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CMMI-Based Lean Risk Management (LRM) Framework for Lean Implementation in Mining (Built on the Risk Management Process Area of CMMI)

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ABSTRACT- The paper proposes a new CMMI-based risk management framework for lean implementation. Any process improvement framework implementation is subject to many unknowns and uncertainties. Generally new process improvement framework starts with certain assumptions, dependencies, and limitations, which may convert into a potential problem or risks. Those risks need to be managed in a systematic and structured way. Lean is one of the most widely used process improvement framework across the industry and in varied domains & spheres of the organisation. Mining organizations are also implementing lean but with a very limited benefits and success. The successful and rewarding lean implementation has been a big challenge for the process improvement experts & lean practitioners. It requires a robust risk management strategy to mitigate unforeseen events and potential issues. The paper proposes CMMI's Risk Management-based framework for managing the risks during lean implementation. It will propose multiple levels of process areas & practices. The framework will be based on the multiple levels of capability / maturity rating system as defined in CMMI V1.3. There are some limitations of using the framework and its should be customized as per the organizational requirements. Also, further enhancement can be done by adding more tools, techniques and practices, which will make it more robust.

Keywords: Lean, Mining, Risk Management, CMMI, Improvement Framework

I. INTRODUCTION

Any process improvement framework implementation is subject to many unknowns and uncertainties. Generally new process improvement framework starts with certain assumptions, dependencies, and limitations, which may convert into a potential problem or risks. Those risks need to be managed in a systematic and structured way. Lean is one of the most widely used process improvement framework across the industry and in varied domains & spheres of the organisation.

Mining organizations are also implementing lean but with a very limited benefits and success. The successful and rewarding lean implementation has been a big challenge for the process improvement experts & lean practitioners. It requires a robust risk management strategy to mitigate unforeseen events and potential issues. Lean implementation's success rate is not very high and one of the reasons for failure could be attributed to lack of effective and systematic risk management during planning & execution. There is a need to define & follow a structured risk assessment & monitoring system during the lean project/program implementation. Lean practitioners can adopt best practices of other process improvement frameworks like CMMI.

CMMI's is one of the widely used process improvement framework across the globe and has benefited thousands of IT / Technology companies handling complex & risky projects. It has process areas related to the project management including risk management. Its being designed by integrating some of the best practices followed by IT / Technology organizations.

The paper proposes CMMI's Risk Management-based framework for managing the risks during lean implementation. It will propose multiple levels of process areas & practices. The framework will be based on the multiple levels of capability / maturity rating system as defined in CMMI V1.3.

II. LITERATURE REVIEW

A. Introduction

As per ASQ (https://asq.org) , Lean is defined as a set of management practices to improve efficiency and effectiveness by eliminating waste. The core principle of lean is to reduce and eliminate non-value adding activities and waste. Lean manufacturing, or lean production, is a system of techniques and activities for running a manufacturing or service operation. The techniques and activities differ according to the application at hand but they have the same underlying principle: the elimination of all non-value-adding activities and waste from the business. Waste, or muda in Japanese, is defined as the performance of unnecessary work as a result of errors, poor organization, or communication. A lean enterprise operates by creating products and services to meet customer orders rather than marketing forecasts. This results in dramatic reductions in development times for new products and services, reducing the cycle time to market. In manufacturing, lean capabilities result from the

introduction of more flexible, more automated, computer-controlled production machinery. [1]

Toyota is one of the early adopters of the Lean Manufacturing (LM) concept in the automotive sector. After that, various sorts of sectors, including petroleum, oil & gas, mining, widely embrace the LM concept. However, there are a number of presumptions that should be considered while applying the LM idea in various businesses. When the LM concept is implemented in new domain / company, it is suggested to put a structured project / program & risk management framework in place and it should be part of overall implementation strategy.

Why risk to be tacked in a structured way? Any circumstance that could prohibit a project or set of actions from accomplishing its goal is seen as a risk. Risk is characterised as a drawback or loss of project / program's benefits. Managing risk is not an easy task for every company. Top management needs decision making tools / frameworks to support them in identifying, analysing, and evaluating potential risks. [2]

So, there is a need to define a customized risk management framework to ensure that projects / programs are implemented successfully. Same is applicable for lean process improvement initiatives / program also, which have lots of uncertainties and may pose a threat to the success of lean implementation in the organization.

In general, risk management framework includes risk identification, action planning, evaluation & monitoring, and governance.

