

# Asset Performance Management (APM) for Masjid Al-Haram: really for a mosque?

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You might think considering implementing 'Asset Performance Management (APM)' for a mosque, or a church or a temple would not be wise. You are 100% correct. But Masjid Al-Haram is not an ordinary mosque. At any given moment, one to five million worshipers will be at this holiest place and its vicinity. This mosque is open to worshipers 24 hours in day, 7 days in week, 365 days in year. This great mosque is one of the [most expensive infrastructure](#) ever built on earth. Indeed, maintaining this great \$120 Billion USD historic infrastructure & mosque in pristine conditions needs a 'most technologically advanced' and meticulously designed Maintenance and/ or Asset Performance Management (APM) program.

Let us start introducing "Masjid Al-Haram" to those who are not familiar with. Then, we will discuss (i) what is APM, (ii) why APM is so crucial for Masjid Al-Haram and (iii) finally we will share lessons learned from this case study.

"APM Software is just an enabler to overall APM solution. It is important to have a right APM software / technology, however in my humble opinion, its contribution on APM implementation & sustainment success would be about 20% to 25%. The overall success of APM implementation depends on other pillars in APM, including adoption e.g. simple & standardized business process, precise & quality data (content), right governance, change management, training/ coaching programs etc.

**Masjid Al-Haram** - 'The Sacred Mosque' also known as the **Great Mosque of Makha**, as the most significant mosque in Islam is situated in the Makha Province of Saudi Arabia. The Great Mosque comprise several important sites, such as the [Kabba](#), the [Black Stone](#), the [Zamzam Well](#), the [Maqam Ibrahim](#), and the hills of [Safa and Marwa](#). As of 2024, the Great Mosque is known as both the [largest mosque](#) in the world, and the [most expensive building](#) in the world.

According to Islamic faith, the history of this \$120 Billion USD mosque can be traced back to the first human Prophet [Adam](#) (AS) and Prophet [Abraham](#) (AS) & Prophet [Ismael](#) (AS). Prophet [Abraham](#) (AS), together with his son Prophet [Ismael](#) (AS), raised the foundations of a house approximate 2000 BCE, which has been identified by scholars / historian as the Kaaba. According to Islamic belief , it is said that Allah (SWS) showed Prophet Abraham the exact site, which was previously built by Prophet [Adam](#) (AS), very near to what is now the [Well of Zamzam](#).

Islam started during the lifetime of the last prophet [Muhammad](#) (SAW) in the 7th century and so did architectural components such as the mosque. Since then it has passed through the

control of various [caliphs](#), [sultans](#) and kings, and is now under the control of the [King of Saudi Arabia](#). It has undergone major renovations and expansions through several centuries. And this would continue many other centuries to come.



Figure1: Bird eye view of the **Masjid Al-Haram**

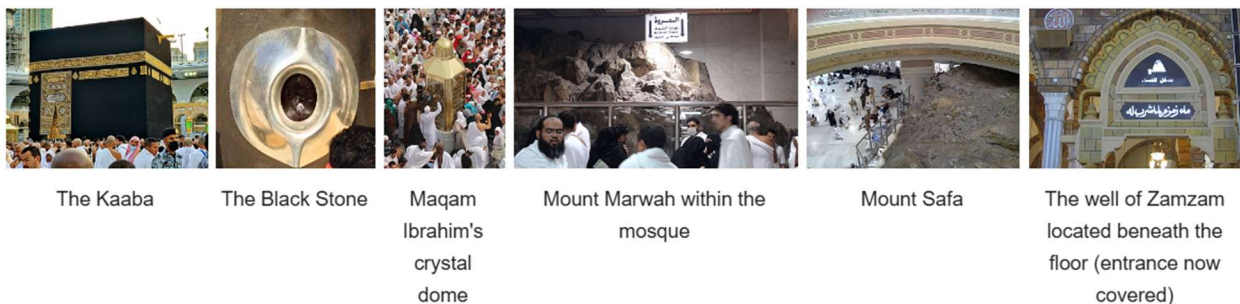


Figure 2: Significant sites at the [Masjid-Al-Haram](#)

The mosque has 356,000 square meters (88 acres) of site area, 7 minarets (or towers, with 6 more are under construction). It can accommodate 3 million pilgrims at any seating for prayers.

