthcare comes with getting the best technology.

The third patient who interns at Stability Health, felt family, friends, and new technology were the main support systems in managing her diabetes. For this patient, her school schedule makes scheduling doctor and endocrinologist appointments very challenging. This patient is not currently enrolled in a virtual diabetes care program, but she did say she would be interested in joining a program like Stability Health’s. For this patient, ideal diabetes care means being able to talk about blood sugar trends, as well as having a strong connection with someone who she would feel comfortable talking through solutions with. Communication, accountability, and self-management are three key factors this patient stressed were key to having successful diabetes care.

II. Understanding the Supply for Diabetes Care

This section discusses our results and findings for finding the supply of diabetes care in Maine. The first subsection discusses the data we looked at for this section and our analysis of that data. The second subsection discusses the findings from our interviews with diabetes care providers. Our final subsection discusses Stability Health’s competition and how they differ.

A. Data Description and Analysis

To better understand the supply of diabetes care in Maine we first gathered and analyzed the data we could find. The data we gathered for the supply of diabetes care in Maine mostly focused on the number of hospitals, the number of endocrinologists and the status of diabetes patients. The data that involved the type of control patients were in was supplied by HealthInfoNet. HealthInfoNet gave us information on what the patients control status was for each county. Data and information provided by HIN was de-identified to ensure there was no violation of patient privacy. The data on the number of hospitals and endocrinologists was gathered by our own research. We used the websites of Maine Health and Northern Light to find

where their hospitals were and how many endocrinologists they had at each hospital. To find other hospitals and endocrinologists we used U.S. News website’s search function to find endocrinologists and hospitals in Maine. To find other data on population statistics we used HomeTown Locator’s website. The full data dictionary for this section can be seen in Table 4.

Table 4: Data Dictionary for Population and Hospital Data

Name	Description
County	Name of each county in Maine
Population	Population of each county in Maine
Median Household Income	Median Household Income for each county in Maine
Unemployment Rate	Unemployment Rate for each county in Maine
Poverty Rate	Poverty Rate for each county in Maine
Median Age	Median Age for each county in Maine
HS Grad Rate	High School Graduation Rate for each county in Maine
Hospitals	Total number of hospitals in each county in Maine
Northern Light	Total number of Northern Light Endocrinologists in each county in Maine
Maine Med	Total number of Maine Med Endocrinologists in each county in Maine
Other	Total number of other Endocrinologists in each county in Maine

Using the data, we collected we were able to develop a good foundation of the supply for diabetes care in Maine. In Figure 10 the total number of hospitals in each county along with the total number of endocrinologists in each county is shown. In each graph, the counties are ordered from highest population to lowest population. Figure 10(a) shows that all counties in Maine have at least one hospital except for Sagadahoc. The graph also shows that Cumberland and Penobscot counties both have the most hospitals in Maine; this makes sense as these are the two most populated counties. When looking at the number of endocrinologists in Figure 10(b), once again Cumberland and Penobscot have the greatest amount. This graph really highlights the lack of specialty diabetes care in the other 14 counties in Maine, even the counties that have a higher population have very few diabetes specialists.

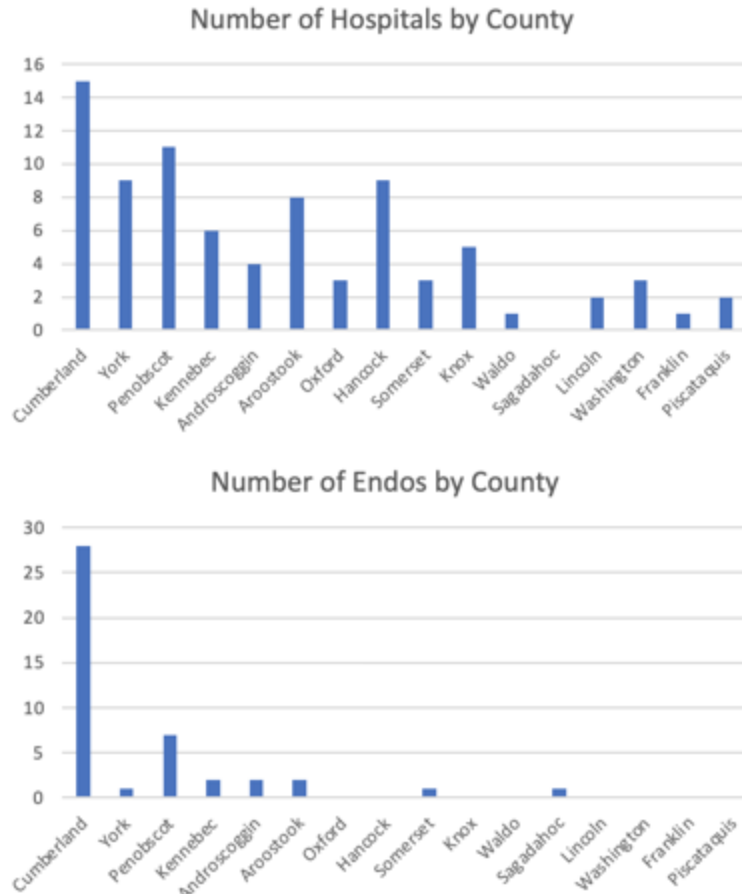


Figure 10: (a) The total number of hospitals in each county in Maine and (b) the total number of endocrinologists in Maine

B. Provider Interviews

To understand the supply of diabetes care, our team interviewed several healthcare professionals to comprehend what they saw working well and what they saw working poorly in their clinics. We interviewed five endocrinologists working in different parts of the United States. The diversity of location allowed for unique points of view as well as breadth in communities served. From our interviews, our group distilled answers that came up multiple times from different interviews and highlighted the takeaways that could be made from that. We also crafted five unique “checklist” questions (Appendix E) that we made a point to ask each interviewee to see how responses differed.