B. Risk Management Framework

As per www.investopedia.com, a company's quest of stability and top performance depends heavily on effective risk management. The foundation of an organization's future may lie in the adoption of a risk management framework that incorporates best practises into the company's risk culture. When designing a framework for risk management, at least five essential elements must be taken into account. They include risk identification; risk measurement and assessment; risk mitigation; risk reporting and monitoring; and risk governance. [3]

- Identifying & defining: the risk catalogue is the first stage in determining the risks that a company may confront. Simply put, the risk catalogue has all potential threats organization may face while doing business.
- Risk measurement: gives data on the amount of a single or collective risk exposure as well as the likelihood that a loss will result from such exposures.
- Risk Mitigation: Getting categorized and measured its risks, a company can then make a decision on which risks to eliminate or reduce through risk mitigation strategy
- Risk Reporting & Monitoring: It is essential to report regularly on specific and aggregate risk measures in order to ensure that risk levels remain at an optimal level & under control.
- Risk governance: The process of risk governance makes sure that every employee of the business carries out their responsibilities in line with the risk management framework. Assigning authority to people, committees, and the board for the approval of major risks, risk limits, exceptions to limitations, and risk reports, as well as for general oversight, is a component of risk governance.

III. RESEARCH GAP

There are many companies implementing lean to improve processes, quality, systems, and customer satisfaction. The implementation programs are subjected to uncertainties & potential risks. There are multiple stakeholders and departments involved in the planning, execution & monitoring of lean projects / programs. There are issues related to coordination, communication, governance, and management. The success rate of lean implementation is not very high and one of the reasons could be lack of a structured projects/program management and risk monitoring & tracking during the lean initiatives implementation. As per author's best of knowledge, there is not risk management framework for lean implementation in mining which is based on CMMI's risk management process area.

So, it's imperative to propose a risk management framework, which can be used to ensure that organizational level projects / programs are implemented successfully. Same is applicable for lean process improvement initiatives / program also, which have lots of uncertainties and unknowns. Those uncertainties need to be dealt with the help of a structured framework. CMMi's risk management process area has been in place & use in many IT / Technology organizations. Its in use as a part of the CMMI model used by organization handling large & complex IT projects / programs. Organizations have put a structured risk management framework to tackle uncertainties & risks during the projects / program execution.

IV. METHODOLOGY

For building the new framework researcher opted to rely upon the secondary data available from the lean implementation in different industries. The researcher studied the existing risk management processes & frameworks and its usage by the organizations. CMMI V1.3 is being used many organizations for process improvement and measurement of organizational maturity / capability.

Researcher decided to use the risk management process area's practices and sub-practices to define a new framework for managing the risk during lean implementation in mining. All 7 practices of risk management process areas were studied and then mapped to a new proposed Lean Risk Management Framework for Mining organisations. The new framework will have processes, practices and sub-practices which must be followed while executing a lean project / program.

V. THE PROPOSED CMMI'S RISK MANAGEMENT PROCESS AREA-BASED FRAMEWORK FOR LEAN PROJECTS / PROGRAM MONITORING AND IMPLEMENTATION

Identifying potential risks is the first stage in the risk assessment process. There are various tools available to find threats / hazards. In-depth interviews, group

brainstorming, questionnaires, historical documents, experience-based judgement, and direct observation can all be used to identify risks. The next phase is risk analysis, which aims to ascertain how risk factors will affect the system as a whole. Additionally, risk analysis is used to determine the Risk Priority Number (RPN). Probability and repercussions are two factors that can be used to quantify risk. The likelihood of a risk occurring is referred to as its probability. Consequences are viewed as having an impact on risk. After risk analysis, mitigation & contingency plan is identified for each risk as per the RPN. It may also include impact time frame, responsibility, risk status etc. CMMI's Risk management process area also have a similar workflow for risk management. However, it has a very structured framework consisting of Specific Goals and Practices & Sub-practices. All the practices have specific / related work products, which would the results / outcomes of the practices followed during risk management. Same structure can be adopted for managing the risk during lean implementation in mining.