The Great Mosque is the main venues where [Hajj](#) and Umrah pilgrimages being performed in the month of [Dhu al-Hijja](#) in the [Islamic calendar](#) and at any time throughout the year,

respectively. The Hajj pilgrimage is one of the Pillars of Islam, required of all Muslims to perform at least once in their lifetime who are physically and mentally fit and financially capable to afford the trip. In recent times, [over 5 million](#) (official number is 3 million) Muslims perform the Hajj every year. During the Hajj season over 5 million pilgrims are normally at the Masjid-al-Haram and its vicinities approximately for a month. During non Hajj season, about 1 to 2 million pilgrims will be at the Masjid-al-Haram to perform prayers five times a day and to perform Tawaf. Tawaf refers to circumambulating or walking in circles around the Kaaba in an anticlockwise motion. The demography of the pilgrims also interesting. Age could be from few months' old babies to 90 years elders, people from all over the world, different races and with little to no educational background to highly educated professionals, ordinary to head of states.

The Masjid-al-Haram is open for 24 hours a day, 7 days in week, 365 days in a year facility. This mosque can not be fully closed not even for a moment. Maintaining, cleaning, expanding at and hosting millions at the same time is not an ordinary operation. Any simple error in operations or maintenance may cause catastrophic consequences. Here are some examples.

#### **Sept 11, 2015**

A crawler crane collapsed over the Masjid-al-Haram, around 5:10 p.m. on 11 September 2015, killing 111 people and injuring 394 others. The collapse has been cited as the deadliest [crane collapse](#) in history, with the previous most deadly incident being the [collapse of a construction crane in New York City](#) in 2008, killing seven people.

#### **Sept 24, 2015**

At least 2,411 pilgrims were killed during a crush and stampede. The [Saudi government](#) has yet released an official report. This is likely to be a communication failure in controlling crowd.

#### **June 2024**

[At least 1,300 people died](#) during this year's Hajj pilgrimage in Saudi Arabia, witnesses and experts say a combination of scorching temperatures and difficulties with crowd control made the sacred event disorienting and dangerous.

These incidents convince you that indeed, this great mosque needs a special & extra ordinary care to operate and maintain in pristine condition. Research suggests that five types of maintenance & construction activities always happening at the mosque.

#### **Maintenance and Construction at Masjid-al-Haram**

- (i) Daily Cleaning & Furnishing (e.g. Operator Round)
- (ii) Regular Maintenance
- (iii) Periodic Maintenance (Turnaround)

- (iv) Expansion (capital projects)

### Daily Cleaning & Furnishing

The Department of Cleaning and Furnishing of “The General Presidency of the Affairs of the Holy Mosque and the Prophet’s Mosque” is responsible to maintain the Masjid-al-Haram in clean, hygienic and pristine conditions for all pilgrims through in 24/7 and 365 days. Constant presences of one to five million people at any given time are at the mosque or its vicinity to perform five mandatory prayers, or to perform Tawaf refers to circumambulating or walking in circles around the Kaaba or performing Sai (walking between Safa and Marwa Mountain) makes daily cleaning and furnishing very challenging.

According to The Department of Cleaning and Furnishing video (lined below) published in 2015, about 200 officials, 100 supervisors, 260 controllers, 2700 skilled workers perform these daunting tasks in four shifts. Few daily tasks are

- Washing & cleaning Kabba, Tawaf, Sai and prayer areas four times a day.
- Washing & cleaning of 30 thousand luxury green carpets three times a day. These include five steps of works: (i) Dusting, (ii) Washing, (iii) Drying, (iv) Exposing to Sun and (v) knitting and sewing using state of the earth technologies and machines.
- Collecting and disposing of 25 tons of garbage daily and about 90 tons during Hajj from the mosque complex alone.
- Distributing about 2 million of plastic bags daily to pilgrims for keeping shoes and disposing those bags.
- Polishing and scenting the Kabba doors, the Black stone, the Maqam Ibrahim, all metals parts daily to keeping them shiny
- Constantly washing, cleaning, disinfecting all washrooms and other public places

This team is also responsible to clean The Kabba twice in a year.

