Applying Predictive Analytics: What Actuaries Can Do to Create a More Sustainable Future

From bushfire in Australia to Typhoon Ulysses in the Philippines, both the Asia region and the rest of the world are facing the challenges of more extreme weather events these days. The economy and the insurance industry are suffering from increasing catastrophic losses. Under pressure from regulators and public expectations, climate-related risks became an increasingly important topic in the actuarial community.

When it comes to climate change and sustainability, how can actuaries create bigger societal impact? In this article, I will share how I apply actuarial skillset, such as predictive analytics and machine learning, in my sustainability consulting work and volunteering in SOA's climate research committee.

Actuaries Tackling Climate Change in Traditional Roles

In recent years, actuaries have been developing more advanced tools for society to adapt to the impacts of climate change. This could be seen from the establishment of Actuarial Climate Index (ACI) to climate risk insurance products in many Asian countries, which are prone to extreme weather events (e.g. crop insurance in the Philippines). These provide data and protection to the society to understand the adverse effects of climate change and minimize such impact. However, do actuaries have the potential to solve the root cause of the problem by reducing carbon emissions?

My Actuarial Skills at Work: Sustainability Consulting in GlobeScan

With such question in mind, I joined GlobeScan, a management consultancy specialized in sustainability. As a project manager, my role in GlobeScan focuses on research and analytics on various ESG topics, including climate change, biodiversity, sustainable living etc. We help our clients build better informed strategies that are supported by data. They are mostly Asia-based corporates and non-governmental organizations (NGOs) whose day-to-day operations create far reaching societal impact.

As an ASA, I am able to directly apply my actuarial skillset, especially predictive analytics skills, to my job. Here are several case studies on how I applied actuarial skillset to project work.

Case Study 1: Predictive Analytics and Driver Analysis – Sustainable and Green Shopping

To protect our planet, it is most effective to start with every individual. The more we consume, the more natural resources we utilize, and more greenhouse gases will be emitted. To promote sustainable shopping practices, we have worked on a research project on how retailers can provide sustainable products that attract customers.

We have conducted a quantitative survey to find out what are the major factors affecting customer behaviour when it comes to sustainable shopping. The survey received more than 3,000 responses, covering several major markets in Asia. In the survey, I have included attributes related to how customers decide where to shop for groceries, like price, location, freshness etc. In particular, I have put in statements on retailer's sustainable practices, like whether they offer products with sustainable certifications (e.g. MSC), and whether the products have minimal packaging.

From traditional research techniques, we could simply conclude that certain amount of people agree/disagree with the statements (e.g. 80% of people will go to a retailer because it advocates for less plastic use). By utilising predictive analytics tools, we can uncover any subconscious motivations which induce actual behavioural changes. To predict whether the customer will visit the retailer, I ran a generalized linear model (GLM) on variables from the questionnaire (properly categorized and binarized, so they are comparable). In the results, we could find the most important features for retailers to act upon. For instance, we could see most respondents agree with retailer's sustainability practices (e.g. partnering with NGOs, promoting BYOB), but to drive actual sales, offering products with sustainable certifications is the most prominent predictor (highest change in R-squared). Together with their internal performance indicators, the results could help the retailer to prioritize their sustainability strategies and communication materials, leading to more sustainable shopping practices.

