



# Cost Effectiveness in Mahakam: A Necessity to Stay Healthy in the Late Life of a Mature Field

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**Abstract.** A mature field typically encounters a dilemmatic situation in which the production is declining, while the hydrocarbon resources required to overcome the decline is commonly limited. The situation becomes even more challenging as the operational cost tends to elevate following the aging of production facilities and equipment. The high volatility of oil price observed in the past few years has added another layer of complexity for a mature field to maintain its sustainability. This paper will discuss the actions taken in Mahakam to respond to those challenges.

To cope with the challenges as a mature asset, a cost effectiveness program was initiated in mid-2019 with the ultimate goal to ensure the production and operations sustainability in Mahakam. At the early stage of the program, a socialization from top management was held to cascade the background and provide vision on the expected outcome of the program. A cost breakdown analysis was then performed to identify the main cost drivers in each of operational activity, and followed by multiple workshops to discuss cost effectiveness improvement ideas particularly in the identified main cost drivers. An online platform was developed which allows the staff to contribute ideas in the most convenient way. Lastly, a digital media is regularly published to all staff to communicate early successes which is important to maintain the staff's engagement throughout the program.

According to the nature of work, all the efforts to improve cost effectiveness in Mahakam come down to these key areas; Budget accuracy, technical standardization & innovation, change of working philosophy, operations optimization, supply chain optimization & renegotiation, cooperation with other companies, and organizational right-sizing. The program has succeeded to reduce the operational cost by ~20% in 2019 and 2020, and will be sustained for the years to come without any compromise on safety aspect.

The practice of cost effectiveness improvement in Mahakam has the potential to be implemented in other mature fields. Even though the challenges facing mature fields have relatively similar roots, some adjustments would certainly be needed to adapt with the specific characteristics of each individual field. Countrywide application of cost effectiveness can potentially become a key enabler in securing national energy supply in Indonesia.

**Keyword:** Mature field, cost effectiveness, sustainability, operational cost, asset management



## 1 INTRODUCTION

**Mature field** or brown field commonly refers to a producing field in declining phase or reaching the end of its productive life (**Figure 1**). Aging production facilities and equipment are quite common to be found in a mature field. Despite of its unappealing name, mature fields play an important role in the global oil and gas production. According IHS Cambridge Energy Research Associates, about two-thirds of the world's daily oil production in 2011 came from mature fields. In Indonesia, the situation is presumably conformable knowing that major field discovery is quite limited in the last decade. This fact exhibits the significant potential of mature fields, and therefore denote the importance of mature fields revitalization.

Apart from the production decline, a mature field commonly owns limited hydrocarbon resources to be developed which complicates the effort to fight the production decline. In addition, the increasing operational cost due to aging production facilities and equipment provides another layer of challenge for sustaining the production and operations. The condition could get even more challenging in the low oil price environment.

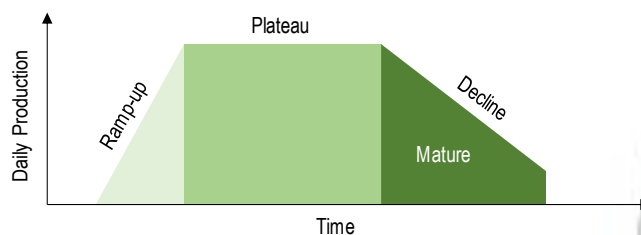


Figure 1: Typical production profile of an oil/gas field. Mature field refers to the field in declining phase.

**Mahakam block** is a good representation of a mature asset. The production commenced in 1974 from Bekapai field, and the block has been in declining phase since 2010. After Bekapai, six other fields (Tunu, Handil, Tambora, Peciko, Sisi Nubi, and cluster South Mahakam – **Figure 2**) have been developed with the current daily production rates of 550 MMscfd gas and 25 kbpd oil and condensate. The block possesses an extensive work setting (6 processing areas, 30 offshore platforms, 77 GTS & clusters, ~2000 wells, and more than 1700 km of pipeline network) and quite intensive operations (121 wells drilled and ~6500 well intervention jobs executed in 2019).



Figure 2: Mahakam block is located in East Kalimantan consisting of seven fields (Tunu, Handil, Tambora, Peciko, Bekapai, Sisi Nubi, and cluster South Mahakam). The block is characterized by its extensive setting and intensive operations.

In Tunu, the infill wells have reached the spacing down to 400 m which implies significantly lower reserves per well compared to the past time (Figure 3: Left). Besides, a substantial amount of well is now considered as sensitive due to reservoir pressure depletion and increasing water production, and therefore the production is prone to disturbance in the production facilities (such as shutdown, maintenance, etc.). Coupled with the increase of operational cost per barrel (Figure 3: Right), all of those conditions clearly indicate the level of maturity of Mahakam asset.

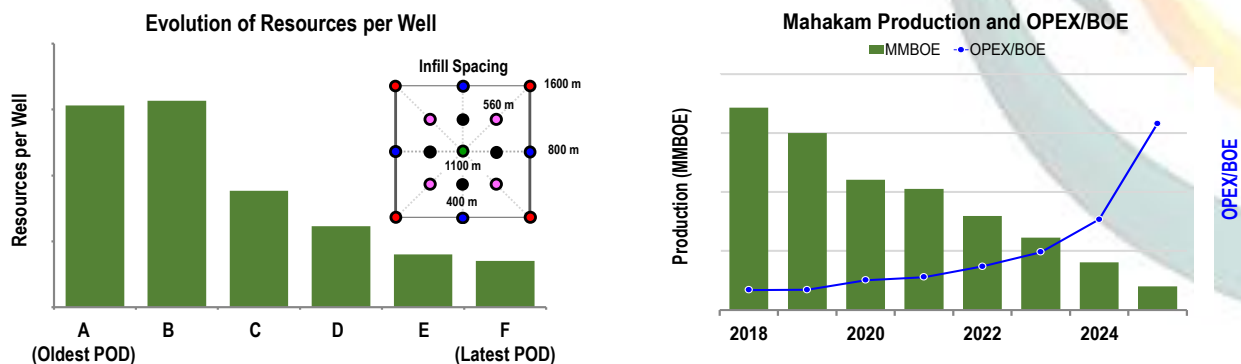


Figure 3: Closer infill well spacing results in decreasing resources per well (left figure). Following its maturity, the operating cost per barrel is increasing (right figure).



The block started as an oil producer in 1974, then shifted to a gas producer after the start-up of giant Tunu field in 1990, and then followed by another giant, Peciko, in 1999 (**Figure 4**). Since the start-up, Mahakam has successfully surpassed several challenging situations in its life. The decline of oil production in the early 1990s was overcome by the development of giant gas fields (Tunu and Peciko). Then, the decline of gas production from those two backbone fields in the early 2000s was successfully tackled by the development of Shallow zones and new gas fields (Sisi Nubi and South Mahakam). Lastly, the downturn in 2014-2015 was countered by implementing a cost effectiveness program (named 4C&D – Change Culture, Compete on Cost, and Deliver). Aiming to maintain company's profit, the program succeeded to bring Mahakam pass the downturn in a good shape.

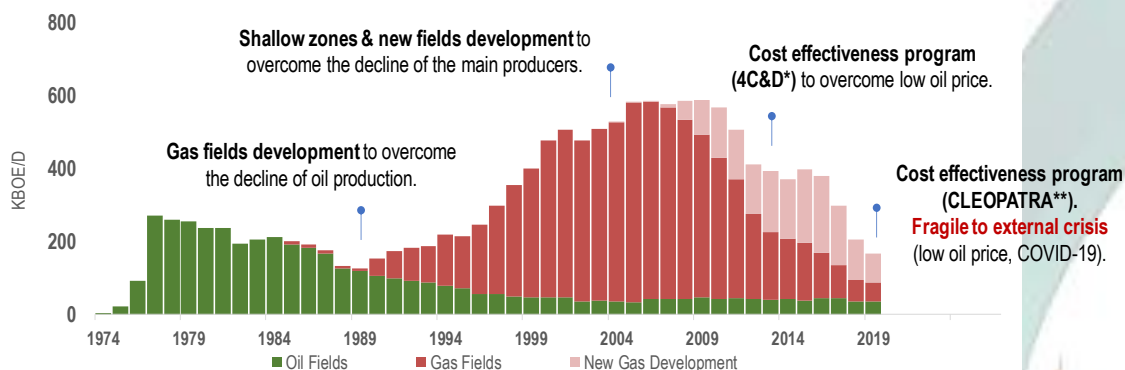


Figure 4: Mahakam production history 1974-2019 and its important milestones to cope with different challenges in different periods.

Another cost effectiveness program (named CLEOPATRA – Cost Effectiveness and Lean Operations in Mature Asset) was initiated in mid-2019. The objective is not focusing on profit anymore, but to ensure sustainability of Mahakam as a mature asset. The downturn in the first half of 2020 and the business uncertainty due to the global pandemic COVID-19 has given additional pressure which urges Mahakam to implement this second cost effectiveness program even deeper and quicker. The methodology, key areas of concern, as well as the achievement of the program will be elaborated in the following sections.

## 2 METHODOLOGY

CLEOPATRA program aims to sustain the production and operations in Mahakam by lowering the operational cost. Kicked-off in mid-2019, the program started with team establishment, then shortly followed with a socialization from the top management. Cost breakdown analysis, trainings, workshops, online idea dropbox, and digital communication media were organized and developed to facilitate the program (**Figure 5**).



Figure 5: Methodology of cost effectiveness program implemented in Mahakam.

**Team Establishment & Socialization.** As the program involves multiple entities and a significant number of initiative, the role of coordination in the team is pivotal. This role is responsible to ensure that the initiatives coming from each divisions are carefully evaluated and executed with well coordination. The coordinator is also accountable for progress tracking which is important for ensuring on time execution, and to get early identification of any obstacle. At the early stage of the program, a company-wide socialization from the top management was conducted in which the background, objectives, and urgency of the program were presented to all staff. This step is important to grab engagement and commitment from all the staff towards the goals of the program.

**Idea Gathering & Communication Media.** For capturing ideas from wider audience, an online platform was developed to allow the staff to submit ideas in the most convenient way. The incoming ideas were then grouped based on its degree of impact and the level of required effort. The ones with high impact & low effort become the priority to be further evaluated. Digital posters were published periodically to all staff to deliver specific achievements or ideas. Delivering achievement early is a key element for maintaining staff's engagement and spirit throughout the program. It also serves as a communication media to showcase a particular idea or initiative such that the idea would inspire others. Merchandising will be arranged in which CLEOPATRA-branded items will be available on sale. The merchandising is intended to improve engagement and will be a handy reminder in the future about this important milestone in Mahakam life cycle.

In addition to the bottom-up approach in which the initiatives are coming from the staff, a top-down approach is also necessary to be implemented from time to time (particularly when hard decision is required). The combination of those two approaches, supported by strong leadership and continuous communication at every level, has played a very important role during the execution of the project.



**Lean & Six Sigma Campaign.** Lean & Six Sigma (LSS) system is a tool for improving performance by systematically removing waste (becoming lean) and reducing variation (six sigma concept). Considering its robustness and resources availability, the system was selected as the supporting tool for cost effectiveness improvement program in Mahakam. A campaign of training and workshop in LSS was held with key personnel from each division in order to equip the manpower resources with the concept, understanding, and mindset of the system.

**Cost Breakdown Analysis & Workshops.** Cost structure in each division was analyzed in order to identify the major cost drivers. In several cases, it was found that the main cost driver in a particular activity was not the one that was expected before. Therefore, it is important to spend effort on this step even though the main cost driver appears obvious initially. Optimization efforts were focused on those main cost drivers without disregarding the other smaller opportunities. Cost breakdown analysis is also needed to identify low-hanging-fruit optimizations which are important for maintaining the spirit of the team. Several brainstorming sessions were then conducted to identify any possible cost optimization ideas. At this step, it is important to gather as many as ideas, focusing more on quantity rather than quality. Afterwards, the ideas were screened and discussed into more detail by all related divisions in a series of workshop.

### 3 RESULTS AND DISCUSSION

Initiatives for cost effectiveness improvement have been implemented in various activity lines. The implementation stretches from maintenance and production, well intervention, petroleum logistic, administration, production operations support, until personnel related matters. The improvement is even expanded to the area related to external parties, such as LNG transformation cost, land & building tax, and operating lease. In 2019 and 2020, the improvement resulted in 10-40% of operational cost reduction in each activity line (**Figure 6**) with an overall reduction of about 20% in each year.

Once an initiative is implemented, the new business process, practice, and workflow are closely monitored for ensuring the sustainability. By operating the asset in a lower cost fashion, the saving can be partially allocated for future investment (development project) which is crucially required for sustaining the production and operations. Having lower operating cost also improves the company's business resilient to external factor (e.g. oil price volatility).



### Cost Effectiveness Results in 2019 & 2020

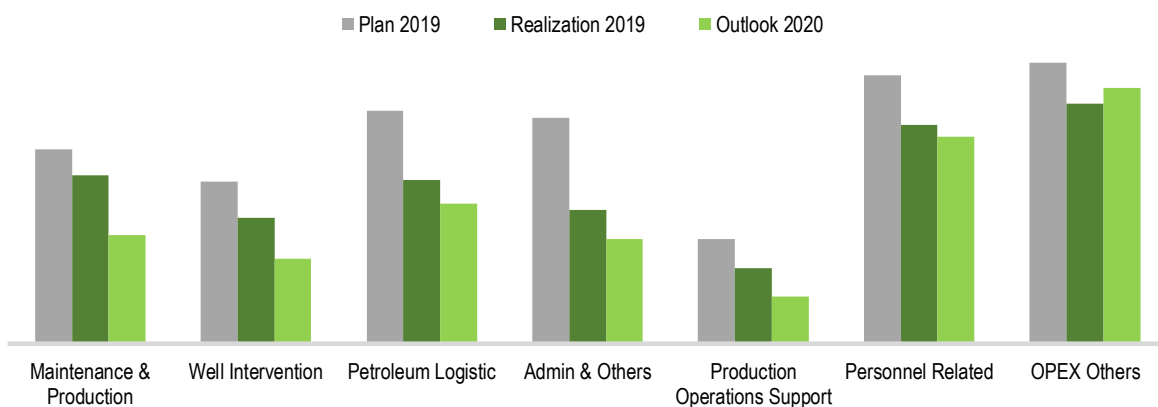


Figure 6: Results of cost effectiveness program in 2019 and 2020 for each activity line. OPEX others include transportation & transformation, land & building tax, and operating lease.

According to the nature of work, all the initiatives for cost effectiveness improvement in Mahakam come down to these key areas (**Figure 7**); Budget accuracy, technical standardization & innovation, change of working philosophy, operations optimization, supply chain optimization & contract renegotiation, cooperation with other companies, and organizational right-sizing. These areas are found to be less critical in the previous business context. Some of them are now becoming applicable due to the transfer of operatorship to Pertamina.

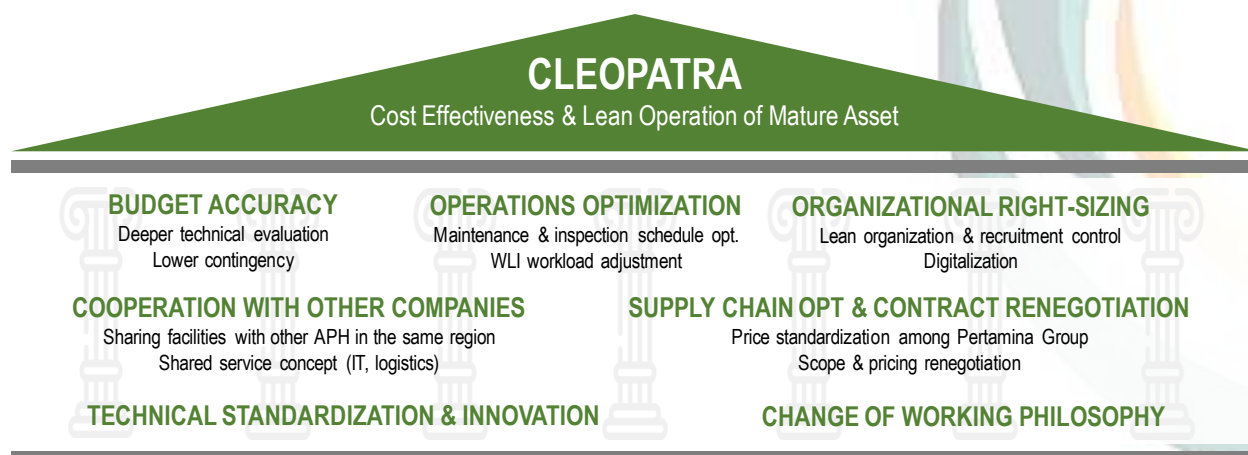


Figure 7: Key areas in cost effectiveness which are the foundation of the program in Mahakam.