#### Source

- Video published by The Department of Cleaning and Furnishing of Mecca <https://www.youtube.com/watch?v=tSq9xWCA9w> in 2015
- Video: How Masjid Al Haram Mosque is cleaned by ROAD2WISDOM <https://www.youtube.com/watch?v=0X0upQTbhQA>



Figure 3: Daily Cleaning & Furnishing. From Top left (i) Overall daily Cleaning & Furnishing activities, (ii) Transport buses for Cleaning & Furnishing crews, (iii) Cleaning at Sai Area, (iv) Cleaning at main tawaf area around the Kabba, (v) Cleaning Carpet, (vi) Polishing Kabba door

### Regular Maintenance

The Grand Mosque receives high attention, constant care, continuous work around the clock, distinguished efforts and high-quality services that are provided by the Presidency General of the Affairs of the Two Holy Mosques to its visitors.

Approximate 800 engineers, technicians and workers are responsible for maintenance of electronic, electric and mechanical systems at the Grand Mosque. The team covers all maintenance works at the Grand Holy Mosque through setting plans and studies and

implementing works on the ground, achieving the highest degrees of excellence and accuracy.

These human personnel include 205 engineers, 450 technicians and 200 workers who perform daily, weekly, monthly and annual inspection and maintenance programs on backup power plants, fire alarms, sound systems, electrical panel, control panels, load panels, lighting units, communication devices, HVACs, elevators, escalators, water reservoirs, other utilities, sterilizers and coolers for Zamzam water, fire extinguishers, and sanitation systems.

The civil work administration performs monitoring role on the building of the Grand Holy Mosque, yards and other surroundings, in addition to the external facilities.

Source: Summary from [Saudi Gazette](#) & [Saudi Press Agency](#).

### **Periodic Maintenance (turnaround maintenance)**

The Project Management Office of the Finance Ministry, and in coordination with several relevant government agencies carry out all the periodic maintenance (industrial term turnaround maintenance) since its establishment in 1438 AH (Gregorian, 1997.).

The office also pays attention to the smallest details of workflow, as it uses the latest technologies in accordance with the best international specifications and standards in implementation of the directives of the wise Saudi leadership.

Source: Summary from [Saudi Gazette](#), [Saudi Press Agency](#)

