WHITE PAPER

BPM FOR STRUCTURAL INTEGRITY MANAGEMENT IN OIL AND GAS INDUSTRY

Saurangshu Chakrabarty

Abstract

Structural Integrity Management (SIM) is an ongoing lifecycle process for ensuring the continued fitness-for-purpose of offshore structures. This Document discusses on how to leverage Intelligent BPM and its adaptive and predictive models along with features like Collaboration and Adaptive Case Management to build an efficient Structural Integrity Management System. This can in turn help in Risk Reduction and save organizations in taking corrective actions well ahead of time and prevent mishaps.

Infosys®
Navigate your next

Table of Contents

1. Business Process Management and its Fitment in SIM

Structural Integrity Management (SIM) is an ongoing lifecycle process for ensuring the continued fitness-for-purpose of Offshore Platforms, Pipelines, Wells, and Onshore Platforms. The structures are designed for a specific environment, defined lifetime and type of operation. As conditions change during their lifetime, modifying, maintaining and upgrading of ageing structures is a continuous process. The SIM process has evolved to provide industry and regulatory authorities a means to ensure the continued safe and reliable operation of the aging fleet of offshore platforms around the world.

Structural Integrity Management (SIM) takes an asset lifecycle approach and follows the industry recognized four-part process:

- *Data*
- *Evaluation*
- *Strategy*
- *Program*

BPM or Business Process Management is a discipline that leverages software and services to provide total visibility into our organizations. Discover, document, automate, and continuously improve business processes to increase efficiency and reduce costs are the key goals of BPM.

Business process management activities can be grouped into six categories: vision, design, modeling, execution, monitoring, and optimization. This maps to the core theme of SIM which is Data Collection on the Structures-> Evaluation for Structural Integrity based on Data collected -> Build Strategy on Improvements based on these evaluations - > Implement the Program based on the Strategy -> Data Collection based on the Program. There is a process of continuous improvement in SIM which follows the BPM Methodology of continuous process improvements and optimization.BPM technology products like Pega PRPC, IBM BPM for example can be used to enhance the capabilities in the SIM Process.

Components of a BPM tool and its reference architecture

The critical components of a typical BPM Product which are relevant to realize the SIM Processes are:

- **Dynamic Case Management:** Supports both planned structured cases and dynamic cases involving ad-hoc steps that are added on demand for the SIM Process participants.
- **Business Process Engine:** a robust platform for modeling the Strategy and executing processes for the Program
- **Business Rules Management:** Business rules management system (BRMS) implement business Decisioning logic and business policies, and these rules drive SIM Processes. There are many categories and types of business rules such as decision trees, decision tables, constraints, and expressions. The focus on business rules is on externalizing the business logic—as close to the business as possible—without worrying about execution time, execution method, or execution order.
- **Content Management:** provides a system for storing and securing electronic documents, images, and other files gathered during the inspection process.
- **Collaboration Tools:** removes communication barriers through discussion forums, dynamic workspaces, and message boards and can be used as a forum for discussion of strategies or business rules before implementing them. SIM process is a lot about sharing specialized knowledge and the collaboration tools provide the engineers an interface to discuss the strategies.
- **Business Analytics:** enables SIM Process users to identify risks and issues, trends, and opportunities of improvements with reports and dashboards and react accordingly. One of the most important trends in the industry is the emergence of data science and especially big data analytics. Both predictive and adaptive (self-learning) analytics, enables the insight that is discovered to become actionable. It can help in building a recommendation system which can unlock the learnings from the huge amount of the historical data that is available and reveal trends which may not be easily recognizable otherwise

2. Mapping of SIM Strategy to BPM Components – Data Capture

Data Capture is a key to SIM Process. Throughout the life of the facility new data are collected, e.g., through periodic inspections, as a result of accidental events or from planned modifications and/or additions to the platform. Data may also get generated from technology development projects or service experience of similar structures within the industry. There are two types of data for any offshore structure:

- ***Characteristic data of the asset be it the Platform, Pipeline or other structures in the Fleet.***