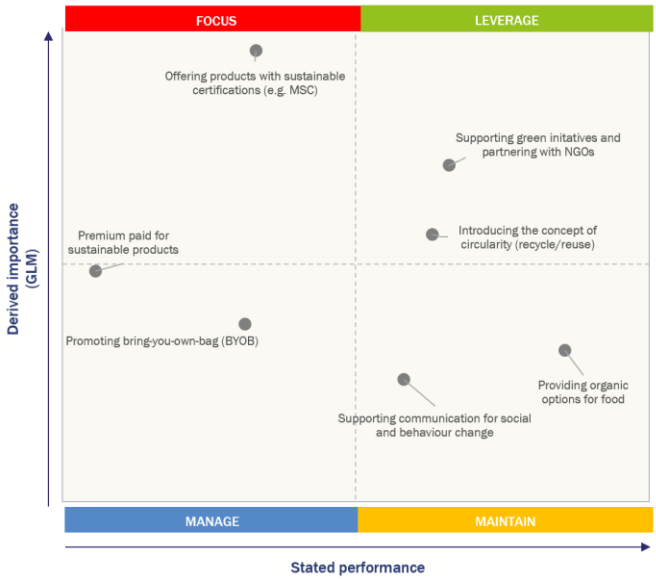


Exhibit 1: Importance (from GLM) vs performance (retailer specific) matrix on retailer's sustainable practices - simplified

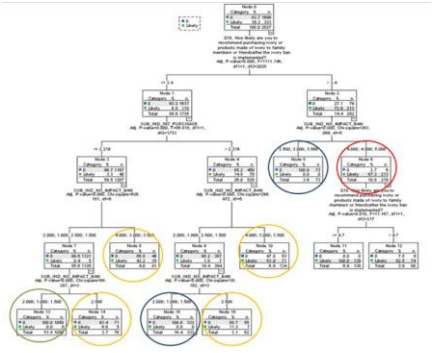
Case Study 2: Customer Segmentation by Decision Trees and PCA – Biodiversity Conservation

Nowadays, many Asian countries are focusing on conservation and reduce wildlife demand. Protecting our ecosystems is the "insurance" for our planet, as it preserves nature's capabilities to absorb carbon and reduces impact of extreme weather. Biodiversity loss is also one of the significant risks facing insurers today, yet it is insufficiently understood. How could actuaries leverage on our data expertise and reduce the risk of the catastrophic losses?

By using decision trees and principal component analysis (PCA), we could monitor and segment the buyers of wildlife products like elephant (ivory), rhino and pangolin in Asia (prominent in countries like Thailand and Japan). The analytics enables us to design campaign messages specific to each buyer segment, relying on insights which are not obtainable by the traditional research approach.

We have built a segmentation model since 2018 to monitor the buyer profile in Asia by asking their intention to purchase and various perceptions on the wildlife products via focus group discussion or quantitative survey. Once we have gathered all the data, we then conducted PCA to reduce the number of features in the model (e.g. categorizing more than 20 factors into 3-4 differentiating groups based on data, like attitudes focus on animal protection and advocacy, prestige and relationship oriented, legal and penalty awareness, etc.). This will be useful in the decision tree model since there will be less parameters, leading to less "poor splits" and results will be easier to understand – essential for designing campaign messages.

From running the decision tree model, we obtained three to four buyer segments with distinctive attitude toward wildlife products. These segments should be of reasonable size and cover from diehard buyers to rejectors. As we are doing this annually, this analysis will be useful to track composition of target buyer groups over time and see how public perception shifts. Underlying purchase motives will be used for campaign design and our partner NGOs will track down the diehard buyers by the specific demographics and behavioural traits illustrated from the model.



Rejectors

- Rejectors are those who are least likely to purchase ivory. They are more likely to be in the 51+ age bracket, tend to have a mid-level of education, have a lower income, and tend not to travel. Almost none have purchased ivory in the past 12 months and none intend to purchase it in the next 12 months.
- Rejectors are strongly concerned about the extinction of elephants and animal cruelty. They know more than other sub-groups about the ivory ban in China, they believe that the ban is important, and say they would report ivory trade to the authorities if they saw it. They do not believe that ivory makes a good gift or souvenir or that it builds business relationships.
- Rejectors have a lower rate of campaign awareness but a more positive response to the campaigns.

Ban Influenced Citizens

- Ban Influenced Citizens are those for whom the ivory trade ban in China plays a strong role in their decision making. They tend to be female, have a higher education, and have a medium income. They have lower ivory purchase rate than Diehard Buyers and their purchase in the past 12 months is decreasing over the three years.
- Before being prompted about the ivory ban, 60 percent of this segments said they were likely to purchase ivory in the future. After being prompted about the ban, this percentage dropped to 0.
- Ban Influenced Citizens believe more strongly in the artistic value of ivory but report a high rate of concern about the illegality of purchase. They are unlikely to recommend others to purchase ivory.
- This segment self-reports that campaign messages about elephant conservation are effective at convincing them not to buy ivory.

