

What criteria should he consider? What should be the sequence for selecting and assigning people to projects?

Case 8.3



Tham Luang Cave Rescue

On June 23, 2018, in Thailand, a group of 12 boys aged between 11 and 17 from the local football team, named the *Wild Boars*, and their 23-year-old assistant coach entered the Tham Luang cave. Tham Luang is a large cave complex in northern Thailand along the border with Myanmar. The cavern was popular with locals and the boys had visited Tham Luang before. Tham Luang cave is isolated—there is no GPS, Wi-Fi, or cell phone service. The last known survey was conducted in the 1980s by a French caving society, but many of the deeper recesses remain unmapped.

The boys had little difficulty getting fairly far into the cave, crawling through a couple of choke points to open spaces. They did not anticipate any problems getting back. The monsoon rains weren't expected until the next week, and the year before, the cave did not begin to flood until the middle of July. The team took no food with them, because this was going to be a brief field trip. They planned to stay for perhaps an hour, then return home to their parents.

However, nature had different plans. Heavy monsoon rain began to fall. The Wild Boars didn't know about the rain at first. There was a thousand feet of rock above them and they were more than a mile from the open forest. Heavy rains gathered in streams that disappeared into sinks, rushing through limestone into the cavern. Water rose suddenly and quickly, forcing the team to retreat farther and farther into the cave. The interior of the cave is not level but rather rises and falls as it burrows into the mountain. The team scrambled for higher ground as the water continued to rise. Finally, they settled on a mud slope and waited to see if the water would continue to rise. It didn't.

A mother of one of the boys contacted the police when her child failed to come home. A teammate who had missed practice that day told people that the team had planned to visit the cave after practice. Parents rushed to the cave, only to find their children's bikes and cleats at the entrance and the cave flooded.

A contingent of Thai Navy SEAL divers arrived the next day and began pushing their way into the flooded cave. This was no easy task. The Thai frogmen were accustomed to tropical open water, not the dark, cold currents racing through the cave. They lacked equipment, much less page 304 expertise needed for caves, where divers cannot just rise to the surface if something goes wrong.

The plight of the Wild Boars drew international attention overnight. Soon skilled cave divers from around the world, including Finland, Britain, China, Australia, and the United States, volunteered their services. At first the foreign divers were not met with open arms by the Thai military in charge of the rescue. Many of the SEAL divers bristled at the idea of needing foreign assistance. The divers were not even allowed into the cave. After much political haggling, the Thai Ministry of Foreign Affairs told the military chiefs to let the foreign divers go.

Even the experienced cave divers found the conditions extremely difficult. "It was like walking into a strong waterfall and feeling the water rushing at you," one diver said. "It was a horizontal climb against water with every move."

The divers painstakingly penetrated the cave, securing guidelines needed to ensure safety. Visibility at times was negligible. "If you put your hand in front of you, it just disappeared," said one diver. "You couldn't see anything."

Meanwhile, on the surface, policemen with sniffer dogs searched for shaft openings that could provide an alternative entrance to the cave system. The search was augmented by hundreds of volunteers dressed in lemon-yellow shirts and sky-blue caps, searching for hidden cracks in the limestone that might reveal an opening to the cave. Drones were also used, but no technology existed to scan for humans deep underground. Local holy men created a shrine at the mouth of the cave, where they chanted and communed with the spirit of the cave, "Jao Mae Tham." Several times the search had to be suspended due to heavy rains.

After the team had spent 10 days of captivity without real food or water, there was little hope among the rescuers of discovering the boys alive.

In the cave, a pair of British divers working to extend the guide ropes popped up near a narrow ledge. First they smelled, and then they saw, 13 emaciated people perched in the dark. The Wild Boars had run out of food and light but had survived by sipping the condensation from the cave walls. Later it was reported that the assistant coach, a Buddhist, had led the boys in meditation to relax and conserve energy. The ledge where they were found was about 2.5 miles from the cave mouth.

The next day Thai SEALs ferried food, water, and blankets to the Wild Boars. Four divers, including a doctor, would stay with them until their rescue. Thai officials reported that the rescuers were providing health checks, keeping the boys entertained, and none of the boys were in serious condition.

Thai officials released a video made by the rescuers and shared to the world. The video showed all 12 boys and their coach introducing themselves and stating their ages. Wrapped in emergency blankets and appearing frail, each boy said hello to the outside world, “*Sawasdee khrap*,” with his palms together in *wai*, the traditional Thai greeting. The video went viral. Soon all the major newscasts across the world were covering the story. The big question then became, now that the boys had been found, how could they be gotten out alive?

A rescue camp was set up at the cave entrance, accommodating the volunteers and journalists in addition to the rescue workers. The camp was divided into zones: restricted areas for the Thai Navy SEALs, other military personnel, and civilian rescuers; an area for relatives to wait in privacy; and areas for the press and general public.