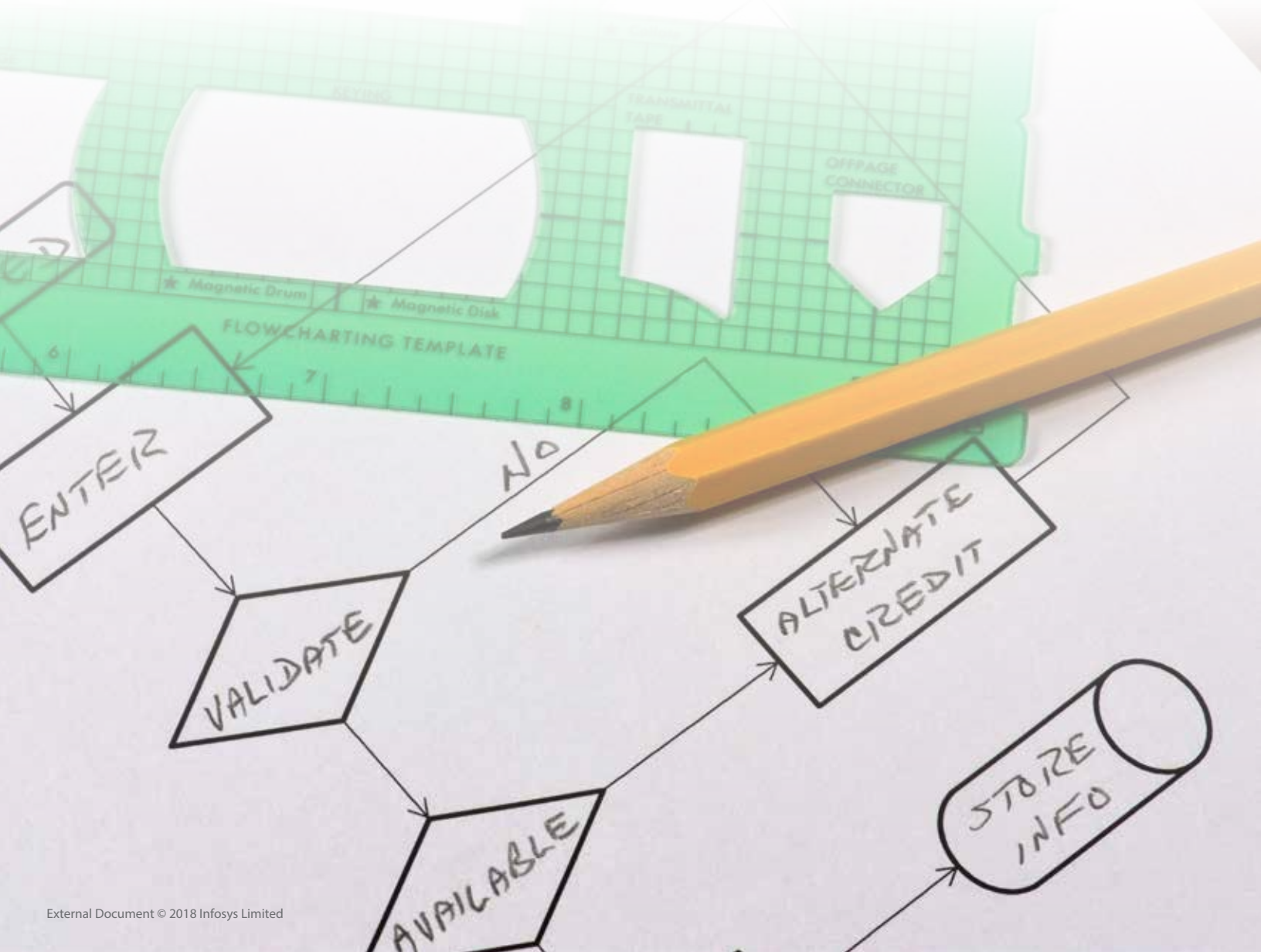
- ***Inspection data of the asset. This would typically consist of raw data like Images, Videos and Inspection Reports.***

