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Safety first
Predictive analytics in construction worksites

A tried and tested solution, predictive analytics has been used in a variety of context and industries to help improve and optimise processes. Retailers, for instance, use predictive analytics to predict which items their customers are likely to purchase, based on their historical data as well as real-time information. In the health care industry, predictive analytics enable the customisation of treatments and medication for individual patients based on their health profiles and expected lifestyles, helping to prevent re-admissions and lower health care costs.

This brochure presents the methodology of an iterative predictive analytics model that was developed for the Ministry of Manpower to gain insight into some of the factors that contribute to worksite accident risks for construction companies in Singapore. Despite being only a proof of concept, the exercise has produced results with far-reaching impacts.

While this model has been designed for a specific context, its methodology can be similarly applied to other issues regardless of industry. We hope that this publication will provide you with a glimpse into the transformative potential of predictive analytics.
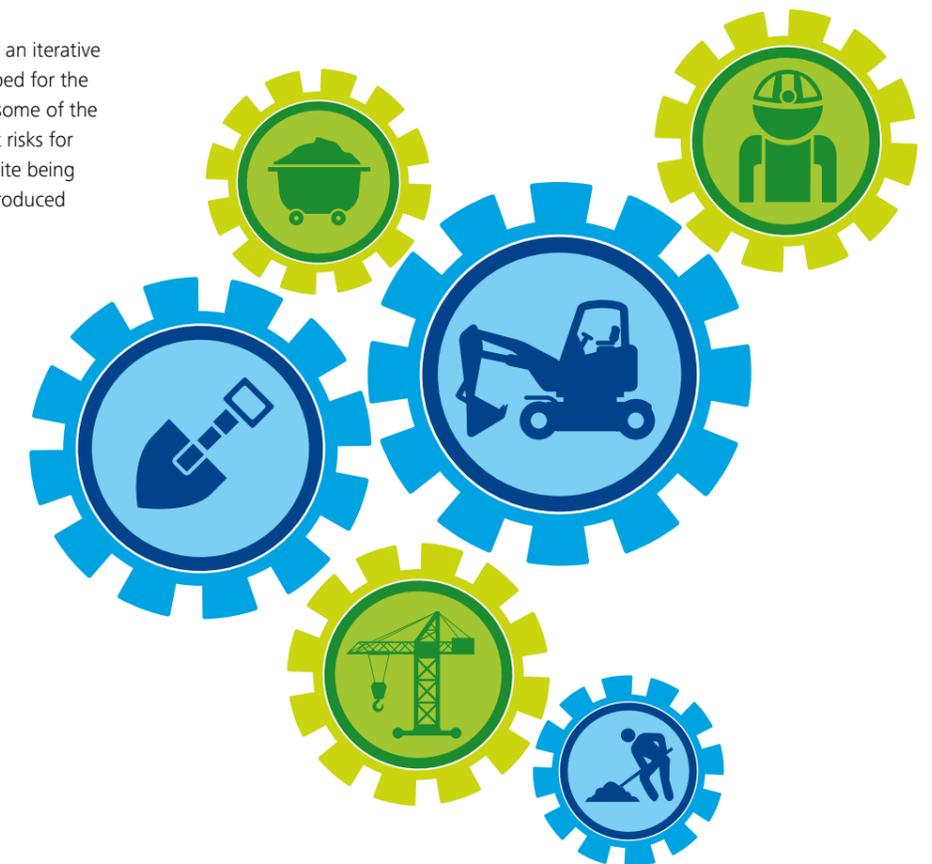
A predictive analytics model:
Hindsight, Insight and Foresight

