Defect Management System Powered by AI (Artificial Intelligence)

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Abstract

Defect management is an important process as part of project management. It helps to provide insight into project health, quality assurance, schedule estimation, risk mitigation, continuous improvement, and resource allocations. This allows the project to raise alerts about quality and make accurate decisions based on data analysis.

The purpose of implementing the Smart Defect Management System (SDMS) is to manage a vast amount of defect data in one tool with a smarter way to provide high data integrity information for the user with regard to defect analysis, defect prevention, and defect reporting. By leveraging AI capabilities, the integration of AI into SDMS empowers the system to process and analyze extensive data, resolve complex problems, and make complex forecasting/decisions with minimum human intelligence.

The goal of SDMS is to deliver high-quality information that enables effective decision-making and enhances operational efficiency while minimizing the costs and efforts involved.

Biography

Peh Wei Wooi is a Platform Validation Lead at Intel Corporation based in Penang, Malaysia. He is certified as the ISTQB tester and holds a Degree in Information Science from UKM, Malaysia.

Liu Keping is a Technical Leader in Software Quality Assurance at Intel Corporation based in Shanghai, China. She is a certified CMMI assessor, ISO internal assessor, ASPICE internal assessor, and CSQE, and gained 6 Sigma Orange Belt and CPMP certification in 2009. She holds a master's degree in computer science and technology from Central South University in China.

Ooi Mei Chen has been in software engineering for over 12 years and has held many roles spanning code development, design, and project management. She currently serves as a senior System Software Quality Engineer at Intel Corporation based in Penang, Malaysia. She holds a Degree in Computer Science from University Tunku Abdul Rahman, MY.

Felix Eu is a Software Quality Engineer at Intel Corporation based in Penang, Malaysia. He has held the Lean Six Sigma Green Badge since 2019, is a certified Software Quality Engineer (CSQE) from ASQ and holds a Degree in Computer Science from the University of Bolton in the UK.

1.0 Introduction

1.1 Problem Statement

Defect management is an important process as part of project management. It helps to:

- Provide insight into project health
- Plan for schedule estimation
- Plan Resource allocation
- Allow the users to raise quality risk alerts
- Make accurate decisions based on data analysis

Traditionally, the defect lifecycle is managed in one system, and defect analysis is done in another system, possibly manually via Microsoft Excel or Microsoft PowerBI. A typical defect management system includes defect reporting, defect analysis, and defect prevention.

It is challenging to manage a large pool of defect data without a robust tool to automate the data collection/manipulation/categorization/analysis and reporting processes. According to this journal, “The Challenges of Data Quality & Data Quality Assessment in the Big Data Era”, data integrity and consistency are always the biggest challenges for users to obtain up-to-date information for analysis, as the data might be collected from several databases and from different user groups.

Furthermore, the most commonly used defect tool on the market today works as a single tool for a particular purpose and it requires human intervention to configure and filter criteria to obtain the result manually. Then the data collection needs to propagate from one function to another function for analysis (For example, the defect management tool and the requirement tool are not linked together; hence the defect ticket is not able to analyze immediately and identify the validity based on the requirement specification) which creates additional overhead to hosting and maintaining the data.

1.2 Smart Defect Management System (SDMS) Concept

An integrated system, especially an AI-powered system, will help to eliminate data gaps between different tools and improve efficiency.

The Smart Defect Management System is targeted to provide a one-stop solution to users with the following benefits:

- Automatic defect classification and defect scrubbing capability
- Automatic defect prioritization and solution recommendation capability
- Real-time defect status dashboard which utilizes the Edge and Cloud services

The one-stop service hosting in the cloud enables the user to access the system without any limitation on time zone, location, hardware, etc. Information will be stored and available on a real-time basis without any delay.

