BP Oil Spill: Project Management Lessons Learned

APS1001 Project

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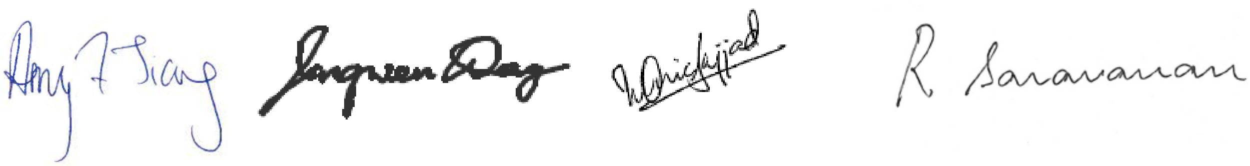
STATEMENT OF WORK

We hereby certify that we are thoroughly familiar with the contents of this project report: it is our own work, we have referenced all sources of information where the work is not our own.



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EXECUTIVE SUMMARY

This report analyzes the project management lessons learned from the catastrophic failure of BP's Macondo deepwater drilling project in the Gulf of Mexico.

On April 20th 2010, an explosion destroyed the off-shore oil rig that was drilling the Macondo deepwater oil well in the Gulf of Mexico, causing an uncontrolled flow of oil that was not fully contained until almost 5 months later, having spilled 4.9 million barrels of oil into the ocean. The explosion, caused by the leak of highly pressurized methane gas up the well that ignited upon reaching the surface, was ultimately the result (according to the BP Oil Spill Commission) of an "overarching failure… of management" on the part of BP, its subcontractors and the federal government agency responsible for overseeing the project (Graham et al, 2011).

This report examines the events that led up to the disaster, and identifies 16 key lessons learned from seven different project management categories: Time and Cost Management; Risk Management; Quality Management; Knowledge Management; Communications Management; Resource Management; and Quality Management.

These lessons indicate that in a project of this size, complexity and risk, it is of critical importance to foster an organization-wide culture of balancing cost/time with quality and safety, and incorporate realistic contingencies into the project's budget and schedule; thoroughly identify, manage and update the impact of project risks in a timely manner, and accurately assess the severity of risks; implement comprehensive quality plans and procedures, and incorporate frequent peer reviews and phase gated quality checks; implement procedures to transfer critical knowledge within the project and disseminate lessons learned from previous projects; implement thorough and effective communication pathways between project stakeholders; carefully manage personnel organization and motivation throughout the project; and provide independent and thorough regulatory oversight.

1 INTRODUCTION

On April 20th 2010 at 9:45pm, an explosion tore through the Deepwater Horizon off-shore oil rig that was drilling the Macondo oil well in the Gulf of Mexico. Eleven crew members were killed and seventeen others were injured. The oil rig sank two days after the explosion; the gushing wellhead was capped on July 15th 2010; and the well was declared "effectively dead" on September 19th 2010 when the relief well process was completed (Crooks, 2010). Approximately 4.9 million barrels of oil were spilled, making it the worst oil spill in US history (Herrmann, 2010).

BP's project – to drill a deepwater oil well in the Gulf of Mexico – was a challenging and complex one involving a large number of stakeholders and resources. Following the disaster, US President Barack Obama created the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling to conduct a detailed investigation into the disaster; their report was published on January 11th, 2011. In the Commission's analysis, much of the blame for the events leading up to the well blowout was attributed to an "overarching failure… of management" on the part of both private industry players and public sector players (Graham et al, 2011).

This paper analyzes the project management failures on BP's Macondo deepwater drilling project and identifies key lessons learned for future projects of this size, complexity and risk. Information for this paper is drawn from the Oil Spill Commission's findings, media reports and academic sources.

2 BACKGROUND TO THE BP OIL SPILL

The BP oil spill resulted from the catastrophic failure of the Macondo deepwater drilling project, a project led by petrochemical giant BP to explore for oil in the Macondo Prospect in the Gulf of Mexico. BP, as the "legal operator" of the well, had leased the drilling rights in the immediate region. Its engineering team in Houston Texas designed the well and the drilling process, and was responsible for overseeing the project. Transocean, an established oil rig owner and operator, was contracted by BP to provide the rig and crew to drill the well. Halliburton, a major oil industry contractor, was contracted by

BP to pour cement – a major undertaking on this type of project where sealing the well to prevent heavily compressed hydrocarbons from shooting back up was crucial. The Minerals Management Service (MMS), as it was then known, was the federal government body responsible for regulating offshore drilling: it sold BP its drilling lease (for $34 million in March 2008) and was also responsible for maintaining and enforcing safety and environmental regulations for all offshore drilling projects (Graham et al, 2011).