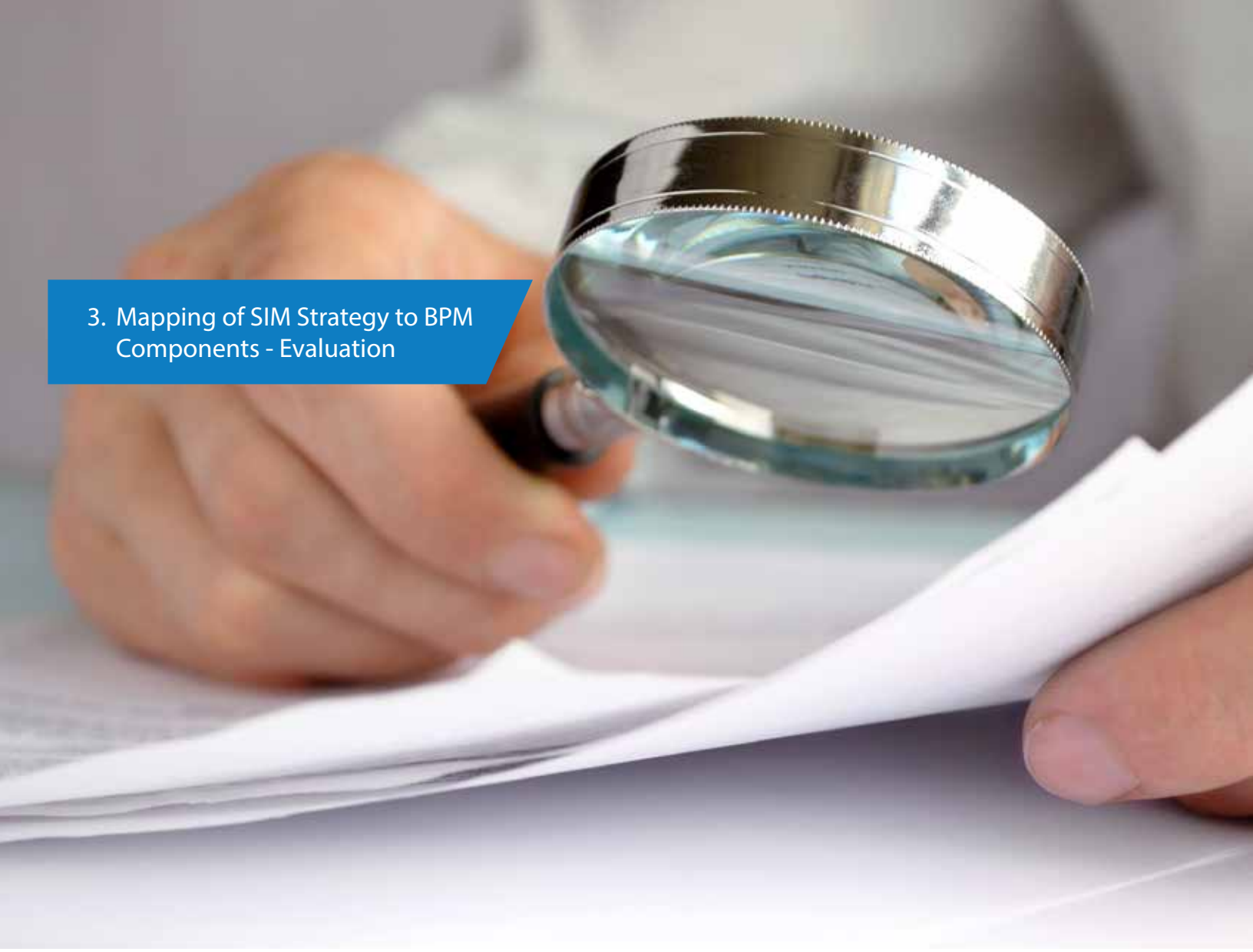
Realization of Data Capture in BPM

The Content Management Feature in BPM realizes the Data Capture. Most of the BPM Products come along with Content Management Features and all of them Provide Integration features with SharePoint and Documentum. BPM Products along with its integration capabilities with Enterprise Content Management Systems enables SIM Tools to leverage a reliable data store in the back end to store huge amounts of data generated from Inspections.

Some additional features that can be exposed by an enterprise content management tool using BPM are:

- Compliance requirements like Storing data related to a particular country or geography to be stored in that location or an approved data center
- Enterprise Content Management tools expose excellent Caching Services where caching servers in geographically nearby locations allows faster access to data
- Mobile device and Smart Phone integrations with Content Management tools provides Structural Engineers and Inspection Staff to use their hand held devices to capture images and videos and then synch up offline with content management stores in the backend for seamless data transfer.
- Enabling communication over a secure channel thereby ensuring that sensitive data is not tampered with
- All the data which is stored in the Enterprise Content Management tools is in a Secure Encrypted format thereby providing additional security on the data
- A lot of the custom characteristic data can be stored in a custom designed database linked to the BPM tool which can then be replicated to a data mart for trending and analysis of the vast amount of data collected
- Data Scientists and Analysts can provide expertise in the tools and methodologies needed to discover predictive models from all types of data including transactional, process, "big data", text and unstructured data collected over the years in the SIM Tool





3. Mapping of SIM Strategy to BPM Components - Evaluation

Risk ranking is a methodology that helps in calculating and analyzing the likelihood and consequence of risk for a Structure's failure. This is based on the characteristic data and inspection data details of a Structure.

The Risk Ranking of a structure is done based on Likelihood of Failure and Consequence of Failure. Based on the data in these two sections, a consolidated Risk Matrix is derived.

To determine the Risk of the structure we have to first find out the Consequence of Failure and the Likelihood of Failure which together sums up the Risk level of the Structure. Usually this is governed by complex mathematical rules in the Oil and Gas Industry defined by certain Engineering Standards.

Consequence of Failure

The consequence of failure is determined by multiple parameters like:

- Health & Safety
- Environmental Impact
- Business Impact
- Public Disruption

Likelihood of Failure

The likelihood of failure is determined by multiple parameters for the structure. Likelihood is a rule-based scoring system that accounts for key platform information that affects platform strength and susceptibility to extreme loads e.g. vintage, framing scheme, number of legs, existing damage, etc.

The likelihood score of a platform is calculated as a summation of scores based on multiple parameters collected. Each of these scores are in turned calculated by complex mathematical formulas and business rules defined based on the characteristic and inspection data collected.

Managing Evaluation Process in SIM using BRMS

Business Rules Management System or BRMS is about "What should be done?" And it standardizes operational decisions and facilitates decision automation and maintenance. It provides a Centralized Business Rules Repository. While BPM controls business processes, BRMs automates decisions in processes.

In order for processes to be automated, the business rules procedures must be translated into a set of business rules that can be applied to individual events and interactions. The more sophisticated the business rules capability, the farther will be the reach of the BPM system. BPM tools support varieties of rule types for eg:

- Process rules that automate the routing, assignment, and tracking of work tasks for e.g. in executing the program tasks like an inspection.
- Decisioning rules of varied types including decision trees, decision maps, and decision table
- Transformation rules that map and parse data across heterogeneous IT systems.
- Integration rules that determine the right system connection to make in each circumstance for e.g. Production data for Crude Oil could be fed from one external system and the production data for gas can be fed from another.

The Risk Ranking components and the business rules and algorithms that define its calculation are best realized in a BRMS tool for BPM.

The consequence of failure and likelihood of failure is calculated based on business rules and logic applied for a specific structure or platform and can vary based on multiple factors like where the platform is located or if the Oil and Gas Company has faced a similar consequence in the recent past in the geography. There are multiple such factors which determine this. Covering these factors is outside the scope of this document.

What this document is trying to highlight is that Rules determining the Consequences of Failure and Likelihood of Failure are calculated by complex business rules and BPM's BRMS (Business Rules Management System) provides the Engineers an effective handle to manage these rules in the IT Systems without being dependent on anyone else.

4. Mapping of SIM Strategy to BPM Components – Strategy and Program

The Strategy Definition provides detailed steps of activities performed during inspection of a selected structure. It also provides the scope of work to be considered for the improvement of a Structure, based on the history and the present condition of the Structure. For example, if there are unrepaired dents seen during the inspection of a Platform, and then the scope of work would be determined based on the various details of the Platform's usability.

Scope of Work Definition using BPM Dynamic Case Management

The Defining of SoW in itself can be mapped to a Case Modelling in BPM Terminology. A case is the coordination and collaboration of multiple parties or participants that process different tasks for a specific business objective.

The coordination of the tasks is organized in a case hierarchy (subcases). Some of the tasks will be planned in predetermined process flows, and some tasks will be unplanned. All of these coordinating tasks in the case are for a concrete business objective or goal. Cases are therefore dynamic, adding or changing any of their elements, and responding to and generating events. It is difficult to predefine the SoW tasks. Most of it will be dynamic based on multiple parameters, some of which are explained below:

- **Details of Past Inspection History:** This is derived from the historical data captured over years of inspection and BPM can render a summarized view based on the data collected.
- **Structure Risk Ranking Matrix:** This is the current risk ranking explained in the earlier section and based on the current set of business rules can show the likelihood and consequence risks associated with a selected Structure.
- **Scope of Work on the Inspected Structure:** Based on the historical data and risk ranking done, a default recommendation on the scope of work can be defined. This is where Predictive BPM or intelligent BPM comes to play providing certain recommendations to engineers who in turn can use the collaboration tools and the information provided can make a conscious decision to define the Case or the recommended processes to be applied for Scope of Work (SoW).

Once the Case is defined, it is possible that new discoveries can be made and it will require the Case Definition be altered with new processes being added and existing processes being removed. Cases need to be dynamic in nature and be able to be modified/altered based on events captured impacting the Case. What BPM provides is a way for Cases to generate and respond to Events. There will be different types of policies and business rules, such as Decisioning rules, expressions, decision tables, and constraints, which are associated with the SoW.

Cases will go through milestones or "stages." Engineers can have complete visibility into these milestones and can easily monitor the progression of the case's lifecycle towards resolution i.e. the SoW completion. Dynamic Case Management can handle these structured processes, but can also handle robust hierarchies of tasks and collaborative processes with ad-hoc changes. During the SoW implementation, new ad-hoc tasks can come up and they can be captured as a part of the process. What BPM does provide with Adaptive Case Management is a handle to capture these details in the System and use this information as learnings for future Case Definitions.

Using Analytics and Process Intelligence in the SIM Process

Often the process intelligence is harvested from knowledge workers and in this case from Structural Engineers and their knowledge on the SIM Process. Increasingly, the intelligence is mined and harvested from data. The sources and types of data vary and can include process or case data, transactional data, data from data warehouses.

Predictive and adaptive analytics mine these data sources to create actionable predictive models. In this specific case of Structural Integrity Management Process Data, huge amount of Inspection Data collected and Case Data from prior SoW definitions and Program implementations done provides a data source to provide predictive models which can help in improving the overall efficiency of the structure and reduce its level of Risk. It enables the system to predict proactively the aberrations and pre-empt next best action for the Case for e.g. Carrying out a specific kind of repair on the structure.

With BPM, companies can have complete visibility and control of their objectives, which are often expressed in their KPIs or enterprise performance measures. They can see and understand what is going on with their support, mission-critical structures. More importantly, they can be proactive and make changes to improve and can prevent mishaps to occur.

This industry has many hidden treasures in their data. The data can be held in operational databases, data warehouses .Tons of data get collected for various structures during the inspections. The whole purpose of predictive analytics is to discover patterns from this data (predictive models), use them to predict future behavior, and then act on the insight. Historical data is analyzed and modeled to predict future behavior.

In adaptive (or self-learning) models instead of looking at a snapshot of data, this model looks at a moving window of data as it enters the adaptive system. These adaptive models is what is needed to be used in SIM as it humanly impossible to design static models based on the data collected for structures over years. Based on this Structural data and the multiple parameters which need to be taken into consideration for the structure in the fleet, the adaptive model provides proactive recommendations which the structural engineers can use for mitigating high risk structures.

5. Conclusion

Most of the Oil and Gas companies use some kind of bespoke system for managing the Structural Integrity of their Assets. Historically these have been custom built applications with a host of business rules and algorithms embedded in custom code that is known only to a limited set of people. Some potential pitfalls of these traditional tools being used for SIM are:

- High Maintenance cost
- Cannot be easily extended for new features
- The IT Knowledge in these tools are known only to a few handful of people in the Organization
- These tools serve just as a source on information but cannot be taken to the next level to identify trends, make predictions based on data collected and provide proactive recommendations.
- The I-Intelligent factor is missing which is brought about by BPM

Some of the key advantages that BPM can bring into the SIM tools and processes are:

- Support situations where process participants need to work on tasks in unpredictable ways, though within a high-level structure with defined goals. The idea here is to create a software tool that can support processes that are constantly changing. When an engineer or an inspector is faced with a new problem, he or she (or perhaps a team coordinating via the Web) assembles and sequences the set of tasks into the process they believe is the best solution to the problem.
- Real-time decision allows achieving tangible benefits by unlocking the insights hidden in vast amounts of digital information collected over a period of time from past inspections and capitalizing on them.
- Provide Adaptive Analytics for "self-learning" that can dynamically incorporate new information and insights and automatically apply them to the next applicable situation in the system.
- Prevent disasters by providing timely alerts from the predictive models which get built.

6. References

a. Structural Integrity Management (SIM) of Offshore Facilities https://www.onepetro.org/conference-paper/OTC-17545-MS

b. Business Process Management http://en.wikipedia.org/wiki/Business_process_management

c. http://www.pega.com/business-rules

d. http://www.pega.com/.../Intelligent-BPM-The-Next-Wave-For-Customer-Centric- Business-Applications_Khoshafian.pdf

About the author

Saurangshu Chakrabarty is a Principal Consultant with Digital & Integration Services – Digital Process Integration unit at Infosys. He has led large programs in BPM as well as SOA/ EAI across business verticals especially Oil and Gas for various clients in North America.

He can be reached at Saurangshu_c@infosys.com