The largest common problem providers we interviewed faced was lack of time with patient, and lack of accessible patient data. All three interviewees mentioned that they lack time with patients. Oftentimes, the lack of easily accessible data ties into this predicament. If a patient only has a 30-minute appointment, upwards of 15-20 minutes is spent uploading data, or if the patients forget their device, asking them about their numbers. One provider called speaking with patients about their numbers “the most time expensive part of appointments.” Also, the accuracy of the numbers given by the patient may not be of the highest quality if they are just guessing or lying about their numbers. This can decrease the quality of care that a provider can give if he/she

does not have accurate patient data to work with. Another provider said this lack of time extends to dietitians and primary care teams as well and is not a problem unique to endocrinologists.

Another major point of consensus amongst the providers we interviewed was the notion that patient motivation is an extremely important factor in patient success. Multiple providers commented on the idea that Type A personalities and analytical thinkers like to take control of their disease by examining their numbers and working to improve them. However, other providers commented on the fact that some patients find it difficult to make their disease a priority at the expense of their job, family, or other needs. One provider made it a point to consider how personality disorders can also have an impact on a person's ability or desire to manage their diabetes effectively.

Finally, the last point of consensus amongst the providers was the idea that telehealth is the future of diabetes care. COVID-19 has brought about a rapid change about how care is delivered. Video and phone appointments have become the norm. This has allowed for patients to more easily access their doctor. They do not have to deal with finding transportation, waiting in traffic, or fear of contracting disease in a doctor's office. The primary roadblock to telehealth visits before COVID-19 was billing laws. However, since the pandemic, billing laws have been eased to allow for providers to use telehealth visits as billable hours. These changes seem to be sticking around permanently, easing the difficulty of conducting telehealth visits. One bonus to telehealth noted by a provider was the unique opportunity to see into patients' lives and homes. This allows the provider to gain a better understanding of what a patient is dealing with on a day-to-day basis and can help them better cater care to ensure patient success. Telehealth also allows for more touchpoints with the patients. The number of touchpoints with a patient and patient success have been found to be positively correlated through many studies, including some referenced in our literature review. Obviously, there are some concerns with access to broadband or WiFi for some patients, which may make virtual health more challenging.

C. Competitive Analysis

In order to examine the supply of diabetes care, our group researched the competitive landscape of companies that provide similar services as Stability Health. Our research focused on three distinct company types: value-based care management companies, chronic care management companies, and diabetic care management companies. While SH does not fit neatly into any of the three types due to its distinct model, these companies provide service to customers that SH is competing for. Table 5 shows the different competitors we looked at and how they compare to SH.

Value based care management companies are companies where customers pay "for health care services in a manner that directly links performance on cost, quality and the patient's experience of care" (Moody-Williams 2018). The major player in this company type is Evolent Health. Evolent Health works with many chronic care medical conditions, and financially rewards performance-based contracts. They are 100% virtual and work with PCPs, but do not have connected devices capabilities. Another big name in this field is Arcadia. Arcadia is based

in Burlington, MA and has partnerships with Medicare, MEDITECH, and Cigna. They are a diabetes-focused, AI driven care management platform which tailors' programs to the patient at a large scale. Arcadia, like SH, employs clinicians and uses risk stratification to prioritize high cost/high risk patients. Arcadia may be the company most like SH, but they do not have connected device capability. Arcadia has 93 million patients and revenue of \$35 million. While SH's cost structure is not yet explicitly defined, they do propose a cost structure where partners will pay SH a portion of the money earned to increase performance. This includes fewer readmissions and higher reimbursements, for example.

The next "bucket" of company types are chronic care management companies. These companies may focus on many or a few chronic diseases, but not exclusively focused on diabetes. Avery Telehealth, part of the Avery Group, is the largest player in this arena, focusing on CHF, hypertension, diabetes, and other diseases. Participants meet weekly to discuss their needs, and Avery Telehealth employs medical practitioners. Lark Health is another chronic care management company that focuses on prediabetes, Type 2 diabetes, and overall wellness. Their program includes instruction from health coaches, a mobile, and connected device capabilities, and participants usually have the program covered if they have Type 2 diabetes.

The final type of companies we explored are diabetic care management companies. These companies focus explicitly on diabetes care. The biggest US company in this sector based on the number of users is Glooko. Glooko is an app that collects data from multiple devices including insulin pumps and fitness trackers. All this data is combined for the review of a patient's care team. The company focuses on both Type 1 and Type 2 diabetes and has partnerships with the Mayo Clinic, Stanford Medicine, and Atrius Health. Livongo is an up-and-coming player in this field, having signed a deal with the US government to expand their member base by 45,000. Livongo focuses on all types of diabetes and uses health coaches and AI to provide care.

Overall, while several companies provide services like SH, there are none that capture the complete mixture of personalized care plans, rules engines, and health coaches that SH does. It is encouraging to see profitability in these similar companies. SH can follow the trail blazers in the industry while utilizing their competitive advantages to carve out share of an overall diabetes market that NCBI values at \$16.4 billion in the US alone, with expected growth to nearly \$40 billion in 2022. The more successful companies (the companies with the biggest user base and highest revenue) have expansive partnerships with health systems and clinics that allow not only integration but patient outreach. By building these valuable relationships, such as the relationship they have forged with HealthInfoNet, SH can continue to scale their model to various regions with success.

Table 5: Outlining SH's Competition

	Value Based Care	Chronic Care	Diabetes Care
Description	Companies' revenue is based on performance and patient experience.	Chronic care companies care for many different chronic diseases, sometimes including diabetes.	Diabetes care companies focus specifically on diabetes, but often do not have medicinal or clinical staff.
Major Players	Arcadia Evolut Health Apervita	Wellbox Orb Avery Telehealth	Glooko Livongo DarioHealth
How SH Differs	SH device tracking and care plans provide a custom approach to each individual patient.	SH focuses exclusively on diabetes. Their expertise is diabetes, and their focus is only on diabetes patients.	SH has endocrinologists and CDCESs on staff. SH is also fully integrated with the patient's provider.

Chapter 5: Analyzing Opportunity

To analyze the opportunity for Stability Health, we considered the two aspects of operational and financial opportunity. We then used our engineering and business backgrounds, combined with research, to determine appropriate analysis tools to base our recommendations on. This ultimately led us to utilize a cost benefit analysis (CBA).