An estimated 10,000 people contributed to the rescue effort, including more than 100 divers, 900 police officers, 2,000 soldiers, and numerous volunteers. Equipment included 10 police helicopters, seven ambulances, and more than 700 diving cylinders, of which more than 500 were in the cave at any time while another 200 were in queue to be refilled.

The plight of the Wild Boars caught the attention of Elon Musk of Tesla and Space X fame. He tasked engineers to build a kid-size submarine that

could be used to transport the boys out of the cave. Within days an actual submarine was sent to Tham Luang. Thai officials praised the effort but concluded it was not practical, given the narrow passages in the cavern.

The journey through the cave to the team took six hours against current and five hours to exit with the current. The route had several flooded sections, some with strong currents and zero visibility, and some extremely narrow parts, the smallest measuring only 15 by 28 inches. The boys were perched on a ledge 400 yards from Pattaya beach chamber, named after an above-ground beach in Thailand. Chamber 3, which was dry, would be used as rescue base.

Pumps were brought in to remove water from the cave. Although not a solution, efforts at draining the cave began to produce results. Craggs and outcroppings emerged from the murk. The most challenging passage, which had taken five hours to navigate early on, could now be traversed in two hours with the help of guide ropes.

As the crisis unfolded, rescuers considered several different methods to save the team. The principal options included

- Wait until the end of the monsoon season, with divers providing food and water.
- Find an alternative entrance to the cave that would allow for an easier escape.
- Drill a rescue shaft.
- Teach the group basic diving skills and have them swim out with the divers.

Waiting until the monsoons ended in November and the water drained was the simplest solution. The boys could walk out on their own. However, the logistics did not make sense. Feeding 13 people, three times a day, for even 60 days is more than 2,750 meals. Every meal would have to be ferried in by a team of divers, flirting with death each time they went under.

This was a growing concern. Four days after the boys were found, retired Navy SEAL diver Saman Kunan lost consciousness while returning from dropping off three air tanks. His dive buddy attempted CPR without success. Kunan had left his airport security job to volunteer for the rescue mission. Before that fatality, three divers were lost for over three hours in the dark cave, and rescue efforts had to be redirected to find them.

From the beginning hundreds of volunteers crawled over the hillside in search of hidden openings. People knew the odds were slim to none, given the depth of the cave, but it was worth a try.

Drilling through a couple thousand feet of rock would require extensive infrastructure work and take too long. Besides, there was significant uncertainty as to where to drill.

That left the fourth option. None of the boys or the coach knew how to dive. Even if they could master the basics, cave diving is not the same as a practice run at a resort swimming pool. A weakened child submerged in darkness and breathing unnaturally through a regulator is likely to panic. Yet through long stretches of the cave, he wouldn't be able to surface and regain his composure—he would be in a flooded tunnel.

Privately experts thought maybe half the boys would survive the journey. But pulling it off 13 times in a row would take a miracle.

While plans were being developed, two alarming events occurred. First, the oxygen levels in the cave began to drop faster than anticipated. This raised fears that the boys could develop hypoxia if they remained for a prolonged time. By July 7 the oxygen level was measured to be 15 percent. The level needed to maintain normal functions for humans is page 306 between 19.5 percent and 23.5 percent. Thai engineers' attempts to install an air supply line to the boys failed.

The second development was the weather forecast. Monsoon rains were predicted for later in the week, which could flood the cave until November.

The Thai Navy SEALs, with the support of U.S. Air Force rescue experts, devised a plan approved by the Thai Minister of the Interior. Rescuers initially wanted to teach the boys basic diving skills to enable them to make the journey. Organizers even built a mockup of a tight passage with chairs and had divers practice with local boys in a nearby school swimming pool. Eventually it was decided that the boys were too weak to swim, and the plan was revised to have divers bring the boys out.

On July 8 the rescue attempt was initiated. For the first part of the mission, 18 divers were sent into the caves to retrieve the boys, with 1 diver to accompany each boy on the dive out. The boys were dressed in a wetsuit, a buoyancy jacket, and a harness. Instead of sticking a regulator in each boy's mouth, they were given a full face mask that allowed them to breathe naturally. An oxygen cylinder was clipped to their front, a handle was

attached to their back, and they were tethered to a diver in case they were lost in poor visibility.

Panic was a chief concern. The SEAL doctor administered an anesthetic to the boys before the journey, rendering them unconscious to prevent them from panicking on the escape and risking the lives of their rescuers.¹ The anesthetic lasted about 50 minutes, requiring the divers, whom the doctor had trained, to re-sedate their bodies during the three-hour-plus journey.