**Budget Accuracy.** One of the advantages of a mature field is abundant data availability given by long production history and substantial operational experiences. Those historical data and past experiences are valuable resources for yielding a deeper and more precise technical evaluation. A fine technical evaluation will allow budget to be estimated with lower contingency. By doing this, unrealized budget can be minimized which eventually allows budget reallocation to other productive workload.



**Technical Standardization & Innovation.** Standardized technical design and specification brings benefits of simpler procurement process and cheaper material cost. As an example, wells in Tunu have a standard design with typical completion types and casing sizes. Beside the benefit in term of material procurement, this standardization also gives flexibility of operations e.g., the dynamic of drilling sequence will not severely impact the material utilization.

Technological innovation and breakthrough have also contributed to more cost effective design and operations (**Figure 8**). Single phase drilling is being implemented for replacing the traditional two phases drilling in shallow wells. This innovation generates saving in casing material and cement. Breakthrough in rigless drilling and completion has also been executed, one of which is the utilization of heavy workover unit for gravel pack operation. Then, light wellhead platform design has been evaluated to adopt with the shorter well lifetime.

In swamp fields, sedimentation on the riverbed is a common issue which frequently prevent a drilling rig or barge to approach the wellhead location. In many occasions, dredging needs to be performed prior a drilling or well intervention operation to remove the sediment and provide sufficient water depth clearance for the means to approach the wellhead location. An innovation has been initiated to optimize the dredging operation by the utilization of CDS (Cutter Suction Dredger) which is faster and more efficient.

DDF (Diesel Dual Fuel) is one of the innovations being evaluated to improve cost effectiveness in Mahakam. It is a technology which combine the utilization of HSD (High Speed Diesel) and LNG as the fuel for offshore vessels. Pilot testing is planned in mid-2021. If the result is positive, it will be continued with full implementation which is expected to reduce the fuel consumption by 30%.



Figure 8: Technological breakthroughs implemented in Mahakam resulting in more cost effective design and operations.





**Operations Optimization & Change of Working Philosophy.** Drilling operations with clustering approach has been implemented in which drilling sequence is arranged according to well candidate locations in each cluster (**Figure 9**). This approach reduces travelling time of the drilling rig and its supporting vessel which eventually improves the effective working time and reduces fuel consumption which is one of the main cost drivers in Mahakam operations.

Perimeter rationalization by performing GTS preservation has been evaluated. Among 34 GTS's in Tunu, some of them are producing with very low rate and there is no remaining potential for further development. Those low productivity GTS's are the candidates for preservation in which the equipment will be put in non-operative state. The preservation will reduce the volume of operation and eventually generate saving from lower maintenance, inspection, and logistics cost.

Optimization has also been implemented in dredging requirement. Previously, it was required to dredge the riverbed to obtain 2 m water depth for allowing drilling or well intervention means to approach wellhead location. The requirement has been optimized to 1.5 m water depth resulting in faster and cheaper dredging operations. Some mitigations have been prepared to anticipate the less flexibility occurred by implementing the new practice.

Besides operations optimization, a transformation on the way things done is also implemented in some other functions, such as removing shut-in wells from insurance coverage, and reducing administration and bureaucracy cost.