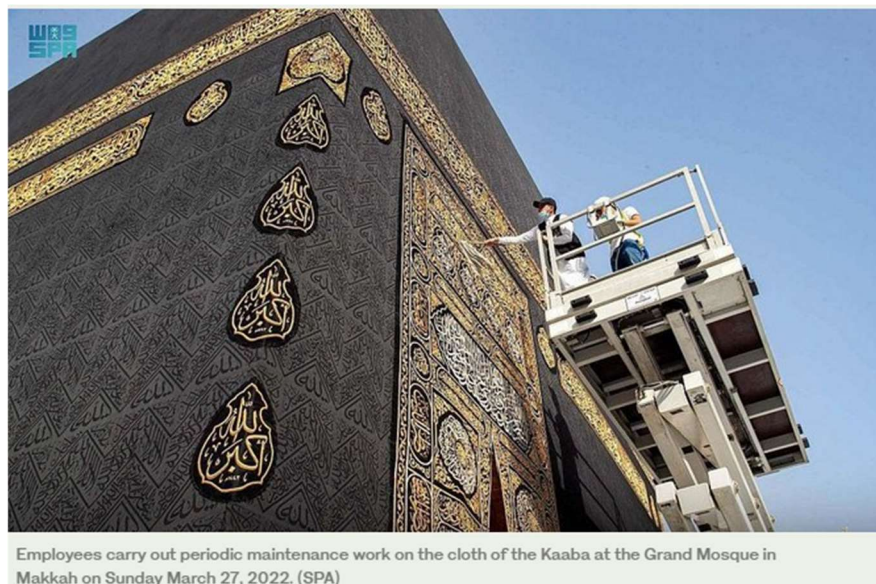


Figure 4: Periodic Maintenance on the KABBA

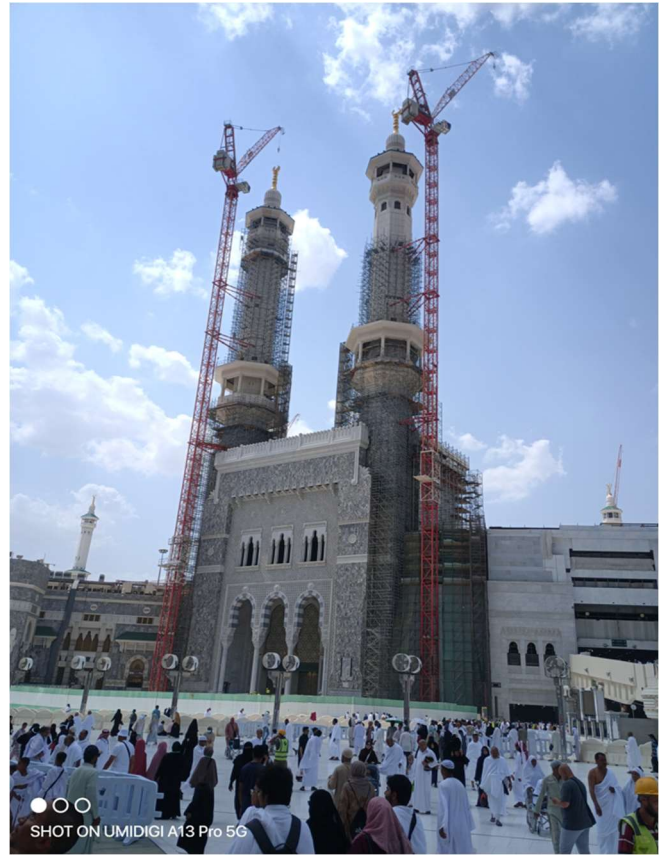
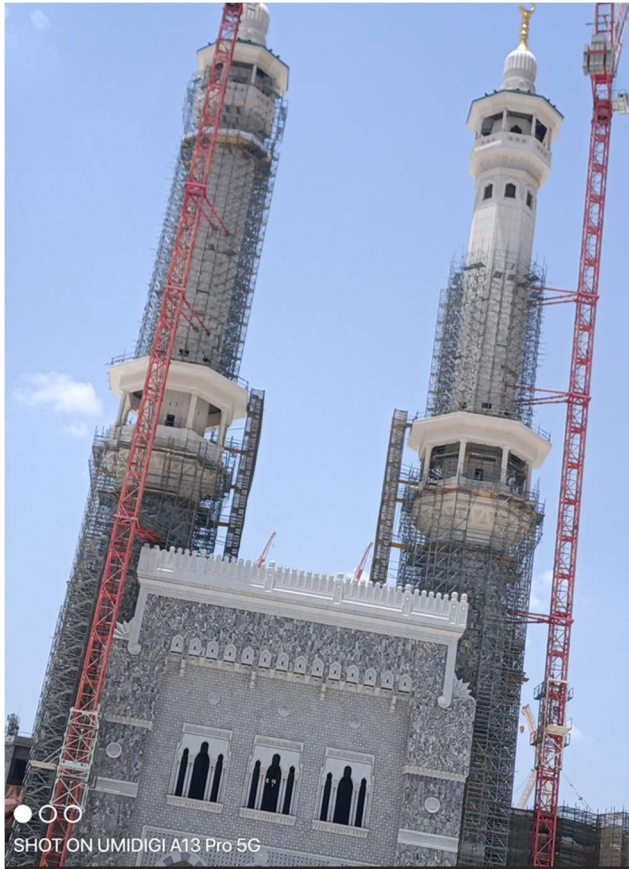


Figure 5: Top two photos of Periodic Maintenance on Minarets, 3<sup>rd</sup> photo, electric panel maintenance on 2<sup>nd</sup> floor at Tawaf area and 4<sup>th</sup> photo larger steel structure at 2<sup>nd</sup> floor tawaf area to change a Building Arch. Photo by Rashed Chowdhury, July 2024

## Ongoing Expansion (Capital Projects)

The Projects Management Office of the Finance Ministry, and in coordination with several relevant government agencies carry out all expansion projects. Current expansions as of June 15, 2024, SPA “The Ministry of Finance continues to implement the largest expansion project ever undertaken at the Grand Mosque.

The Saudi Third Expansion of the Grand Mosque, driven by the leadership of Custodian of the Two Holy Mosques King Salman bin Abdulaziz Al Saud and His Royal Highness Prince Mohammed bin Salman bin Abdulaziz Al Saud, Crown Prince and Prime Minister, aims at significantly increasing the mosque capacity, to serve growing numbers of pilgrims.

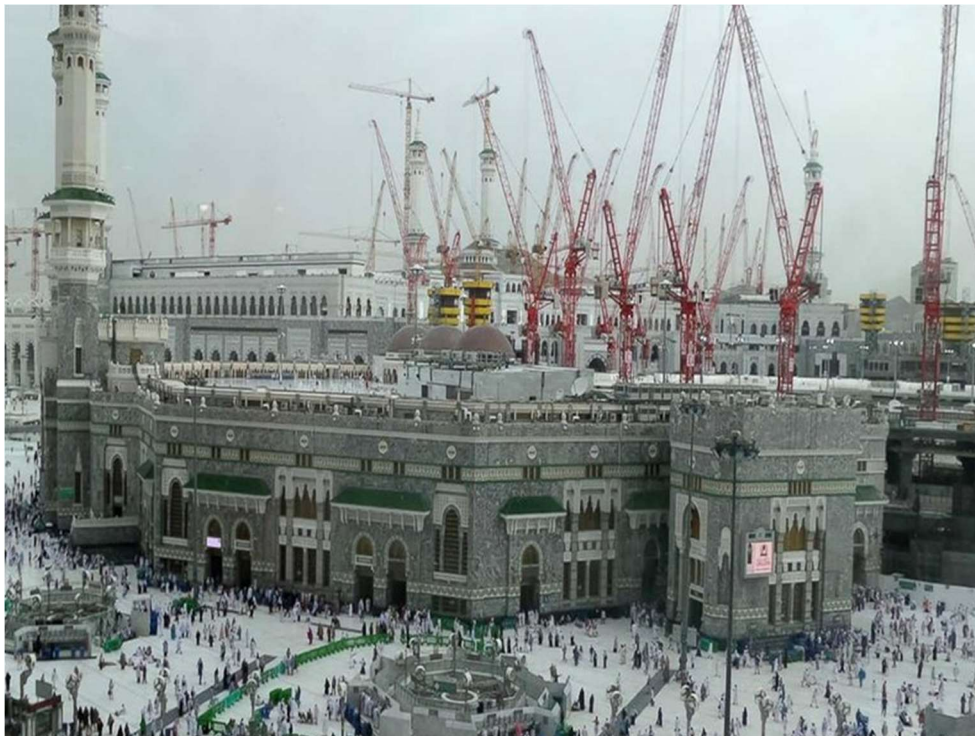
The project will increase the expansion's footprint from 414,000 square meters to a staggering 1.564 million square meters. This translates to a prayer area nearly doubling in size, from 390,000 to 912,000 square meters. Pilgrims can also expect vastly improved amenities. The number of restrooms will increase from 3,515 to 16,726, and ablution facilities from 2,479 to 12,639. Climate control gets a major upgrade too, with cooling capacity boosted from 39,000 to 199,000 refrigeration tons. The expansion is built with future growth in mind. The project's construction allows for the addition of prayer floors and corridors, ensuring that the Grand Mosque can continue to serve the ever-growing number of worshippers.

The expansion of the building extends beyond functionality, to esthetics. Movable and fixed glass domes, intricate glass facades, and exterior metal mashrabiyyas with a captivating interplay of light and color create a truly awe-inspiring atmosphere. Swarovski crystal accents and Quranic calligraphy spanning 2,700 square meters further enrich the space.

This expansion reflects the Saudi government's dedication to providing pilgrims with an exceptional experience. Improved amenities, increased capacity, and a focus on easy access will ensure that worshippers perform their rituals comfortably and safely year-round.

Source: Summary from [Saudi Press Society](#)





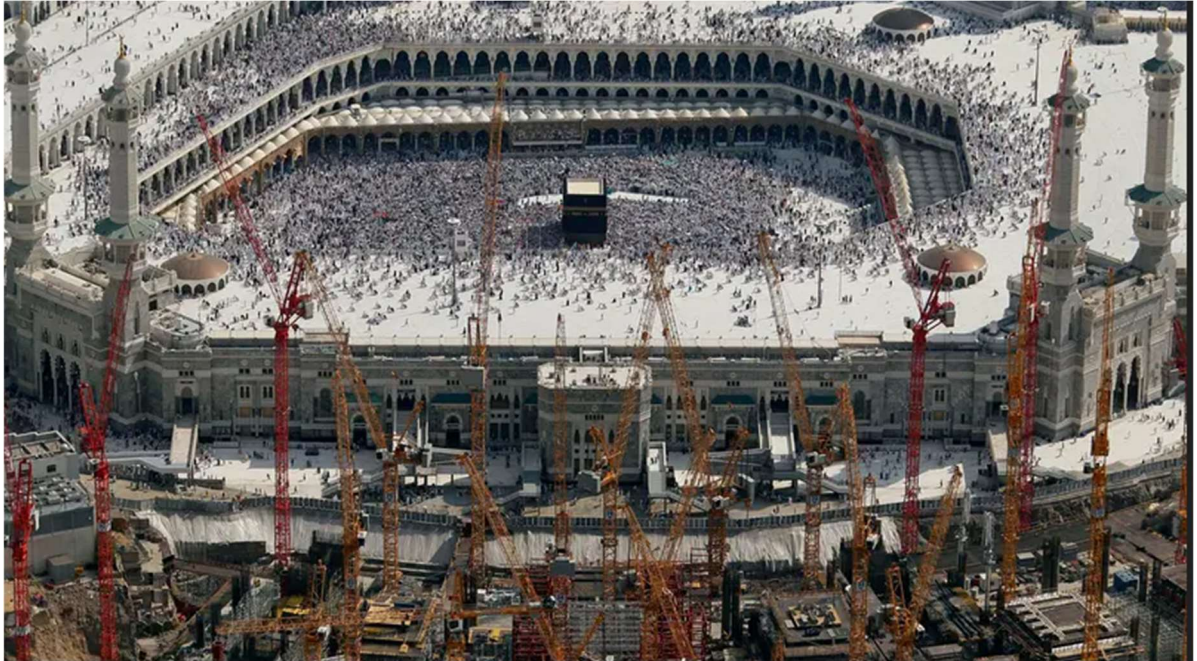


Figure 6: Expansion projects as observed by Rashed Chowdhury visit to Masjid-al-Haram in July 2024

## Asset Performance Management (APM) for the Masjid-Al-Haram

What I have described so far are the output of Asset Strategy actions in the form of maintenance & construction activities. Asset strategy is the key component of APM. But how to measure the effectiveness of maintenance/ asset strategies or Asset Performance Management of the Masjid Al-Harm, I could not find many statistics on it. So, I was researching all pilgrimages related incidents in Saudi Arabia and especially in the vicinity of the Masjid Al-Harm in the last 25 years. I can summarize all incidents into main categories as follows:

- **Extreme Weather:** It is related to extreme heat exhaustion such what I stated earlier with approximate 1300 dead in 2024.
- Several stampede incidents due to **crowd control failure**, especially when millions of pilgrims' travel around several Hajj sites.
- Several **road accidents**.
- **Only one significant incident** that happen in Masjid-Al-Haram complex; the crane collapse in 2015 that killed about 111 pilgrims.

Mentioned earlier, at any given day about 1 to 2 million pilgrims are at the Great Mosque, and this number reached to 4 to 5 million daily during Hajj month/season. Considering the number of people and wide demography variation, the Great Mosque authority has demonstrated an outstanding safety record. No significant **health outbreak** in the mosque. And the Mosque is **exceptionally clean and healthy place**. The place is exceptionally maintained and kept in pristine conditions. This 5000 years old, \$120 billion worth facility (of course has multiple renovations, expansion) can impress you indeed as one of the most modern, and engineering marvel ever built in the world.

According to the [General Authority for Statistics \(GASTAT\)](#) 19 Government and Private Entities Providing more than 136 Main Services to Pilgrims in Saudi Arabia in 2017. More than 192,200 Male and Female Employees Working Around the Clock to Serve the Pilgrims in the Field of Public Services. About 10,000 to 15,000 employees provide cleaning & furnishing, regular & periodic maintenance in the Masjid-Al-Haram alone. I was not able to find number of employees/ contractors working in Masjid expansion projects. And the outcome of the maintenance services is the Masjid-Al-Harm is open to millions of pilgrims 24 hours a day, 7 days in a week, 385 days in a year. In reliability term, availability is 100%.

Let us now analyse what & how APM that has been implemented/ adopted in this \$120 Billion mosque. Not much information that I can find on the internet.