Drilling of the well began in October 2009. By April 20th 2010, the project was almost 6 weeks behind schedule and more than $58 million over budget (Graham et al, 2011). The complexities and technical challenges of the project had led some team members to dub it the "well from hell" – though it was not the first well to have earned this nickname: deepwater drilling is inherently a challenging and risky endeavour (Graham et al, 2011). On the day of the explosion, the project was nearing completion. The wellbore had been drilled, and cementing had taken place to seal the space between the wellbore and the inner steel casing. Because there had been some rock fracturing at the bottom of the well that resulted in the well being shallower than originally planned, BP engineers had made some last-minute changes to the well design to maximize the oil output and reduce project time, but they felt these changes were justified and safe. The project team was preparing to pour cement for the temporary plug that would contain the well while the Deepwater Horizon rig was unlatched and a smaller rig for day-to-day operations was brought in.

Due to a series of flawed design decisions and missed warnings stemming from a series of key management failures, at approximately 9:45pm on April 20th, 2010, highly pressurized methane gas leaked into the drill pipe from the bottom of the well and shot up the well despite the drilling mud and other fluids designed to keep it down. A few minutes later, the gas reached the oil rig platform, ignited and exploded.

3 Project Management Lessons Learned

3.1 Time and Cost Management

In this project, as in most others, project time and cost were closely related. It cost BP approximately $1 million per day to lease the Deepwater Horizon oil rig (Graham et al, 2011).

Lesson Learned # 1: Ensure adequate balance of time and cost with quality and safety in the project's performance indicators.

Managers on the Macondo project were heavily focussed on cutting back on time and cost. BP Wells Team Leader John Guide had "championed the every dollar counts culture", according to his supervisor. One of Guide's key project performance indicators was to achieve well objectives at "cost less than Authorization for Expenditure (AFE)". BP's engineers were pressured to "always think… about how to drill wells faster", and "about cost and efficiency". (Bartlit et al, 2011)

Although time and cost are extremely important considerations in high-capital, high-risk projects of this sort, it is critical to avoid prioritizing these above all others, given the risks involved. To help foster a culture of balance, the project performance indicators should show a clear balance between time and cost with quality and safety, and managers should continuously reinforce the importance of balance with their employees, for example through day to day guidance and employee performance evaluation criteria.

Lesson Learned # 2: Foster an organization-wide culture of quality and safety.

The pressure to save cost (and often therefore, time) is prevalent throughout BP's organizational culture. A former BP engineer working on another BP project (the North Sea platform) during a 2003 gas line rupture said:

> *"The focus on controlling costs was acute at BP, to the point that it became a distraction. They just go after it with a ferocity that is mind-numbing and terrifying. No one's ever asked to cut corners or take a risk, but it often ends up like that".* (Graham et al, 2011)

An organizational culture based around controlling cost can be dangerous as it makes it difficult for individual managers and employees to adequately focus on other considerations – including quality, safety and risk management – regardless of what project they work on. Because “it takes a conscious management presence to counter [the constant pressure to perform faster]” (Graham et al, 2011), as noted by one industry expert at a BP Oil Spill Commission hearing, BP’s highest levels of management need to be seen to fully commit to a culture of quality and safety over purely time and cost. To do this they should lead by example, create employee reward systems based on such criteria as safety, quality and proper risk management, provide training to managers to further foster such a culture, and provide training to employees based on industry best practises in safety and quality.

Lesson Learned # 3: Incorporate realistic contingencies into the project schedule, based on risk.

By the time of the well blowout, the project was almost 6 weeks behind schedule and $58 million over budget (Graham et al, 2011). Multiple incidents had contributed to the delay. Some were not project related (such as Hurricane Ida), but others were related to foreseeable risks and should have been accounted for. For example on March 8th 2010, workers discovered natural gas seeping into the well. They lowered a measuring device into the well to diagnose the problem, but it became stuck. BP engineers eventually instructed the workers to plug the hole and continue drilling in another direction. This caused several days of delay, in addition to time lost to backtracking and re-drilling. Then on April 9th 2010, drilling hit another setback when a rock crack formed at the bottom of the borehole. This was not an uncommon problem in this type of drilling (i.e. it was a foreseeable risk), and required the crew to plug the fractures with specialized fluid, which took approximately 1 week. It also resulted in BP’s engineers needing to make design changes to the well to minimize further damage to the rock.

These delays contributed to a feeling of rush on the rig (Casselman & Gold, 2010 (1)), but were related to foreseeable risks that could have been better accounted for in the project schedule – by assigning more realistic contingencies to specific tasks based on the risk associated with those tasks.

3.2 RISK MANAGEMENT

One of the most important "overarching failures of management" in the Macondo project was perhaps the failure of risk management: a failure to appropriately analyze and appreciate the risks that were involved.

Lesson Learned # 4: Adopt a systematic, formalized approach to risk management.

A lack of comprehensive risk management procedures led to important risk factors being improperly evaluated or missed altogether. On April 20th, following the completion of Halliburton's cementing job, BP made preparations for temporary well abandonment – the final stage of the well drilling project, prior to regular operation of the well using a different crew and a smaller rig. In the two weeks leading up to this day, BP made numerous changes to the temporary abandonment procedures, including changes to depth of the cement plug that would be set inside the wellbore, the method in which the plug would be set, and the negative-pressure test that would be conducted as a key test for hydrocarbon leaks. Despite these significant changes, the BP Oil Spill Commission notes that "there is no evidence that these changes went through *any* sort of formal risk assessment" (Graham et al, 2011). For example, during the negative pressure test, the type of fluid used to conduct the test (the "spacer") consisted of, at BP's direction, a mixture that had never been used before for that purpose by anyone at BP, and which had never been thoroughly tested.

The risk management plan should contain a comprehensive and systematic evaluation of risks, and be based on the Work Breakdown Structure to ensure that every task is considered. In addition, it should include formal risk assessment procedures that should be directly integrated into design procedures.

Lesson Learned # 5: Evaluate and control risks adaptively, in response to changing conditions.

Risk management procedures and tests used on the Macondo project were often static; they were not responsive to the changing operational and design conditions of the well. As a result, the project team was unable to detect key risk indicators in a timely manner. For example, following the completion of Halliburton's cement job on April 20th 2011 to set the steel casing, BP and Halliburton conducted a single valve test to determine that the cementing job – a complex one – was a success. As a result, BP decided to forgo further testing of the cement job despite the fact that a 3-person evaluation team from Schlumberger (a subcontractor) had been on the rig for the past day waiting to perform the tests. BP made their decision using a pre-prepared decision tree, which stated that no further tests would be required. But the decision tree did not take into account the fact that multiple design factors had changed – including the design of the steel casing, the use of 6 centralizers instead of 21, and a change in the cement mix.

Because risk factors and severities are constantly evolving, formal change management processes should be adopted to evaluate the impact of design changes, and continuously update the risk management plan in response to the changing conditions.

Lesson Learned # 6: Accurately evaluate the severity of risks.

Throughout the project, BP team members failed to genuinely believe that a blowout could happen. This led them to underestimate the severity of various risk factors when redesigning components of the well and ignore warning signs. For example, BP staff overlooked the results of a test for valve conversion, where four times the design pressure was applied to valves in the steel casing in an attempt to open them before a desired zero-pressure reading was obtained. Engineers did not ask why such high pressure was required, and whether the zero-pressure reading was even an indicator of success – or an indicator of a leak. In addition, BP's later negative pressure tests to check the integrity of the well showed, repeatedly, that hydrocarbons could have been flowing into the well (as pressure readings kept building in the drilling pipe) – but the test was repeatedly readjusted to attempt to reduce the pressure readings; a team member eventually concluded that the high pressure readings were caused by a phenomenon called the "bladder effect", caused by drilling mud and not by leaking hydrocarbons.

As well, BP engineers failed to properly account for the true impact of their design decisions. One major last-minute decision was to use 6 centralizers in the well, instead of 21 as had been originally intended. The centralizers were intended to stabilize the steel casing inside the well and ensure that the cement poured in to seal the well could flow all the way down the well. Due to the last-minute unavailability of all 21 centralizers, BP engineers decided that the 6 they had on hand would be sufficient. Not all BP engineers agreed with this decision, but one BP engineer who disagreed with it wrote in an email: “But who cares, it’s done, end of story, [we] will probably be fine and we’ll get a good cement job” (Graham et al, 2011).