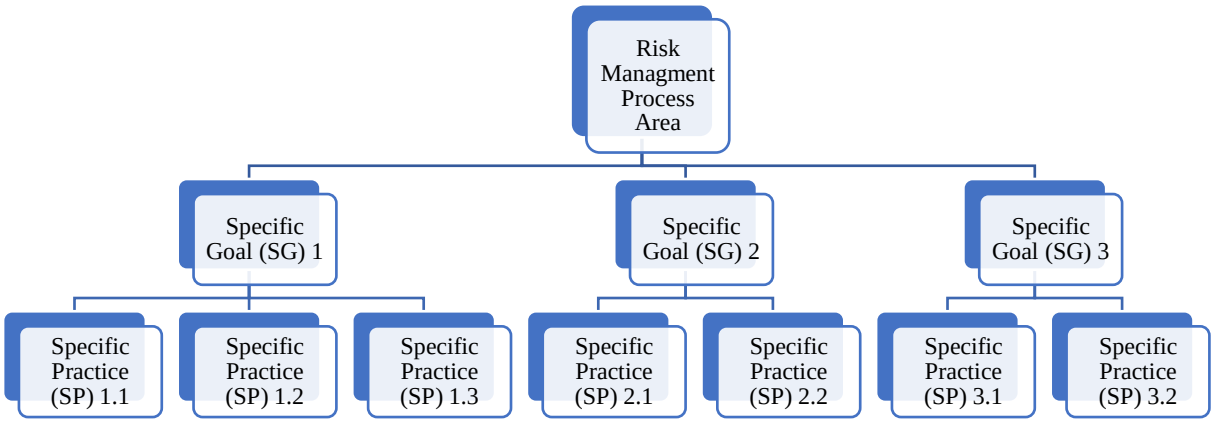

Figure 1: CMMI Risk Management Process Area Structure

The following table shows mapping of CMMI's Risk Management Process Areas Practices and the proposed Lean Risk Management (LRM) framework:

Table 1: Mapping of CMMI Risk Management Process Area's Practices to New LRM Framework

As per www.wibas.com, CMMI Risk Management PA's Practices and Processes [4]	**Proposed Lean Risk Measurement (LRM) Practices & Processes**
RSKM.SG 1 Prepare for Risk Management Preparation for risk management is conducted	LRM.SG 1 Prepare for Risk Management Preparation for risk management for lean project / program is conducted
RSKM.SP 1.1 Determine Risk Sources and Categories	LRM.SP 1.1 Determine Risk Sources and Categories of lean project / program
Determine risk sources and categories.	Determine risk sources and categories for lean project / program
RSKM.SP 1.2 Define Risk Parameters	LRM.SP 1.2 Define Risk Parameters of lean project / program
Define parameters used to analyze and categorize risks and to control the risk management effort.	Define parameters used to analyze and categorize risks and to control the risk management effort for lean project / program
RSKM.SP 1.3 Establish a Risk Management Strategy	LRM.SP 1.3 Establish a Risk Management Strategy for lean project / program
Establish and maintain the strategy to be used for risk management.	Establish and maintain the strategy to be used for risk management for lean project / program
RSKM.SG 2 Identify and Analyze Risks Risks are identified and analyzed to determine their relative importance	LRM.SG 2 Identify and Analyze Risks Risks are identified and analyzed to determine their relative importance for lean project / program
RSKM.SP 2.1 Identify Risks	LRM.SP 2.1 Identify Risks of lean project / program
Identify and document risks.	Identify and document risks of lean project / program
RSKM.SP 2.2 Evaluate, Categorize, and Prioritize Risks	LRM.SP 2.2 Evaluate, Categorize, and Prioritize Risks of lean project / program
Evaluate and categorize each identified risk using the defined risk categories and parameters, and determine its relative priority	Evaluate and categorize each identified risk using the defined risk categories and parameters, and determine its relative priority of lean project / program
RSKM.SG 3 Mitigate Risks Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives	LRM.SG 3 Mitigate Risks Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives of lean project / program
RSKM.SP 3.1 Develop Risk Mitigation Plans	LRM.SP 3.1 Develop Risk Mitigation Plans

Develop a risk mitigation plan in accordance with the risk management strategy.	Develop a risk mitigation plan for lean project / program in accordance with the risk management strategy of lean project / program implementation
RSKM.SP 3.2 Implement Risk Mitigation Plans	LRM.SP 3.2 Implement Risk Mitigation Plans for lean project / program
Monitor the status of each risk periodically and implement the risk mitigation plan as appropriate.	Monitor the status of each risk periodically and implement the risk mitigation plan of lean project / program as appropriate.

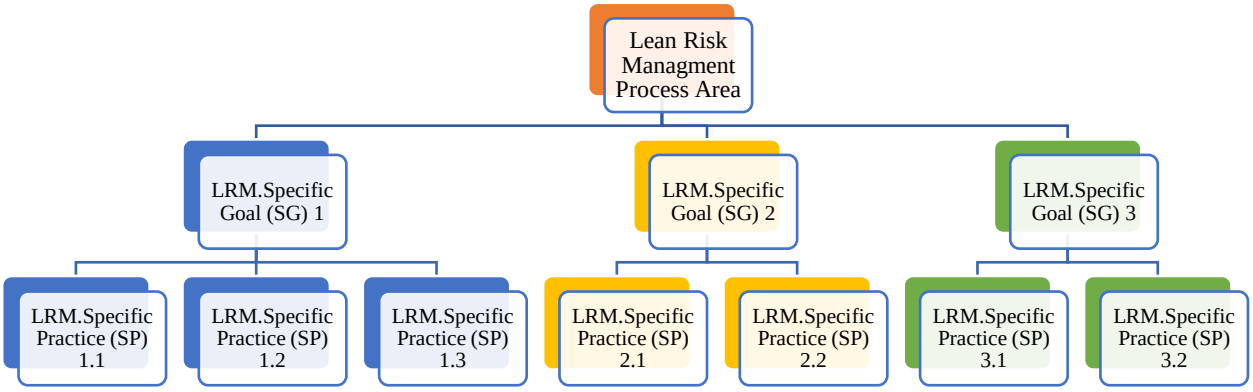

Figure 2: CMMI-based Lean Risk Management (LRM) Framework

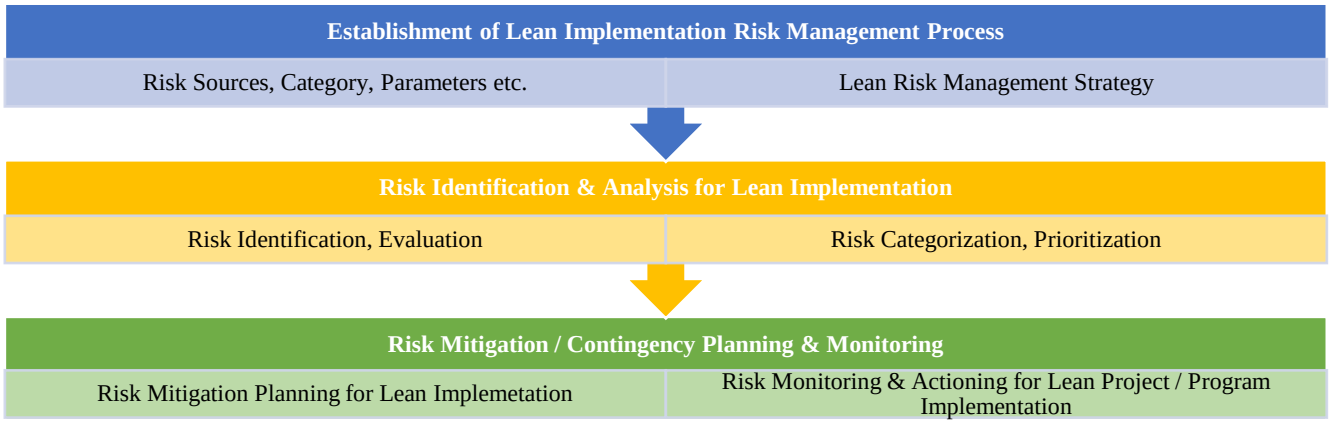

Figure 3: CMMI-based LRM Framework's Work / Execution flow

The following set of tools / techniques can be used along with the proposed framework:

Table 2: Risk Management Tools / Techniques

	Risk Management Tools / Techniques
⚓	Strength Weakness Opportunity Threat (SWOT) Analysis
⚓	Risk Register for risk database / sourcing
⚓	Expert judgement
⚓	Brainstorming
⚓	Root Cause Analysis (RCA)
⚓	Fault Tree Analysis (FTA)
⚓	Failure Mode Effect Analysis (FMEA)
⚓	Taxonomy-based Questionnaire (TBQ) for risk identification

The proposed framework will generate following reports / outputs:

- Risk Sources and Database
- Risk Management Plan
- Risk Monitoring & Tracking Reports
  - Project / Program-wise risks
  - Category-wise reports
  - Severity and RPN-wise reports
  - Risk Status Reports
  - Residual Risk Reports

- Lesson Learned & Best Practices
- Top Management Review Reports for Risk Management Status and Tracking
- Action planning status reports
- Mitigation Plan / Action Effectiveness Reports

The reports, dashboards, outputs and database should be used by management & lean practitioners very judiciously and while monitoring & tracking the focus should be on the processes & system's improvement, not on the individuals or groups. All the action planning based on the risk management framework should be clearly communicated to relevant stakeholders during the reviews & meetings. The roles & responsibilities of mitigation actions should be in agreement with the relevant stakeholders.

All the reports and dashboards should be published through an online system for better communication and transparency throughout the lean implementation projects / program.

VI. LIMITATIONS

The proposed framework is based on the available literature and built based on CMMI & lean implementation experience of the author. The framework needs to be validated by mining companies and lean practitioners.

VII. CONCLUSION & WAY FORWARD

Risk management is one of the key aspects of lean improvement initiatives and should be an integral part of overall planning & monitoring. By using the CMMI-based LRM framework, organizations will be able to plan and manage the Lean initiative projects / programs in better way. Management is suggested to use the required tools, techniques, reports as per the organizational needs. The framework can also be customized as per the organizational context and management requirements.

In future more & more processes, practices and tools can be added to make the proposed framework more practical, acceptable, and robust. The rating system for each practices can also be included to make it more qualitative and measurable.

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