A CBA is a process in which a business can analyze which decisions to make by evaluating potential benefits expected from a decision and then subtracting the associated costs. This kind of analysis allows us to include value on both tangible and intangible items. The CBA shows the benefits that SH's model provides and their associated costs. There are three subsections in the CBA for SH, potential providers, and potential patients.

I. How Stability Health can Fill the Gaps in Conventional Diabetes Care

This section has been redacted for confidentiality reasons.

II. Operational Opportunity: Process Flowchart

Figure 12 is a flowchart that describes how SH can integrate their model operationally. The diamonds in this model show common difficulties unique to rural settings, outlined in our background research and literature review. Low population density can make virtual diabetes care an attractive option as it negates the need for people to travel long distances to receive care. Low annual exams (foot and eye) can show a market that is not meeting the diabetes standard of care. This type of market can be attractive for SH to enter as there is potential to increase control. Low health literacy also represents a market where SH's services would be welcomed as their health coaches can provide education to participants. Once an ideal market is located, a partner in the region will be chosen. If the region has low broadband access, a local Walmart or library could provide an area with WiFi and a computer to let SH participants speak with health coaches. Then SH and their partner will determine outcomes and initiatives. The next step is a discovery phase between stakeholders on both sides followed by defining requirements and specifications. Finally, the development phase takes place followed by implementation and evaluation.

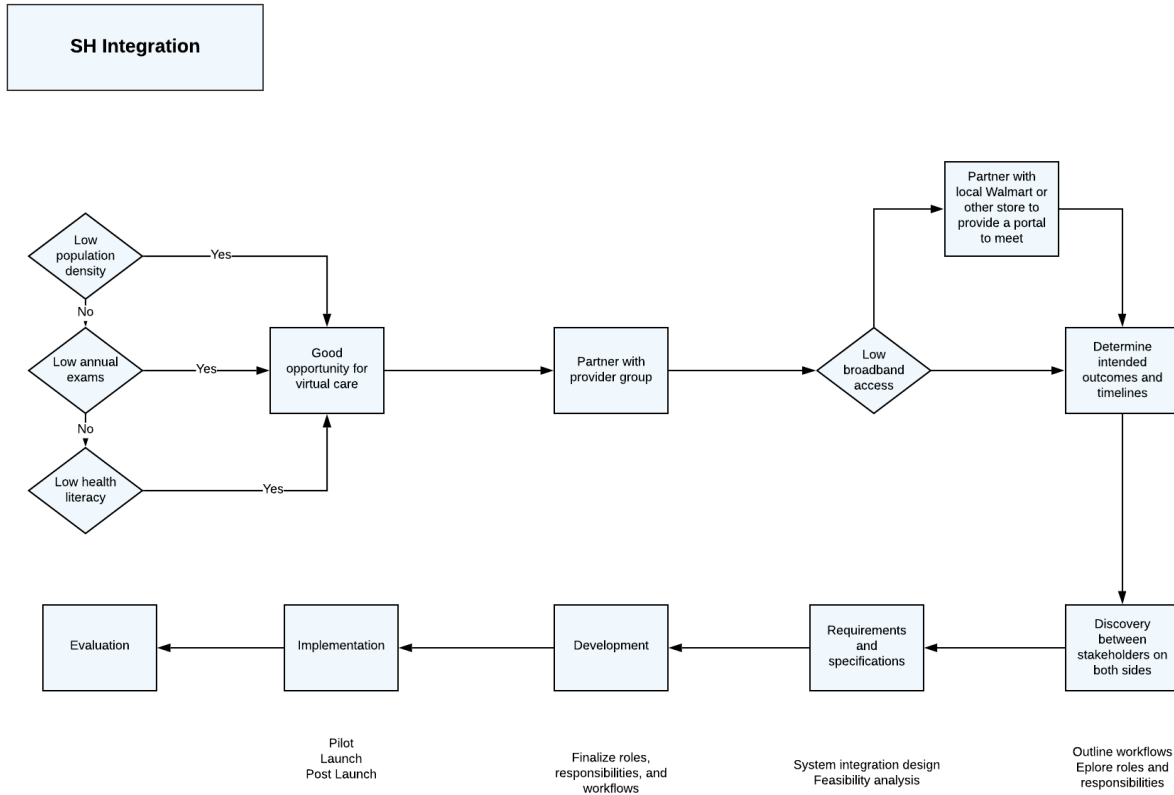


Figure 11: Flowchart for how SH can integrate their model

III. Financial Opportunity: Costs/Benefit Analysis Template

The cost-benefit analysis (CBA) template in Table 6 breaks down the different benefits and their associated costs by the different parties involved in SH’s business model, specific to expanding to rural areas of Maine. In order for SH to integrate business and services into more areas, there are expenses such as labor costs that include possible new hires, their training, and the time they spend coaching and working. There may be legal costs associated with a contract or plan with a new provider or client. Another cost that needs to be accounted for would be the potential renewal of hardware and software to be able to undergo an expansion and the data storage it would need. Current employees would be needed to work on the integration steps. This includes determining the general project scope that needs to be identified between SH and their potential client. The discovery, requirement, and specification steps involve SH and the client working together to create a feasibility analysis and ensure goals are established. The development and implementation steps create, modify, and place processes and technology into a pilot of the system and an evaluation is performed last. The benefits that can be reached from encountering these costs would be the obvious business expansion, paving the way for future revenue. That revenue would depend on different aspects such as the number of patients who enroll or savings generated.

Table 6 Cost/Benefit Analysis Template

	Costs	Benefits
Stability Health	<ul style="list-style-type: none"> ● Time <ul style="list-style-type: none"> ○ Scope ○ Discovery ○ Requirement Specifications ○ Development ○ Implementation ○ Evaluation ● Potential Software/Hardware Renewal <ul style="list-style-type: none"> ○ Data Storage ● Opportunity Costs <ul style="list-style-type: none"> ○ Opportunity Elsewhere ● Labor Costs <ul style="list-style-type: none"> ○ Training ○ Coaching time ○ Hiring ● Legal Costs 	<ul style="list-style-type: none"> ● Business Expansion <ul style="list-style-type: none"> ○ Can lead to further expansion ● Self-Marketing <ul style="list-style-type: none"> ○ To Patients/Families ○ To other Provider Organizations
Potential Provider Organization	<ul style="list-style-type: none"> ● Money (Cost of SH services) ● Time ● Labor Costs <ul style="list-style-type: none"> ○ Training ● Legal Costs ● System Changes <ul style="list-style-type: none"> ○ Reacclimation ○ Go Live Support/Post Go Live Support ● Lack of Patient Interest 	<ul style="list-style-type: none"> ● Save on health care expenditure <ul style="list-style-type: none"> ○ Lower readmission rates ○ Less calls to EMTs ○ Less inpatient hospital stays ● Increase in resources for patients ● Less in-person appointments <ul style="list-style-type: none"> ○ Less blood glucose monitoring
Potential Patients	<ul style="list-style-type: none"> ● Time <ul style="list-style-type: none"> ○ Learning the program ○ Meet new coaches ● Resources <ul style="list-style-type: none"> ○ Phone/Virtual Services ○ Potential broadband updates 	<ul style="list-style-type: none"> ● Fewer in-person appointments <ul style="list-style-type: none"> ○ Transportation Savings ● Flexibility in schedule ● Health coach <ul style="list-style-type: none"> ○ Motivation ○ Accountability ○ Diabetes-specific education ● Personalized care plan <ul style="list-style-type: none"> ○ Diet, labs, vitals, lifestyle, medications ○ Goals and recommendations ● Technology <ul style="list-style-type: none"> ○ Assess blood glucose ○ Easy sharing with primary care doctor

The same kind of analysis was conducted for potential provider organizations that could be used to market SH's services. Providers' costs include paying for SH's services, and the similar time, labor, and legal costs that SH would experience. There would also be system changes such as reacclimating and Go Live Support and Post Go Live Support which could help staff gain confidence in using new services. Another possible cost to a provider would be losses if there is a lack of patient interest or participation. There are many benefits for potential provider organizations. With an increase in resources for patients, the costs associated with health care expenditure have the chance to be cut by large amounts. There is potential to save money with fewer EMT calls, fewer inpatient hospital stays, and lower readmission rates to the hospital. Lower readmission rates also will decrease the amount of readmission penalties the hospital would receive. Another important benefit is that there will be less in-person appointments for diabetes patients. This can help primary care physicians have more time in their schedules and spend less time monitoring blood glucose levels because of the technology that SH provides to the patient.

For new patients working with SH, there are few costs. It will take time to learn the program and meet new coaches and educators. The patient will need phone and internet access which could call for broadband updates. Contrastingly, there are many benefits for SH patients. Having an individual care plan is a unique service for a diabetes patient because everyone's disease is different. This care plan consists of set goals and recommendations of diet, labs, vitals, lifestyle, and medications. Along with a personal care plan, patients have a health coach and are offered diabetes education which helps patients stay motivated and accountable. The technology that SH provides that easily assess blood glucose and shares it with primary care physicians means that patients can take less trips to the doctor. This can create opportunities for savings in time and transportation and allow for flexible scheduling.

This template can be used by SH in the future to determine the different benefits and costs related to expanding their operations. Using this template SH will be able to put numbers associated to each one of the costs that are explained. This will allow for SH to easily analyze whether the expansion will be worthwhile or not. SH will also be able to put different values associated with each benefit that will make it easier for them to see the rewards. Some of these values will be easier to estimate than others, SH will need to be able to conduct research on each cost and benefit to determine what the correct value is. The CBA template will be a valuable resource for SH in the future as they will be able to understand what the different costs and benefits are of expanding and be able to make a well-informed decision on whether they should expand or not.

Chapter 6: Recommendations and Conclusion

The goal of our project was to determine the opportunity of implementing SH's model into Maine and providing them with tools to do this in other areas. From our analysis, we were able to craft recommendations for Stability Health, specifically related to markets opportunities for Maine. We combined our results from the AHP, TOPSIS, and DecisionTree analysis to conclude that Franklin County had the most demand for improved diabetes care, followed by Piscataquis County and Washington County. We also were able to recommend which pricing model would be best for Stability Health to use in a rural area like Franklin County. We anticipate SH can recreate our procedure and come to the same conclusion. Then, SH can reimplement the procedure in other areas they are considering entering.

I. Recommendations

Our goal was to create an easily repeatable process that SH could recreate in multiple areas to assess how worthwhile a county may be to implement into. We used the Maine counties as a case study. We analyzed publicly available data using a variety of tools including Analytical Hierarchy Process (AHP), Technique for Order of Preference by Similarity (TOPSIS), and DecisionTree. SH could recreate this process using data from other areas to determine demand for their services.

In the results of our AHP calculation, found in Appendix F, Franklin County had the highest demand. Franklin was followed by Washington, Piscataquis, Penobscot, and finally Cumberland. In the results for our TOPSIS calculation, found in Appendix G, Piscataquis had the highest demand according to our TOPSIS analysis, followed by Washington, Franklin, Penobscot, and Cumberland. Franklin was the highest demand county according to our DecisionTree, results in Appendix H, rendering it our recommendation for the top county in Maine for SH to consider for integration. Piscataquis and Washington had similar metrics, so it would make sense for SH to look there as well. The rural nature and lack of hospitals and endocrinologists made a virtual care service like Stability Health provides a good fit. In the more urban counties of Cumberland and Penobscot, there is less opportunity.

Although SH has worked directly with consumers, they are seeking to work with health systems to fully integrate their system and model. To do this, SH has already begun discussing preliminary revenue models in that would be part of financial agreements with organizations. SH would like to make direct agreements with provider organizations such as hospitals, primary care physician offices, endocrinologists, physical therapy offices, and more. These agreements would have SH provide their services and receive revenue using three different fee structure options with the option for an incentive. In the first fee structure option, the provider would have provider organization pay an upfront fee in exchange for SH to analyze and implement a new diabetes care delivery operating system using their digital system and platform. This would mean a commercial contract in which SH would re-engineer the workflows of these providers in order to try to make their system more efficient. The second fee structure would involve a program agreement in which the provider organization would pay annually for SH to provide system

characteristics as well as different services that would depend on variables such as the size of the health care providers' system and the different services provided. This would serve as a license fee in which the provider would pay every year for SH to provide certain services. The last fee structure option would have providers pay for SH services on a per patient supported method. This would entail providers paying SH based on how many active users or accessible populations that choose to use the digital platform that is provided by SH (Stability Health Internal Document, 2020) (Stability Health Interview, October 9th, 2020).

SH has also indicated that provider organizations have the option to provide incentives for SH in which they would provide bonuses for achieving certain measures such as clinical outcomes, organization satisfaction, consumer satisfaction, total savings, shared risk, and others. SH acknowledges that these measures depend on the value drivers that come with providing their services. SH hopes to provide value to provider organizations by increasing their patient volume with little or no need for additional resources such as staff or facilities. This would entail increasing provider organizations revenue by potentially using remote patient monitoring, chronic care management, pharmacy services and more while also decreasing their costs by reducing total medical expenditure. Additionally, they hope to simultaneously increase patient satisfaction by minimizing patient risk and maximizing consumer efficiency which can lead to customer retention or even better rating for the provider organizations. Furthermore, SH hopes to achieve provider professional satisfaction leading to reduced turnover and higher productivity. In conclusion, SH's system can be expected to increase overall profits by increasing revenue and decreasing costs while not only potentially increasing consumer satisfaction but also health care providers satisfaction. SH hopes that these value drivers will convince provider organizations to provide incentives for them which could lead to additional revenue for the company (Stability Health Internal Document, 2020).

Because of the complexity and variables involved with paying for healthcare alone, the pricing model that Stability Health uses in the event of future expansion will need to be dynamic. A dynamic pricing model is when the price for the same product changes depending on who is being sold that product, for SH this means that each provider organization can be charged a different price (Campbell, 2020). The information collected from interviews with providers and the SH team, the analysis of financial opportunity, and research on different kinds of pricing models also concluded that a dynamic pricing model should be utilized. This will allow SH to have different costs specified based on different numbers of patients, location, or other factors that directly affect costs of services. This also gives SH the opportunity to charge upfront fees, annual fees, per patient per month fees, and give incentives to providers for achieving different measures at different prices for each health system they partner with. This kind of fee structure bases revenue on active users or the accessible population, which can assure revenue even if there are no cost savings. Other fee structures such as penetration pricing, when prices are set very low to gain quick market shares, or cost-plus pricing, when prices are marked up after the total cost to the company, would not be ideal for SH due to the need for revenue to offer services (Boundless Business). Other pricing models that are competition-based also may not work as

SH's telehealth services are so different from other services in the industry. With the ability to shift and change prices, SH will have the best opportunity at earning revenue as the company expands to Maine and further.

II. Conclusion

Rural areas face many unique challenges when it comes to receiving diabetes care. Lack of public transport, lack of adequate facilities, and food deserts are just some of the elements that compound to make managing diabetes more difficult. With Stability Health's virtual model, managing diabetes can become easier for patients. Health coaches inspire patients to become more engaged, help patients organize their data before appointments, and conduct frequent check-ins to increase touchpoints. All these strategies are clinically proven to increase positive patient outcomes.

We found many similar themes through interviews with patients and providers. One topic brought up was that staying on top of diabetes is hard. Often patients find themselves in predicaments with competing priorities including their family, their job, and their diabetes. Stability Health's health coaches can help motivate patients just by being there to support them and answer any questions they may have. A participant does not need to drive to a doctor's office to have their device explained to them, instead a SH health coach can do it virtually. This motivation leads to better patient outcomes, as it helps the patient stay on top of their diabetes, which helps their provider provide better care.

When treating diabetes, there is just not enough time to ensure every patient gets the care they deserve. Locating and uploading data often takes up most of the appointment which causes providers to lose valuable time with the patient. SH sends reminders to patients to get their labs done and sends data to the provider ahead of time so once the patient walks into the office, they are ready to go. This data piece is important to providers as they no longer must rely on patients to guess at their numbers. Knowing the data is accurate allows them to provide better care and leads to positive patient outcomes.

Check-ins are a regular part of the SH model. Check-ins are often done through the phone, but they can also be done over text or video call. These multiple patient touch points allow for the patient to become more engaged, which leads to better outcomes. Patients often commented in interviews about check-ins being valuable and knowing they could always contact their SH health coach for any of their needs or questions.

Stability Health has designed a model where they can accomplish each of these strategies virtually, which is extremely appropriate for rural areas. Using HealthInfoNet's data, we were able to quantitatively analyze which areas were the best fit for SH's services in Maine. Our procedure could be repeated in any area and following our methodology will serve SH well as they continue to expand. Leveraging data from HIN was integral to our project's success. Assuming SH can form a partnership with similar entities in other areas, the tools and processes we used can be repeated with data from other regions.

While we found that Franklin County is the best option for SH amongst the five counties we analyzed, we understand that the way we weighted criteria as well as the five individual counties we picked to analyze had a large impact on our conclusions. Weighting the criteria differently could have produced a different result, but the same procedure can still be followed. This process allows for a custom result, backed by whatever criteria SH deems the most important in a certain area. We designed the process with an eye toward the future growth of SH and have little doubt it will serve them well as they continue to expand operations.

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Appendices

Appendix A-Glossary of Terms

A1c- Glycated hemoglobin, a measure of how much sugar is attached to the blood's hemoglobin protein

Analytical Hierarchy Process (AHP)- A process for determining the best alternative based on weights of each criterion analyzed

CDCES- Certified Diabetes Care and Education Specialist

Death Rate- The ratio of diabetes deaths to the diabetes population of the counts

Diabetes Good Control- A1c between 6.4 and 8.9 or FPG between 125 and 199 mg/dL

Diabetes Poor Control- A1c greater than 9.0 or FPG greater than 200mg/dL

Diabetes Readmit Rate- Ratio of 30 day readmissions to total population

Normal- A1c lower than 5.7 or FPG lower than 100 mg/dL

Population per hospital- The number of persons in a county divided by the number of hospitals in the county

Prediabetes- A1c between 5.7 and 6.3 or FPG between 100 and 124 mg/dL

Rural Population- Ratio of those who live in a defined rural area to total population

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)- Process for determining the best alternative based on which alternative is closest to the ideal solution

Appendix B-Questions for Diabetes Patients/Family Members

- 1) What are your greatest daily challenges?
- 2) Describe the area in which you live.
- 3) Do you have difficulty in managing your diabetes?
- 4) What about your environment makes managing your diabetes difficult?
- 5) Do you have access to WiFi?
- 6) Do you have reliable transportation?
- 7) How often do you see your doctor?
- 8) How easy is it for you to take off work if you need to?
- 9) What is your opinion (if you have one) on virtual diabetes care?
- 10) What does ideal diabetes care look like to you?

Appendix C-Questions for Diabetes Care Providers

- 1) What are your greatest daily challenges?
- 2) Describe the area in which you work?
- 3) What is the health literacy of most of your patients?
- 4) What are some common problems your patients seem to have in managing their diabetes?
- 5) Have you seen any alternative technologies or methods used to treat diabetes effectively recently?
- 6) Does your practice use telehealth services?
- 7) Where do you see the future of telehealth going in terms of its role in diabetes care?

Appendix D-Questions for SH Team

- 1) What is your background/experience working with patients who come from rural areas?
- 2) What were the biggest challenges they had in managing their diabetes/health in general?
- 3) What was the health literacy of your rural patients?
- 4) Did you do anything unique to cater to the needs of rural patients?
- 5) Do you believe that telehealth services benefit rural patients more than urban or suburban?
- 6) What does ideal diabetes care look like to rural patients?
- 7) What does an ideal partner for SH look like?

Appendix E-Checklist Questions for Providers

- 1) Do you feel lack of data/time with patients inhibits your ability to provide good care?
- 2) Does a patient's personality play a big role in managing their diabetes?
- 3) How valuable do you think diabetes educators are?
- 4) General thoughts about future of diabetes care

Appendix F- AHP Analysis

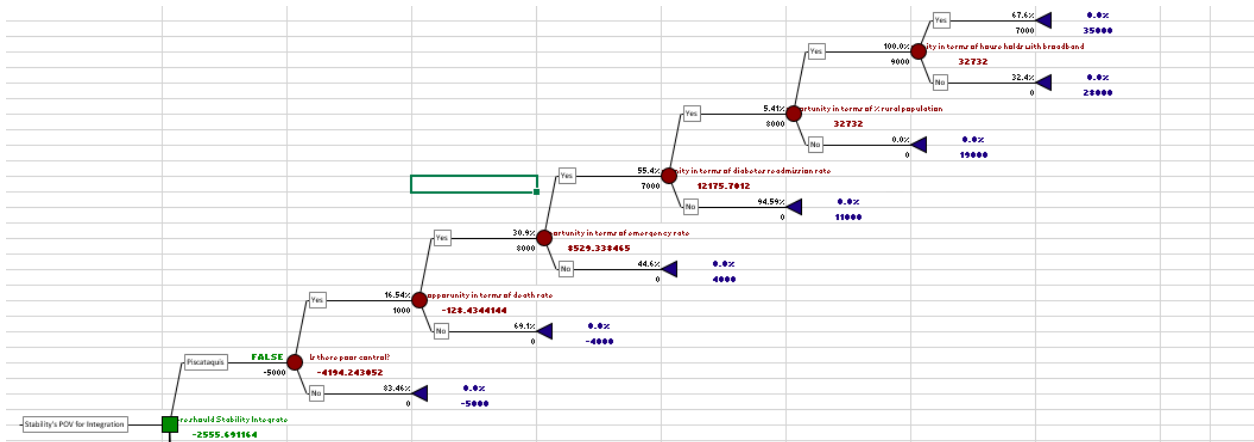
MCDM	%PC	Hospitals Per Capita	Death Rate	Emergency Rate	Diabetes Readmit Rate	%Rural Population	Households w/ Broadband	Weighted Sum	Rank
Criterion Weight	0.250	0.194	0.167	0.139	0.111	0.083	0.056		
Piscataquis	1	1	8	7	8	9	7	4.778	3
Franklin	7	7	7	3	2	7	4	5.722	1
Washington	5	2	6	8	4	8	5	5.139	2
Penobscot	4	3	5	4	6	4	3	4.139	4
Cumberland	3	4	2	3	3	2	2	2.889	5

MCDM	Households w/ Broadband	%Rural Population	Diabetes Readmit Rate	Emergency Rate	Death Rate	Hospitals Per Capita	%PC	Weighted Sum	Rank
Criterion Weight	0.250	0.194	0.167	0.139	0.111	0.083	0.056		
Piscataquis	7	9	8	7	8	8	1	7.417	1
Franklin	4	7	2	3	7	9	7	5.028	3
Washington	5	8	4	8	6	7	5	6.111	2
Penobscot	3	4	6	4	5	3	4	4.111	4
Cumberland	2	2	3	3	2	1	3	2.278	5

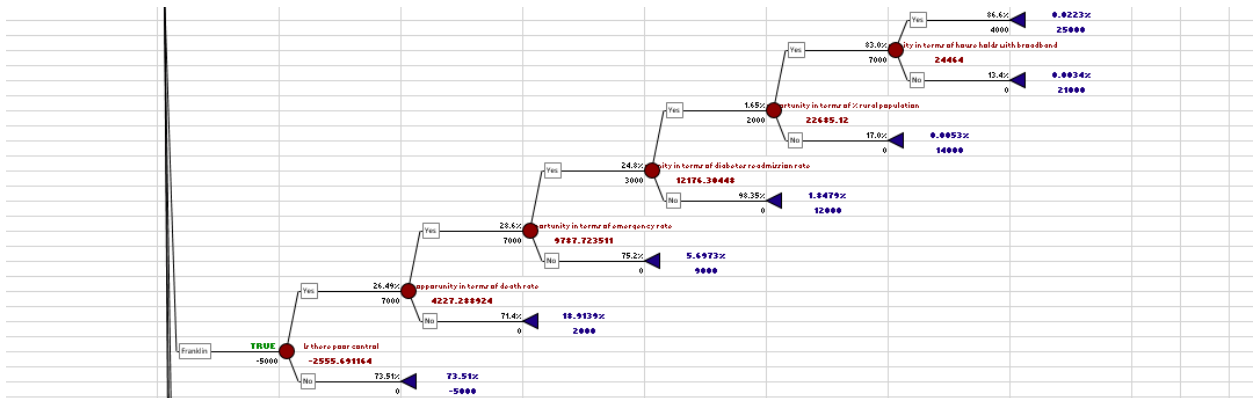
Appendix G-TOPSIS Analysis

	Piscataquis	Franklin	Washington	Penobscot	Cumberland	
Si(Ideal Solution)	3.35	3.54		2.91	3.96	5.58
Si(Negative Ideal Solution)	5.24	4.51		4.25	2.69	1.46
si(Ideal)+Si(Negative)	8.59	8.05		7.16	6.65	7.04
Closeness to ideal	0.610011641	0.560248447		0.593575419	0.404511278	0.207386364
Rank	1	3		2	4	5

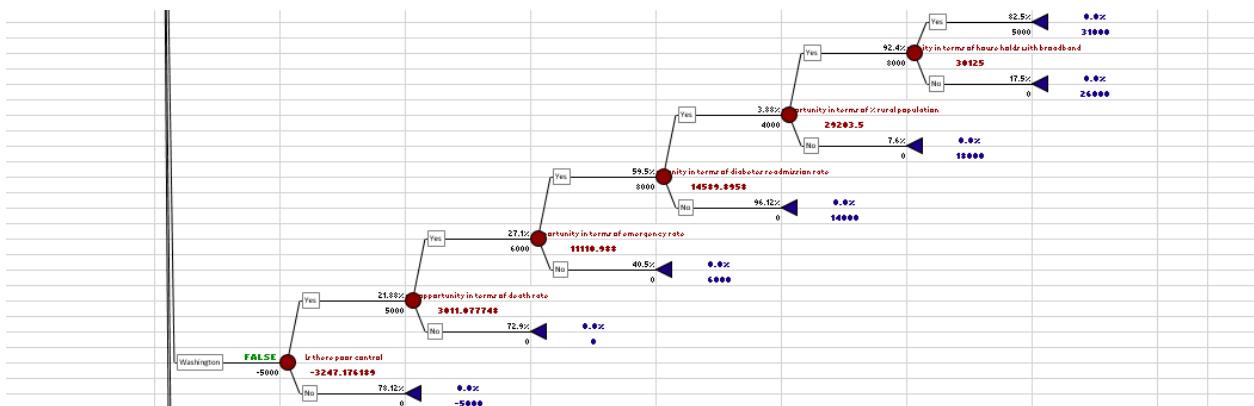
Appendix H-Decision Tree Branches for Each County



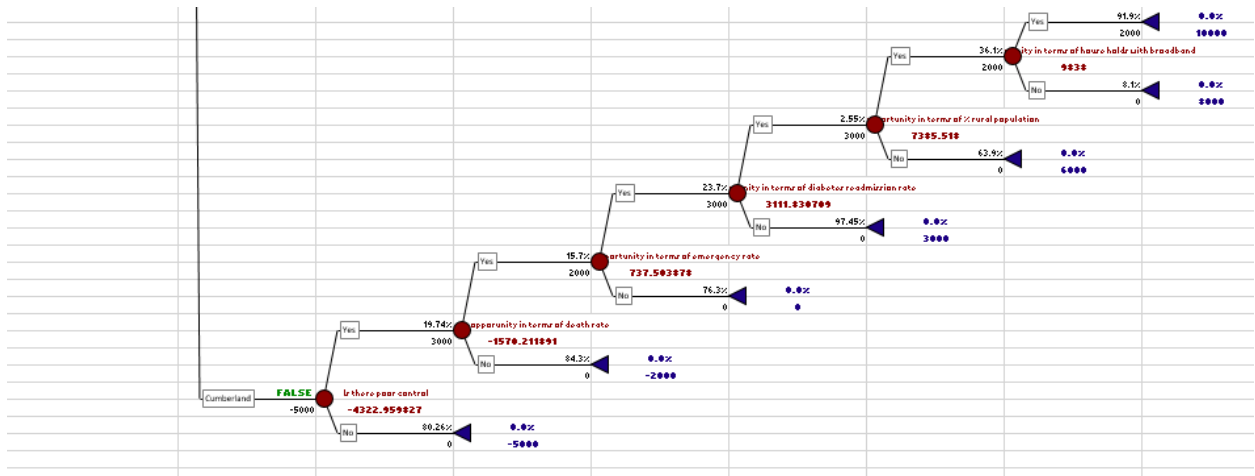
Decision Tree: Piscataquis County Branch