Diehard Buyers

- Diehard buyers are those who are least likely to be swayed from purchasing ivory. They are statistically more likely to be male, have a high income, have a high education, and travel more regularly compared to the general population. They have the highest rates of past ivory purchase and their intention to purchase ivory in the future is increasing, despite the ivory ban.
- Their most strongly held opinions about ivory relate to its artistic value and unique nature, and they are less concerned with price. Half say they have heard of the ivory trade ban when prompted, but they have the lowest rates of knowledge that ivory is illegal to transport internationally.
- They have the highest rates of prompted campaign recognition and report positively about the campaigns, though less so than the other two groups.

Exhibit 2: Decision tree model (left) and the three distinct segments of ivory buyers (right)

Case Study 3: Language Processing by R – Healthy and Sustainable Lifestyles

The two cases illustrated above were mainly applying actuarial skillsets under the predictive analytics framework. I would like to provide one more extended example using machine learning in sustainability projects.

In GlobeScan, we conduct a public multi-country survey annually, which aims to understand lifestyle trends related to sustainability, health and fitness. There are several open-ended questions in the survey about how the respondent contributes to a more sustainable society and a better self. With up to 25,000 global respondents participating in the survey, it becomes necessary to make the analysis of text data more efficient and accurate. One useful technique available in R is topic modelling, which is a machine learning process to categorize a large amount of text. As R and its packages are all free to use, the modelling is easily accessible for everyone. I have used packages like “tm”, “dplyr”, “tidytext”, “topicmodels” which broadly involves the following stages:

1) removing punctuation, white space etc.

2) stemming words (e.g. grouping “donation”, “donate”, “donates”)

3) counting frequency of each word

4) grouping words as themes according to the probability that they would appear together in the same response

5) repeating step 4 with randomized combinations of training and validation sets as part of the machine learning process

6) picking up the top themes from all the runs

By understanding how people are being environmental-friendly and healthy, these insights could help different organizations in promoting sustainable practices which are in line with preferences from the general public.

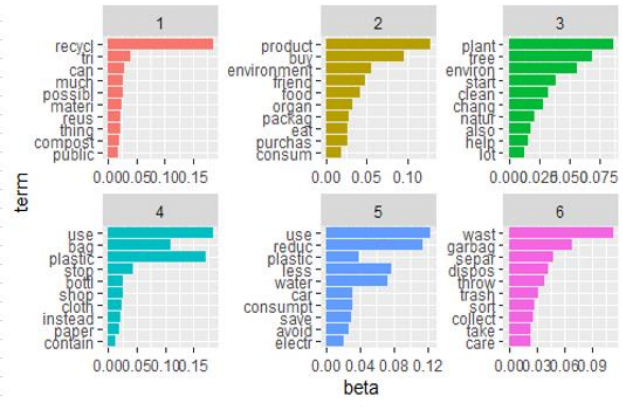


Exhibit 3: Topic modelling output from R (Gibbs sampling method)

Creating More Impact

As the defining issue of our time, climate change and sustainability have never been more important for all of us today.

This year, I am grateful to be selected as part of SOA's Climate and Environmental Sustainability Research Committee (CESRC). I have engaged in various tasks like consolidating climate data sources for actuaries and providing oversights to SOA research projects. I have cooperated with other volunteers from different timezones on topics like climate disclosure for insurers and flood risk resilience. We also publish monthly articles to support the actuarial community on climate matters. It is great to connect with other like-minded actuaries around the world and share our knowledge.

I believe it is important for us to explore more possibilities as a young actuary and work together for a better society at large. You can always find ways to make a positive impact at work. Even if you are working in traditional actuarial roles, you could be a volunteer in NGOs and associations doing social good. This responsibility falls onto everyone, no matter how young or experienced you are. You will definitely benefit from it!