Traditional Defect Management System (DMS)	Smart Defect Management System (SDMS)
Manually manage a large pool of data	Automated & more efficient
Data consistency & integrity is **LOW**	Data consistency & integrity is **HIGH**
Required multiple tools	Required **ONE** tool for all
Non-real time	Real-time
On-premises/Server based	Edge & Cloud services
Downtime is **HIGH**	Downtime is **LOW**
Less predictive	**More** predictive
Slow decision making	Quick & better decision making

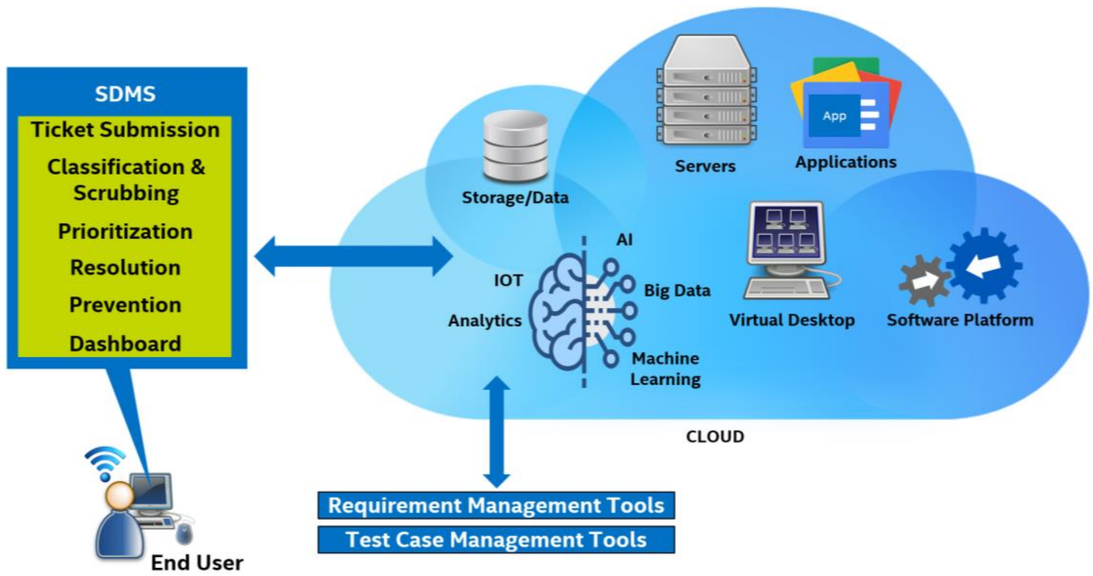
Table-1 Traditional DMS vs. SDMS

2.0 Opportunities & Solutions

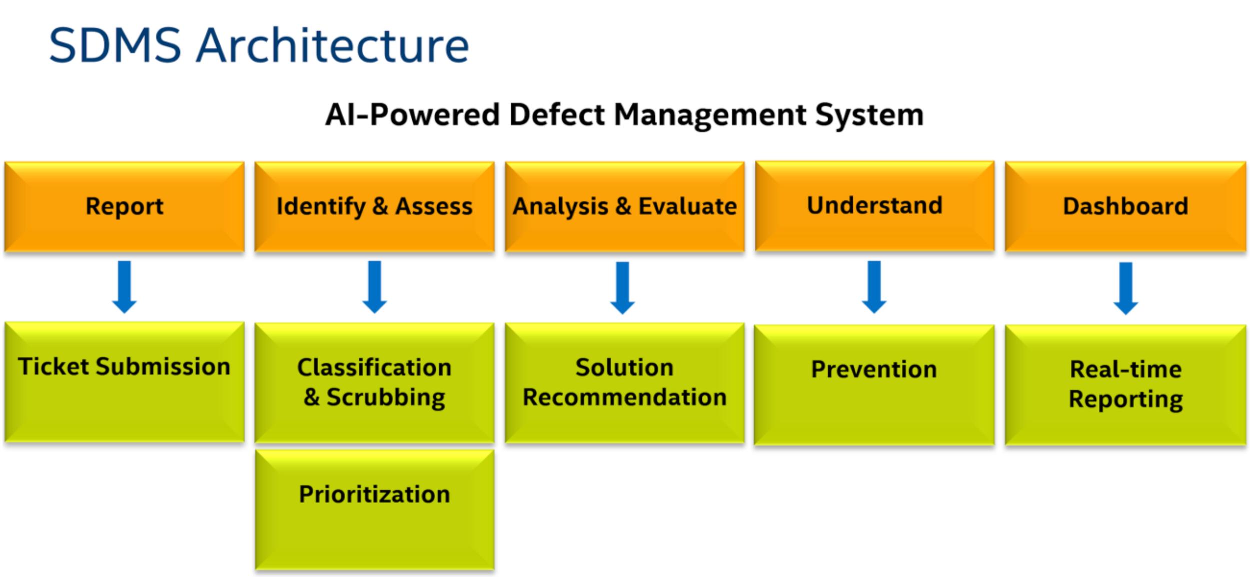
By examining the problem statements, we have identified significant opportunities for advancement.