There was discussion about which boy should go first—the weakest, the youngest, the strongest—but in the end it came to a boy who volunteered. The boys were maneuvered out by the divers holding on to their back or chest, with each boy on the left or right depending upon the guideline. In very narrow spots, the divers had to push the boys from behind. The divers kept their heads higher than the boys so that in poor visibility the divers would hit their heads first against the rocks. After a short dive to a dry section of cave, the divers and boys were met by three divers, and the boys' dive gear was removed. A drag stretcher was used to transport the boys up over a 200-meter stretch of rocks and sandy hills. The dive gear was put back on before entering the next submerged section.

After being delivered by the divers into the rescue base in chamber 3, the boys were then passed along a “daisy chain” of hundreds of workers stationed along the treacherous path out of the cave. The boys were alternately carried, slid, and zip-lined over a complex network of pulleys installed by rock climbers. The path out of the chamber contained many areas still partially submerged, and the boys had to be transported over slippery rocks and through muddy waters. The journey out of chamber 3 took about four to five hours initially, less later as a result of drainage.

Soon after 7 p.m. local officials announced that two boys had been rescued. Shortly later, two more boys appeared out of the cave. On July 9, four more boys were rescued. On July 10, the last four boys and their coach were rescued.

The four Thai Navy SEALs, including the doctor who had stayed with the boys the entire time, were the last to dive out. When they got to chamber 3, a water pipe burst, and the main pump stopped working. All of a sudden, the water began to rise rapidly. This forced the SEALs and 100 of the rescuers still a mile inside the cave to abandon the rescue equipment and scramble out of the cave.

Upon reaching the surface the boys were quarantined while health workers determined whether they had caught any infectious diseases. The boys were on a fixed rice porridge diet for the first 10 days. Parents initially visited their children looking through a window, but once the laboratory results proved negative, they were allowed to visit in person while wearing a medical gown, face mask, and hair cap.

After the rescue, the boys' families, officials, and thousands of volunteers gathered at the cave entrance. The group gave thanks for the lives saved and asked forgiveness from the cave goddess, "Jao Mae Tham," for the intrusion of pumps, ropes, and people during the rescue.

The world rejoiced with the news of the successful rescue. The head of the rescue mission said that the cave system would eventually be turned into a living museum to highlight how the operation unfolded. As a result of the incident, Thailand's Navy SEALs will include cave diving in their training programs.

On September 7, 2018, the Royal Thai government hosted a reception for all Thai and foreign officials and personnel involved in the rescue. His Majesty the King granted a royal decoration, *The Most Admirable Order of the Direkgunabhorn*, to those who were involved in the rescue of the football team—114 foreigners and 74 Thais. The order is bestowed upon those who render devotional service to the Kingdom of Thailand. The title *Direkgunabhorn* roughly translates as "Noble order of abundance and quality."

Three months after being rescued, the entire Wild Boar team and coach appeared on the U.S. day-time talk show *Ellen*. Speaking through a translator, the team revealed that four of the boys had had birthdays while trapped in the cave. The team and coach were stunned when their football hero, Zlatan Ibrahimović, who now plays for the LA Galaxy, made a surprise appearance on the show to meet them. The Swedish star high-fived each member. "These kids, this team is braver than me and they showed their collective teamwork and had patience, faith," Ibrahimović said. "This is probably the best team in the world."

1. How did the physical environment of the cave affect the rescue plan?
2. How did the rescue team respond to the risks of the project?

3. Some have called the rescue a miracle and that luck was the decisive factor. Do you agree?

Sources

ABC News, “It Was Utter Chaos: Inside the Thai Cave Rescue That Nearly Didn’t Happen,” December 1, 2018. www.abc.net.au. Accessed 2/8/19.

ABC News, “Thai Cave Rescue: Elon Musk Hits Out at Mission Chief Who Turned Down Mini-submarine Offer,” July 11, 2018. www.abc.net.au. Accessed 2/8/19.

Beech, H., R. C. Paddock, and M. Suhartono, “Still Can’t Believe It Worked: The Story of the Thailand Cave Rescue,” *New York Times*, July 12, 2018. www.nytimes.com. Accessed 2/9/2019.

Ellis-Petersen, H., “Thai Cave Rescue Boys Meet Hero Zlatan during *Ellen* Interview,” *The Guardian*, October 17, 2018. www.theguardian.com. Accessed 2/12/19.

Flynn, S., “Miracle at Tham Luang,” *GQ*, December 3, 2018. www.gq.com. Accessed 2/10/19.

¹ The Thai government provided the SEAL doctor with diplomatic immunity if something went wrong.

Appendix 8.1

The Critical-Chain Approach

LEARNING OBJECTIVES

After reading this appendix you should be able to: