**Why should mining consider open-source software?**

Abstract:

This study explores the potential benefits of integrating open-source software into mining operations. It examines the cost-effectiveness, customization capabilities, transparency, community support, flexibility, scalability, and freedom from vendor lock-in that open-source software can offer to the mining industry. Using case studies from Reiche Zeche mine, and MMP ODAP, this research aims to highlight the practical advantages and challenges associated with adopting open-source solutions in mining.

Introduction:

The mining industry has long relied on proprietary software and traditional systems for various operational needs, but with the rise of open-source solutions, new opportunities for cost savings and customization have emerged. This study investigates why the mining industry should consider integrating open-source software, focusing on the potential benefits and challenges. The research question driving this study is: Why should the mining industry consider integrating open-source software? This question is significant as it addresses the potential impact on cost savings, customization, transparency, and operational efficiency in mining.

Cost-Effectiveness:

When it comes to managing budget, value for money counts. That's why the cost-effectiveness of open-source software is a must consider for the mining industry. Unlike proprietary solutions that come with hefty price tags, open-source software is freely available for use. For example, operations such as data analysis, GIS, simulation, and environmental monitoring could be leveraged by open-source software. While open-source software offers cost savings and flexibility, it may require additional investment in training and support to address complexities and ensure security. Proper management and integration can mitigate these challenges effectively.

Customization:

No two mining operations are exactly alike. That's why it's important to have software that can be tailored to specific needs. Open-source software provides the flexibility needed to customize solutions to fit unique requirements. For instance, Gispo Ltd has a massive project related to developing new open-source tools for mineral exploration. The project is the result of the Exploration Information System (EIS) proposal compiled by a pan-European consortium including 17 partners from research institutes, academia, service providers and the industry lead by Geological Survey of Finland (GTK). The goal is less emission, exploration costs, and this ensures adherence to ESG. Carbon neutrality is one of the goals that need to be achieved by the year 2050; hence "EIS".

Transparency and Security:

Security is a top priority in the mining industry, and open-source software offers transparency, rapid vulnerability fixes, and assurance against software price increases. With the source code openly available, vulnerabilities can be identified and fixed faster. This collaborative approach to security ensures that data remains protected.

Community Support:

One of the things to consider when it comes to open-source software is the supportive community behind it. Whether it's troubleshooting issues or sharing best practices, there's always someone willing to help through online requests.

Flexibility and Scalability:

In the fast-paced world of mining, we need software that can keep up with our changing needs. Open-source software offers the flexibility and scalability required to adapt to evolving circumstances.

Avoiding Vendor Lock-In:

Vendor lock-in can be a major headache for mining companies. By embracing open-source software, a company can avoid being tied to specific vendors and maintain control over their technology stack. Vendor dependency and vulnerability to agreeing with unfair terms of conditions are real risks to the project's sustainability. Open-source platforms are therefore a viable alternative. Many vendors in any case use open-source software to a certain degree to form parts of their commercial software functionality.

Possible Open-Source Use-cases:

Utilizing open-source GIS software for geological mapping and exploration purposes.

Employing open-source fleet management systems to track and manage vehicle fleets effectively.

Incorporating open-source cybersecurity tools to strengthen company's security infrastructure.

Which mines/mining companies use open-source software?:

Reiche Zeche case study:

Reiche Zeche, the research and education mine associated with TU Bergakademie Freiberg in Germany, is using open-source software for its mine control station. Specifically, they utilize Firebird DB as a database management system, utilizing open-source software such as .NET Core for backend development, which is an open-source and industry-approved software. Found at (<https://mining-report.de/wp-content/uploads/_pda/2020/06/MRG_2003_Datenerfassung_Bergbau_TUBAF_200603.pdf>)

#### **Case Study Analysis of Reiche Zeche Mine**

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| **Aspect** | **Description** | **Outcome** |
| Software Used | Firebird DB, .NET Core | Cost-effective and industry-approved solutions |
| Customization | Tailored software to specific mine control station needs | High level of customization achieved |
| Security | Open-source transparency allows for quicker identification and fixing of vulnerabilities | Improved security measures |
| Community Support | Leveraged community resources for troubleshooting and best practices | Enhanced problem-solving capabilities |
| Challenges | Encountered issues with reliance on community updates | Potential delays in receiving updates |

*Description:* This table provides a detailed analysis of the Reiche Zeche mine case study, focusing on aspects such as software used, customization, security, community support, and challenges encountered.

Pros:

Use of Open-Source Software: Reiche Zeche benefits from using open-source software such as Firebird DB for their mine control station, which is cost-effective and industry-approved.

Flexibility and Customization: Open-source software often provides flexibility for customization to suit specific needs and requirements of Reiche Zeche's mine control station.

Cons:

Potential Lack of Dedicated Support: Unlike proprietary software, open-source software may not always come with dedicated technical support, which could pose challenges if issues arise that require immediate resolution.

Dependency on Community Updates: They *may* rely on community updates and contributions for software improvements and bug fixes, which could potentially lead to delays in receiving necessary updates.

ODAP case study:

Why are miners hesitant and would rather choose paid-for products?

Companies may develop in-house/ closed-source or acquire software from third-party vendors because they have more control over the software and can protect their intellectual property.

While open-source software can/and undergo rigorous peer review, mining companies are often concerned about potential vulnerabilities or backdoors that could be exploited.

Mining companies *may* prefer working with software vendors that offer dedicated support and maintenance services. While with open-source software, the responsibility for support and maintenance falls on the community or the company itself.

Change is seen as a risk by some, so, many companies rely on traditional systems. These companies traditionally operated with specific software tools and systems that have been used for years. These legacy systems may not be compatible with open-source software or may require significant modifications for integration. Of which miners may regard changing established workflows and systems challenging, disruptive, and ultimately not worth it.

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| **Step** | **Tasks** | **Check** |
| **1. Assessment and Planning** | - Identify Needs and Goals: Define specific needs and objectives. |  |
|  | - Conduct a Feasibility Study: Evaluate feasibility, cost savings, and operational impact. |  |
|  | - Risk Assessment: Identify risks and develop a risk management plan. |  |
| **2. Research and Selection** | - Identify Available Open-Source Software: Research and evaluate relevant options. |  |
|  | - Review Case Studies and Success Stories: Learn from other companies' experiences. |  |
| **3. Technical Evaluation** | - Compatibility Check: Ensure software compatibility with existing systems. |  |
|  | - Performance Testing: Conduct tests for performance, scalability, and reliability. |  |
| **4. Customization and Development** | - Customization Needs: Identify and plan for necessary customizations. |  |
|  | - Develop and Test Customizations: Implement and test custom features. |  |
| **5. Security and Compliance** | - Security Assessment: Conduct a thorough security evaluation. |  |
|  | - Compliance Check: Ensure compliance with industry regulations and licensing. |  |
| **6. Training and Support** | - Staff Training: Provide comprehensive training for staff. |  |
|  | - Support Plan: Establish a support plan with in-house and community resources. |  |
| **7. Implementation and Monitoring** | - Pilot Testing: Conduct a pilot test and collect feedback. |  |
|  | - Full Deployment: Roll out software and monitor the implementation process. |  |
| **8. Evaluation and Continuous Improvement** | - Performance Monitoring: Continuously monitor software performance. |  |
|  | - Regular Updates and Maintenance: Stay updated with latest versions and schedule maintenance. |  |
|  | - Feedback Loop: Establish a feedback loop with users and stakeholders. |  |
| **9. Documentation and Reporting** | - Document the Process: Maintain detailed documentation of the transition. |  |
|  | - Reporting: Prepare and share performance and benefit reports with stakeholders. |  |
| **10. Community Engagement** | - Participate in the Open-Source Community: Engage, contribute, and stay informed. |  |

*Description:* This figure illustrates a recommended “to do list” that can play a vital role when selecting open-source software for mining operations.

Application possibilities/areas for open source in the mining value chain?

Some areas that open-source software might play a vital role in when it comes to mining are:

1. Exploration and Geology: Open-source software can be used for geological modeling, geospatial analysis, and data visualization, helping mining companies in their exploration efforts and decision-making processes.

2. Resource Estimation: Open-source tools can be utilized for resource estimation and modeling, allowing mining companies to accurately assess the size, grade, and distribution of mineral deposits.

3. Mining Operations: Open-source software can support various aspects of mining operations, including mine planning, fleet management, and production optimization. It can help improve operational efficiency, reduce costs, and enhance safety. Tools like SLO3D demonstrate the potential for open-source solutions in mine layout optimization and planning.

4. Environmental Monitoring: Open-source solutions can facilitate environmental monitoring and management in mining operations. This can include monitoring air quality, water quality, and biodiversity, helping companies comply with regulations and mitigate environmental impacts.

5. Supply Chain Management: Open-source software can be employed for supply chain management, enabling transparency and traceability of minerals throughout the value chain. It can help address concerns related to responsible sourcing and ethical practices.

6. Community Engagement: Open-source platforms can facilitate community engagement and stakeholder participation in mining projects. They can provide a platform for dialogue, information sharing, and collaboration between mining companies and local communities.

7. Sustainability and ESG Reporting: Open-source tools can support sustainability reporting and Environmental, Social, and Governance (ESG) initiatives in the mining industry. They can assist in tracking and measuring key performance indicators related to sustainability goals.

Conclusion:

In conclusion, integrating open-source software into mining operations offers numerous benefits, including cost-effectiveness, customization, transparency, community support, flexibility, scalability, and freedom from vendor lock-in. As the industry continues to innovate and adapt to the ever-changing demands, open-source software will play a crucial role in driving success.

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