- **All-in-One Solutions** to reduce the maintenance effort & cost
- **AI-powered Defect Classification & Scrubbing** to enable efficient information retrieval & eliminate redundancy of data
- **Smart Defect Prioritization** to manage the risk & improve time efficiently with better resource allocation to meet deadlines
- **Defect Solution Recommendation** to improve the defect triage cycle time
- **Intelligent Preventive Quality Measures** to improve product quality & cost savings
- **Real-Time Dashboard** to expedite data-driven decision-making

2.1 Smart Defect Management System (SDMS) Architecture



The SDMS is hosted in the cloud which enables the user to access without any limitation on time zone, location, hardware limitation, etc. All the information will be available on a real-time basis.



The SDMS possesses the below capabilities

- Defect reporting
- Defect classification & scrubbing
- Defect prioritization
- Defect root cause analysis recommendation
- Defect prevention recommendation
- Defect real-time dashboard

The SDMS will use a smart way to identify the validity of the defect when it is reported. Once the defect has been identified as valid, the SDMS will classify the defect based on its severity after assessing the defect fixing lead time (Including the code fixing complexity) and the release milestone.

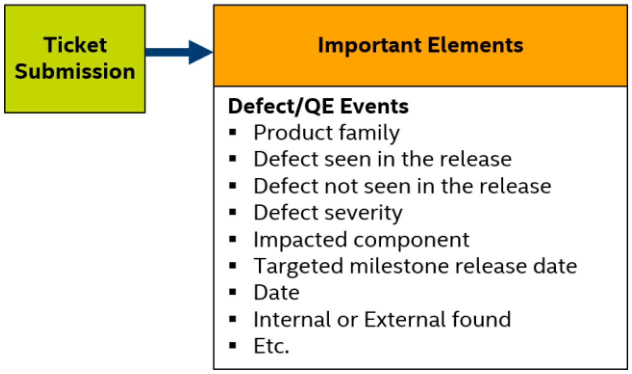
Based on the track records analysis, the SDMS will evaluate and propose a potential fix solution to the user. With the source data collected, the SDMS then automatically plots the Root Cause Analysis (RCA) and defect prediction charts via logic incorporated with AI algorithm and machine learning.

By processing the escaped defects database strategically, the SDMS will then derive an actionable prevention plan and recommend it to the user.

All the information will be in real-time and displayed in a dynamic and up-to-date manner without user intervention. This real-time dashboard provides a snapshot of critical data and metrics that allow users to monitor and track status, trends, or events as they happen.