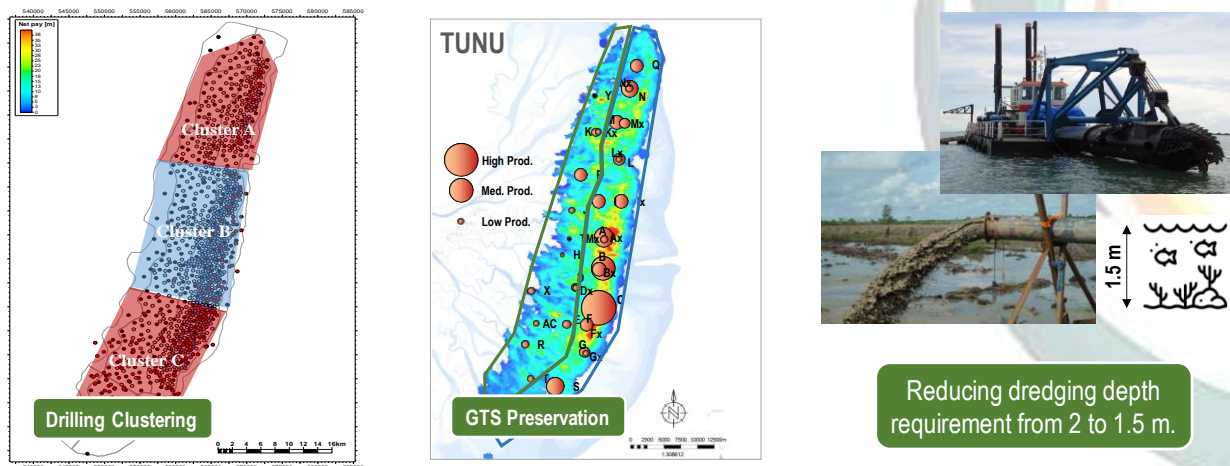


Figure 9: Change in working philosophy has been implemented across various functions; GTS preservation, drilling clustering, dredging depth reduction.

**Supply Chain Optimization.** Having long term contract and creating competition among several vendors are some of the efforts for optimizing contractual terms. However, obtaining long term contract needs to be done with extra care such that the benefit could balance its less flexibility for adapting to the future



condition. For contract with low value, it is found more beneficial to involve fewer vendors in order to be able to offer bigger volume, thus obtaining better bargaining position to lower the cost.

**Contract Renegotiation & Cooperation with Other Companies.** After the merger of Mahakam to Pertamina Group, it is now feasible to perform contract benchmarking among Pertamina's subsidiaries. The results can then be used to justify renegotiation with suppliers. Cooperation with other Pertamina subsidiaries in East Kalimantan region (Pertamina Hulu Kalimantan Timur, Pertamina Hulu Sanga-Sanga, etc.) is now becoming a new practice which was not possible in the past time. Logistics and infrastructure costs can potentially be reduced by sharing IT infrastructure, warehouse, working base, and transportation means (e.g., helicopters, boats, etc.). Joint studies and development efforts within the region are being implemented and expected to create meaningful synergy.

**Organizational Right-Sizing.** The size of an organization needs to transform for adapting to the current production and the volume of operations. Manpower reallocation to other Pertamina's subsidiaries is gradually being implemented to achieve this transformation. Sustainable and continuous personnel competency development is important for ensuring smooth process during the transformation. Besides, digitalization is currently being implemented to increase work efficiency and potentially becomes a key enabler during this transformation. Online meetings and trainings, dashboard data visualization, drone utilization for inspection works, and machine learning application for subsurface evaluation are some of digitalization initiatives which are being and will be implemented to improve the current business processes towards the organizational transformation.

#### 4 CONCLUSION

A mature field commonly encounters an unfavorable situation in which the production is decreasing, the hydrocarbon resources are limited, and the operational cost is increasing. Mahakam has shown that cost effectiveness program is an essential part in the effort to overcome the situation. In 2019 and 2020, the program succeeded to reduce the operational cost by around 20%. The saving will generate higher capacity for future investment (development project) which is important for sustaining the production and operations.

Several areas have been discovered as the main concern for cost effectiveness improvement in Mahakam. These key areas cover budget accuracy, technical standardization & innovation, change of working philosophy, operations optimization, supply chain optimization & contract renegotiation, cooperation with other companies, and organizational right-sizing. Strong leadership and commitment, as well as continuous communication at every level are critical to build a new culture towards cost effectiveness across the company.

As mature fields commonly encounter relatively similar challenges, the practice of cost effectiveness implemented in Mahakam is potentially applicable in other mature fields. Collective effort in revitalizing mature fields can be one of the key elements for securing national energy supply in Indonesia.



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