In assessing risk impacts, it is critical that the entire project team – including managers, engineers and staff – start with the belief that the worst case scenario *is* possible, and adequately assess the potential severity of their decisions.

3.3 QUALITY MANAGEMENT

As is so often the case with projects that end up in difficulties, schedule or cost pressures result in sacrificing quality. Situations where quality management is limited to carefully drafted documents and procedures that are not properly carried out in the field are not unusual. BP’s drilling effort for the Macondo well suffered similar problems.

Lesson Learned # 7: Create a thorough quality management plan and ensure it is followed.

Though BP had mandatory engineering policies for drilling, they did not have a plan to ensure compliance during the execution of drilling (Bartlit et al, 2011). It appears that there was no quality plan in place to provide quality assessment and ensure compliance with BP’s drilling standards.

In the days leading up to the disaster, BP engineers imposed significant constraints on Halliburton’s design for pouring cement to set the steel casing, in order to minimize risk of causing rock fractures that would lose oil later on. Firstly, they limited the circulation of drilling mud (used to cool down the drill bit and maintain well pressure during drilling) through the well bore before cementing began – this saved time and reduced risk of inflicting damage at the bottom of the well, but it prevented the wellbore from being properly cleaned and prevented engineers from checking for leakages at the bottom of the well. Secondly, BP instructed Halliburton to pump cement at lower pressures than usual. Thirdly, they limited the volume of cement to be pumped down the well. This last design change met government safety regulations, but actually did not satisfy BP's own internal guidelines (which were twice as stringent). As it turned out, all these design decisions were flawed and overly favoured cost and time over quality. A quality management plan that clearly set out guidelines for audit procedures to ensure work was being done as per the documented guidelines (e.g. ISO9001 quality management standards) could have pre-empted some of these fatal flaws.

Quality management plans should be created early on in the project, and should specify quality assessment procedures, minimum quality standards, and a plan to ensure these procedures are followed and the standards are abided by.

Lesson Learned # 8: Incorporate frequent peer reviews and phase gated quality checks to ensure quality and reliability of deliverables.

It was BP's responsibility to ensure that its contractors provided them with the correct design and quality of work. But for the cementing work done by Halliburton, BP failed to provide adequate supervision of their work or ensure that senior Halliburton staff performed peer reviews for work they knew could be problematic. The cement mixture that was provided by Halliburton turned out to be unstable, but this was not discovered until after the blowout. The Halliburton engineer who tested the cement mixture sent BP results that should have shown – to the trained eye – that the mixture was not stable; but he provided no such comment or warning, and in fact it does not appear BP examined the data at all (Graham et al, 2011). Not only did BP not perform a quality check on the cement test results prior to the start of cementing, but they had been aware of problems with this engineer for several years, even describing him as "not cutting it" (Bartlit et al, 2011). Knowing this, BP should have assigned one of their own or Halliburton's experts to peer-review his work. A phase-gated quality check and peer review prior to the start of cementing should have identified this severe quality issue.

BP's drilling projects typically go through the following phases: Appraise, Select, Define, Execute and Review. Though there were phase gates and peer reviews for stages *prior* to execution, there appeared to be none during the actual execution phase (Bartlit et al, 2011).

Complex projects with high technical complexities and many stakeholders should incorporate phase-gated peer assessments and quality reviews at the end key tasks throughout all stages of the project including project execution. In addition, particular attention should be paid to work the team knows could be problematic, through the use of peer reviews.

3.4 KNOWLEDGE MANAGEMENT

Lesson Learned # 9: Implement procedures for critical knowledge transfer and ensure they are communicated to the team early on in the project.

BP's onshore design team was always trying to catch up with rig operations in order to provide procedures (e.g. for design and testing) which should have been available before the work started (Bartlit et al, 2011). In a BP leadership meeting prior to the blowout, BP's vice president of drilling and completions worried about problems arising from delayed well plan delivery. BP's engineering manager acknowledged that "If you have more time to write detailed procedures, there is a greater chance that the result… might be more successful" (Bartlit et al, 2011). BP's organizational culture seemed to eschew procedures in favour of recognizing performance alone as the key to achievement (Bartlit et al, 2011). If details for the critical negative pressure test had been provided to the rig team in a timely manner, for example, the crew might have identified warning signs of a blowout and could have responded appropriately. Therefore, for any complex task to be completed successfully, guidelines and procedures for critical knowledge/information transfer should be communicated to the team early on in the project.

Lesson Learned # 10: Provide adequate emergency training for staff in high risk projects, to mitigate the risk of accidents and reduce their impact.

The mismanagement of human resources and the lack of rigorous staff training contributed greatly to the severity of the Macondo disaster (Bartlit et al, 2011). Firstly, BP, Transocean and Halliburton all failed to provide their employees with sufficient training and thorough response procedures to handle emergency situations even though they relied heavily on employees' decisions in those times. For example Transocean's failure to provide its Dynamic Positioning Officer with emergency training resulted in confusion and hesitation when the first alarms sounded before the blowout (Bartlit et al, 2011). Training could have enabled a prompt response by preparing the officer for what to expect, how to read the severity of risk and take decisive action. Any organization involved in complex and high risk operations should train their personnel for routine as well as emergency situations.

Lesson Learned # 11: Effectively transfer and disseminate lessons learned from previous projects.

Had BP and Transocean not failed to communicate lessons learnt from previous experiences, their crew could have been in a better position to deal with the problems leading up to the blowout (Bartlit et al, 2011). Transocean had a similar incident on December 23, 2009, where they narrowly escaped a leak and blowout in the North Sea (Bartlit et al, 2011). The lessons learned from this near miss were not shared with the relevant groups on other projects. Instead, a presentation was given to North Sea staff and an advisory on risk awareness and control was posted online which was never seen by Deepwater Horizon personnel. It is usual in organizations to compile lessons learnt or the very least discuss them. Where they often fail is in making sure that people who can learn from this historical data see and use it.

Organizations should implement procedures to ensure that critical lessons learned are effectively transferred and disseminated organization-wide, for example through hosting training sessions for critical staff, organizing management conferences to discuss lessons learned, adding the lessons learned to the Project Management Office inventories and training plans, and implementing the lessons learned directly into the organization's project management plans/procedures.

3.5 Communication Management

Lesson Learned # 12: Create thorough, user-friendly communication plan.

Accessing the right information at the right time is critical in complex projects such as the Macondo project, which also involved complex functional groups with on-shore and off-shore staff and contractors/subcontractors. BP had a communication plan in place to guide communications between the project team, for example to guide the rig staff on when to consult on-shore staff for technical matters, and whom to consult. But the plan was ineffective: one team member described it as “weird drawings with boxes & arrows” (Bartlit et al, 2011). With no clear plan to follow, the rig staff did not consult on-shore personnel when the negative pressure test results came out abnormal, which directly contributed to the blowout.

Lack of communication between BP and Halliburton also contributed to the disaster. For the new cement mixture design (used to seal the steel casing into the well), Halliburton conducted two tests prior to the incident where both tests showed it to be unstable. Some of these test results were not communicated to BP, and where they were, Halliburton did not provide comment on what they meant (i.e. that the mixture was unstable). The testing conditions were later altered once more details of the work were confirmed, and finally stable results were obtained. However BP did not receive these last test results until after the cement work, and after blowout. Halliburton issued no notice of the changes to the testing conditions. Halliburton is mainly at fault in this lapse of communication, but BP should also have maintained ongoing communication channels to obtain and understand the test results prior to cementing.

A thorough, user-friendly communication plan should be created, and all staff trained in its use, to maintain appropriate communication channels between all project stakeholders and ensure critical information exchange.

3.6 Human Resources Management

Lesson Learned # 13: Minimize or carefully manage personnel reorganization during critical project stages to avoid uncertainty, loss of project knowledge, and interpersonal or departmental conflicts.

Effective utilization of human resources is an essential part of a project’s success. Especially for a complex technical project involving many functional departments and contractors, a well structured team of people with sufficient technical background and clear division of responsibilities is crucial. A poorly timed personnel reorganization in the late stages of the Macondo project led to poor untimely decision making. To avoid conflicts between the operations and engineering leads of the Macondo project, the team was split into two functional groups: “Engineering” and “Operations”. Where one person had been responsible for both engineering and operations, now there were two each with a separate supervisor. The new engineering team leader had no experience or knowledge of the already troublesome Macondo project when he was appointed in April 2010; others noted that he was taking longer to make decisions and was having a hard time keeping up with this new role (Bartlit et al).

In another instance, BP bypassed a formal MOC “Management of Change” process for the transfer of key project personnel. The process typically requires multiple approvals/sign-offs from various managers. But towards the end of the project, BP’s Well Site leader (Sepulvado) was pulled out of the project to attend on-shore training that could have been postponed. He was replaced by another leader (Kaluza), who wasn’t familiar with the project, bypassing the MOC process (Bartlit et al, 2011).

Major personnel reorganization during the project should be carefully considered and managed to avoid confusion over responsibilities, unnecessary distractions and delays. Reorganization should be avoided at critical stages of the project. If it cannot be avoided, a transitional period should be incorporated in order to avoid knowledge gaps.

Lesson Learned # 14: Create ways to motivate a “pure projectized” team to fully concentrate on the work even towards the end of the project.

The Macondo project used a “pure projectized” organizational structure, where all staff are fully assigned to the project for its duration, and are moved elsewhere afterwards. In this type of project organization, it is common for project members to lose focus at the end of the project. BP’s Subsea Wells Supervisor admitted during the later investigation that once the final cement job was done, people tended to think that everything would go well and start thinking about the next job (Bartlit et al). As it turned out, the fact that the cement job did not go well was not properly detected or diagnosed until it was too late. Personnel lost focus, and failed to properly consider the ongoing risks of their work.

In projects like Macondo, the testing stage towards the end is critical to ensure a properly functional well and to detect problems. Motivational tools and management oversight should be increased towards the end of the project to ensure the team pays full attention to their work.

3.7 REGULATION MANAGEMENT

The federal government failed in its role of providing regulatory management and enforcement for private sector offshore drilling projects. Although much responsibility for preventing disasters of this nature lies with the private sector stakeholders, the public sector has a crucial role to play in protecting the public's interest/wellbeing by providing regulatory oversight and properly enforcing standards.

Lesson Learned # 15: Create and fund an independent government body to manage safety regulations for the oil and gas industry.

The Minerals Management Service (MMS), as it was known before and during BP's Macondo project, was the single governmental body responsible for regulating offshore drilling – it both promoted offshore development and was responsible for ensuring safety and environmental protection. "Political pressure generated by a demand for lease revenues… often combined to push MMS toward elevating the former goal over the latter" (Graham et al, 2011). This, combined with an inert bureaucratic organizational structure, persistent lack of resources and lack of sufficient technological expertise, resulted in an effective agency incapable of managing the oil and gas sector on behalf of the public (Clayton, 2010).

Following the BP oil spill, the MMS was split into three separate sections, one of which is now solely responsible for managing and enforcing safety and environmental regulations.

Lesson Learned # 16: Utilize up-to-date regulatory standards based on industry best practices.

The safety standards used by the MMS to regulate offshore drilling were created by the American Petroleum Institute (API), a private sector body that is also the principal lobbyist on behalf of the oil and gas industry. The API routinely opposes safety regulations that increase government oversight of industry activities (Graham et al, 2011). The standards failed to provide meaningful regulation for key pressure tests for the well's integrity, which, if properly conducted, would have detected the problems much earlier and possibly prevented the blowout. The MMS should create and use meaningful regulation to manage offshore drilling free of industry lobbying, and based on industry best practices – not the "lowest common denominator" (Graham et al, 2011).

4 CONCLUSION

The catastrophic failure of the Macondo deepwater drilling project could have been avoided, and was caused in large part by a systematic failure in project management – particularly by BP as the project owner, but also by its subcontractors and the federal government agency responsible for regulating the work.

There are many critical project management lessons to be learned from this disaster. Key among these are the importance of fostering an organization-wide culture of balancing cost/time with quality and safety, and incorporating realistic contingencies into the project's budget and schedule; thoroughly identifying, managing and updating the impact of project risks in a timely manner, and accurately assessing the severity of risks; implementing comprehensive quality plans and procedures, and incorporating frequent peer reviews and phase gated quality checks; implementing procedures to transfer critical knowledge within the project and disseminating lessons learned from previous projects; implementing thorough and effective communication pathways between project stakeholders; carefully managing personnel organization and motivation throughout the project; and providing independent and thorough regulatory oversight.

Had these project management practises been implemented in the Macondo project, the project may have been a success. It is of critical importance, then, that these lessons be effectively disseminated to – and implemented by – stakeholders in future projects of this size, complexity and risk, to avert similar catastrophe.

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