Let's start with what is APM

**Asset Performance Management (APM)** is a business capability focused on optimizing operational assets (such as plants, equipment and infrastructure) essential to the operation of an enterprise. It comprises a set of methods, processes, tools and technologies that aim

*to reduce unplanned repair work, increase asset availability, minimize maintenance costs and reduce the risk of failure for critical assets.*

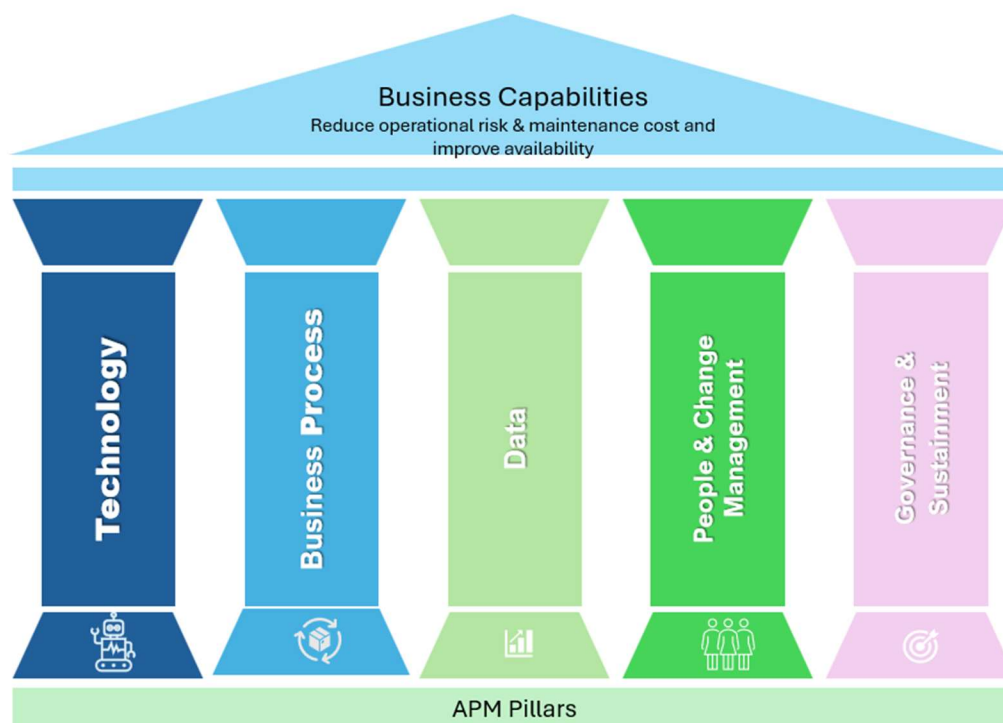


Figure 7: 5 Pillars of APM

In my humble opinion Masjid-Al-Haram has successfully implemented & adopted all five pillars of APM shown above to its full potential.

However, I am unsure which **APM Software (Technology)** that is implemented in the Masjid-Al-Harm. However, looks like the technology / software is working. A right software is essential for APM success and its sustainment. APM Software companies like us to believe that Software is the most important pillar of APM. In my opinion, Technology (APM Software) is an enabler for APM and its contribution to APM adoption success would be one fifth. The other four fifth of success depends on simplified & standardized **Business Process**, and right **Data** usages. My observation, all front level crews (**People**) seem they know what they are doing. They seem very knowledge about their works. Governance structure looks like working and sustaining model for the mosque is working. The mosque is still in pristine condition for last five thousand years.

### Conclusion

To implement and sustain Asset Performance management we need a right digital technology (software) as an enabler. Succes depends on how business process is simplified

& standardized, how people are trained, data is used, how it is governed and finally how changes are managed.

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Note:

All information presented here based on what Rashed Chowdhury had witnessed in his last two visits to the holiest place (Aug 2019 for Hajj and July 2024 for Umrah) and his research on the internet. All internet contents are hyperlinked through out this document.

[Rashed Chowdhury](#) and key members of [Global Asset Care](#) bring firsthand expertise of Maintenance, Reliability and APM. Rashed had led several projects at one of the top three fully integrated Oil & Gas companies in Canada. One main project Global Asset Care has managed was to implement end-to-end asset strategies, asset integrities, predictive maintenance (in short APM) in upstream & refinery operations, all associated utility facilities.