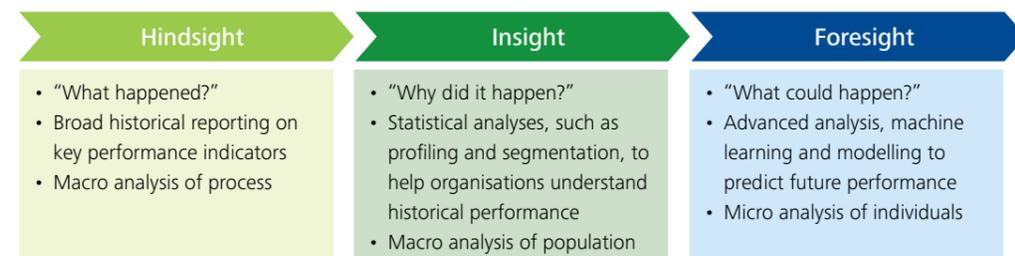A predictive analytics model was developed for the Ministry of Manpower with the goal of identifying high risk companies and target intervention areas to reduce the incidences of worksite injury in Singapore's construction sector. Its methodology is characterised by a three-step process: gathering hindsight, deriving insights, and then, finally, producing foresight.

Hindsight	Insight	Foresight
• "What happened?" • Broad historical reporting on key performance indicators • Macro analysis of process	• "Why did it happen?" • Statistical analyses, such as profiling and segmentation, to help organisations understand historical performance • Macro analysis of population	• "What could happen?" • Advanced analysis, machine learning and modelling to predict future performance • Micro analysis of individuals

Step one: Gathering hindsight

As the first step, hindsight analyses attempt to answer the question: "What happened?". This involves looking at historical data, while also keeping an eye on the macro trends that could influence the dependent variable at hand. Did the number of fatalities and major injuries increase over the years? What are the factors driving the change in the number of injuries over the years? These are some questions that this phase attempts to address.

A root cause analysis is then conducted to identify all the possible factors that could have an impact on injury rates. During a brainstorming session, participants are encouraged to share their ideas on the factors that they think could influence injury rates. Using a layered approach, the session then dives deeper to try to uncover its root causes by asking a series of "why" questions to drill a possibly confounding question down to its core.

Step two: Deriving insight

After identifying the root cause, the second step attempts to answer the question: "Why did it happen?". In this phase, statistical methods are employed to verify and explain the hypotheses of factors that contribute to the occurrence of the incidents.

The validity of the hypotheses is tested using two methods. Firstly, an analysis is conducted using a combination of statistical tests that are employed depending on the distribution of the data and the type of variable tested. Then, each hypothesis is validated against the tacit knowledge of subject matter experts in order to gain insights from the ground and to verify the logic of each hypothesis. The combination of these two methods will help to develop strong rationales for the results that will later be generated in the third phase.

It is also worthwhile to mention that this phase can be crucial in creating awareness within the organisation as conducting the exercise can help to bridge the gaps between the tacit knowledge of the individual teams.

Step three: Producing foresight

The third and final step attempts to answer the question: "What will happen?". That is, given the historical information, what is the likelihood of future incidents occurring? In this phase, the focus shifts from prescriptive to predictive – an approach that is both a science and an art. Specifically, while data cleansing, population modelling and the interpretation of statistical outputs are driven by a largely standardised approach, the process of variable transformation and model selection leaves more room for judgement.

As a culmination of the insights and analysis gleaned from the earlier analysis, this phase presents a robust approach for identifying the key drivers of worksite safety. Eventually, the data points are combined into a rigorous model and an advanced analysis is undertaken to model and predict future performance.

An illustration

Predictive analytics in construction worksites

Ben, an employee at a construction worksite, recently suffered a number of burn injuries from a leaking pipe as he did not know how to operate a machine properly. This incident could have simply have been an isolated case, or an immediate cause that is a symptom of a larger problem.

Step one: Gathering hindsight

Questions to examine during this phase could include: Was there a knowledge or skills gap in the first place? If so, was it due to a lack of training? And if that was the case, is the lack of training due to a lack of a safety culture in Ben's organisation? Or was it that the organisation simply did not have sufficient resources to provide its employees with the appropriate training?

Step two: Deriving insight

This phase could explore, for instance, if there are measures that can help to reduce the number of injuries. Will employee training be effective? By providing evidence-based explanations for the historical trends, insights can be uncovered as to whether such employee training courses are likely to have an impact on injury rates.

Step three: Producing foresight

Given the historical data, what is the likelihood of an incident occurring in the future?