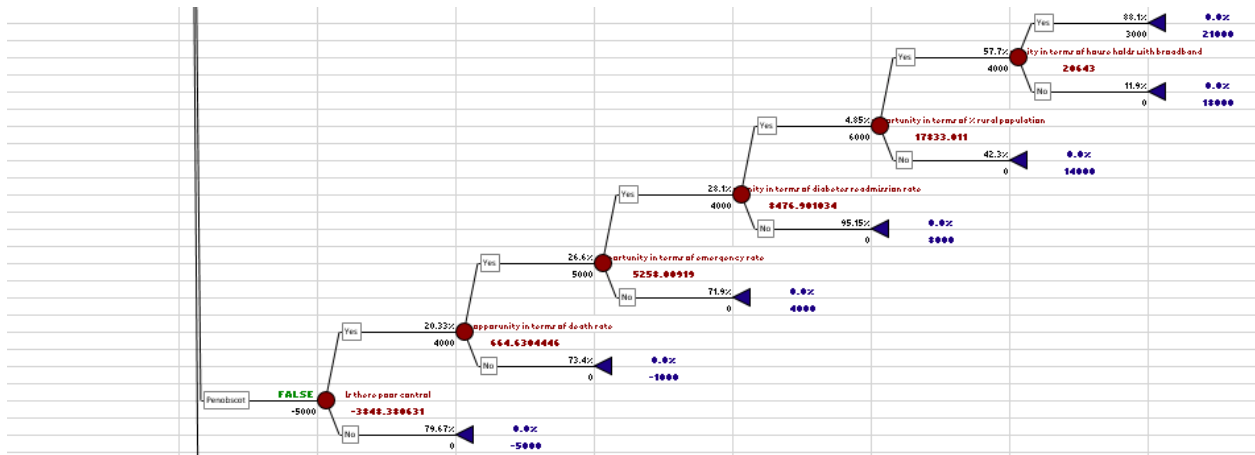
Decision Tree: Franklin County Branch



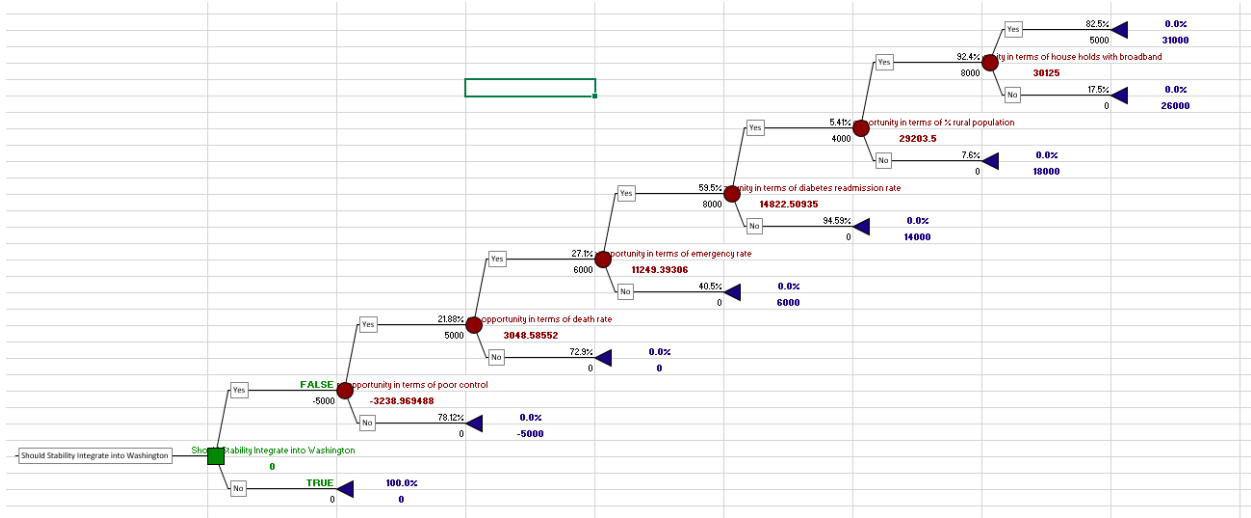
Decision Tree: Washington County Branch



Decision Tree: Cumberland County Branch



Decision Tree: Penobscot County Branch



Appendix I-Reflection on MQP

Discussion of design in the context of the project

Our group designed the process of implementing Stability Health incorporated diabetes care into the rural areas of Maine. We designed this process using background research, interviews, considering risk with potential payoffs, and practicing different types of data analysis. We also designed tools that can help Stability Health assess the need of a certain region or county. These tools were primarily based on data available for the region or county and included AHP analysis, TOPSIS analysis, and a DecisionTree. Originally, we were going to include an Arena simulation, but we settled on our three analyses because SH could easily repeat them in other areas. We acquired this data from HealthInfoNet as well as publicly available sources from the CDC and US Census. Our solutions provided in this project considered multiple standards that were provided by Stability health that kept in mind economic, regional, and diabetes care factors.

Discussion of constraints considered in the design and broader impact

Our group did extensive research into rural areas and found that there were multiple dynamics that had to be taken into account. Economic and social factors are unique in rural areas and were captured in the data we collected and analyzed. Taking these into account when designing the Stability Health-integrated diabetes care model was integral to the project. Elements like low broadband access and little to no public transportation had to be considered in order to develop a realistic design. We designed our tools with these considerations as well. We believe our tools are applicable to many rural regions and counties and can be reused in different settings as long as the data is available. Our recommendations inherently were affected by these considerations as our recommendations were a direct result of the outputs of the tools we designed.

Discussion of your experience acquiring and applying new knowledge

Our project contained a substantial social aspect. The group acquired new knowledge through conducting interviews and a literature review, two elements not covered in the WPI IE curriculum. We had to create, edit, and track answers to interview questions as well as conduct research of scholarly articles in the field of diabetes. With all the different factors we had to consider during this project, our group gained valuable experience in developing multiple deliverables that Stability Health could use when integrating in any rural areas of the country. These strategies served as cornerstones of our project.

Discussion of teamwork in the project

Our group functioned well as a team throughout the duration of the project. We made it a priority to not only meet weekly outside of our weekly meetings with our advisor and biweekly meetings with our sponsor, but also keep communication channels open via email and SMS. We used Gantt Charts created in A Term to track our progress on project goals and ensure we always knew what the next step was. We set agendas and created presentations for advisor and sponsor meetings to ensure the meetings were efficient and effective. We set self-

imposed deadlines in advance of deliverable due dates to ensure there was time for revision. Our teamwork and diligent work on the project, allowed us to provide all deliverables to our sponsor and to our advisor well before the due date. To promote leadership and inclusivity in our group we kept an open dialogue at meetings and allowed anyone to speak and voice their opinions. We also assigned duties such as note taker and emailer to ensure everyone would do their fair share.