2.2 Solutions

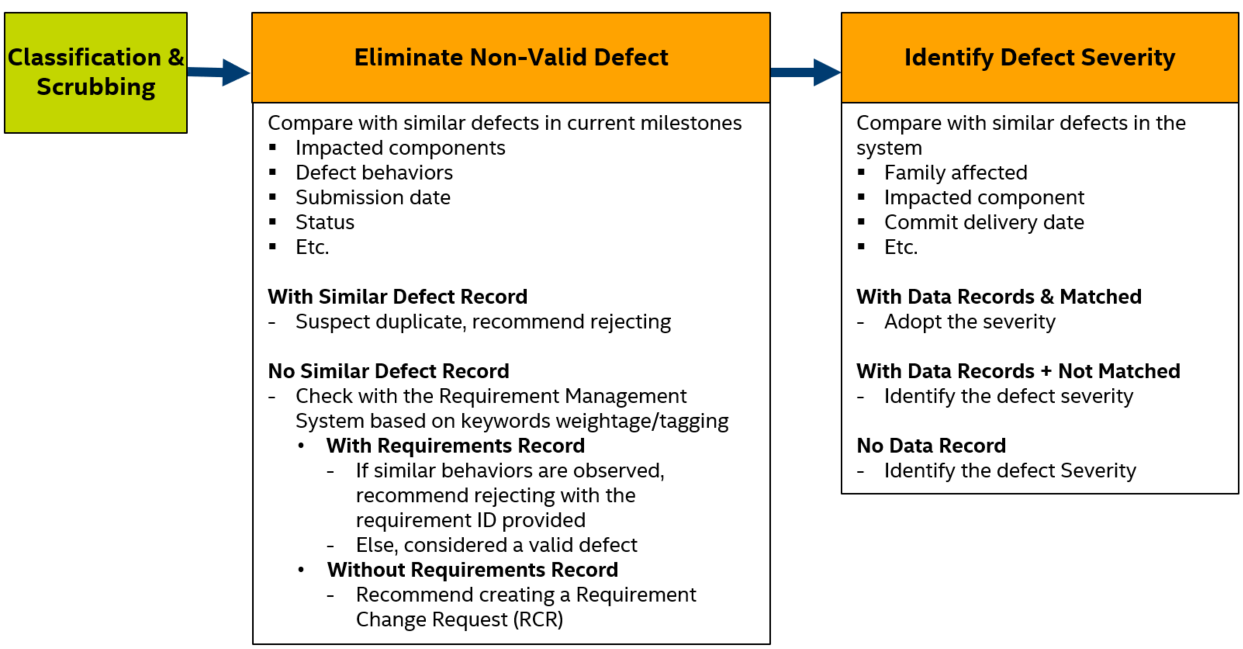
2.2.1 Defect Reporting



It is crucial to ensure all the relevant information is provided when filing out the defective ticket. This will help to:

i) Identify the problem accurately
ii) Efficient troubleshooting and debugging
iii) Priority and impact assessment
iv) Documentation and historical context

2.2.2 Defect Classification & Scrubbing



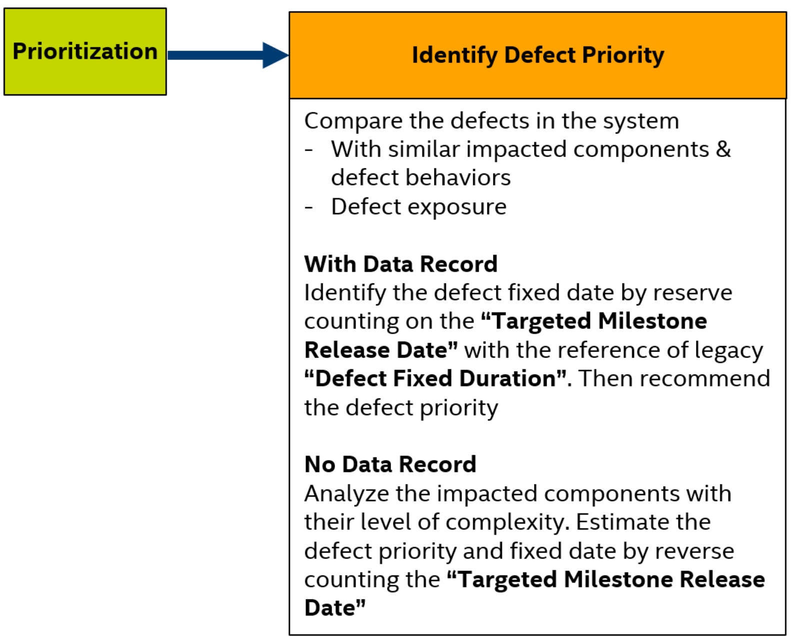
The newly submitted defect will draw a comparison with similar defects in the current milestones based on its impacted components, defect behaviors, etc. If a similar defect record is found (suspect duplication), then the SDMS will recommend the user consider rejecting this newly submitted defect.

If no similar defect record is found, then the SDMS will compare the defect behaviors with the requirement specification stored in the requirement management tool. By using the defined keywords weightage/tagging, the SDMS will evaluate if the behaviors work as designed or as a valid defect. Meanwhile, the SDMS will also recommend the user raise a requirement change request (RCR) for requirement specification improvement if there is no relevant info found. This will help to address the requirement coverage gap.

Once the newly submitted defect is identified as valid, a defect severity will be evaluated based on the impact, visibility, and standard violation. The SDMS will compare the severity level based on the defect database. The data records will be based on the similarity of the "important elements" defined in the issue ticket such as impacted product family, components, operating system, defective behaviors, etc.

i) With Data Records & Matched – Adopt the severity level
ii) With Data Records & Not Matched – Either adopt or assign a new severity level
iii) No Data Record – User to assign a new severity level

2.2.3 Defect Prioritization



Severity	Lead Time	Priority
Critical	-	1
High	-	2
Medium	Depends on lead time	3
Low	Depends on lead time	4

The SDMS will then assess the defect priority & fixed date based on:

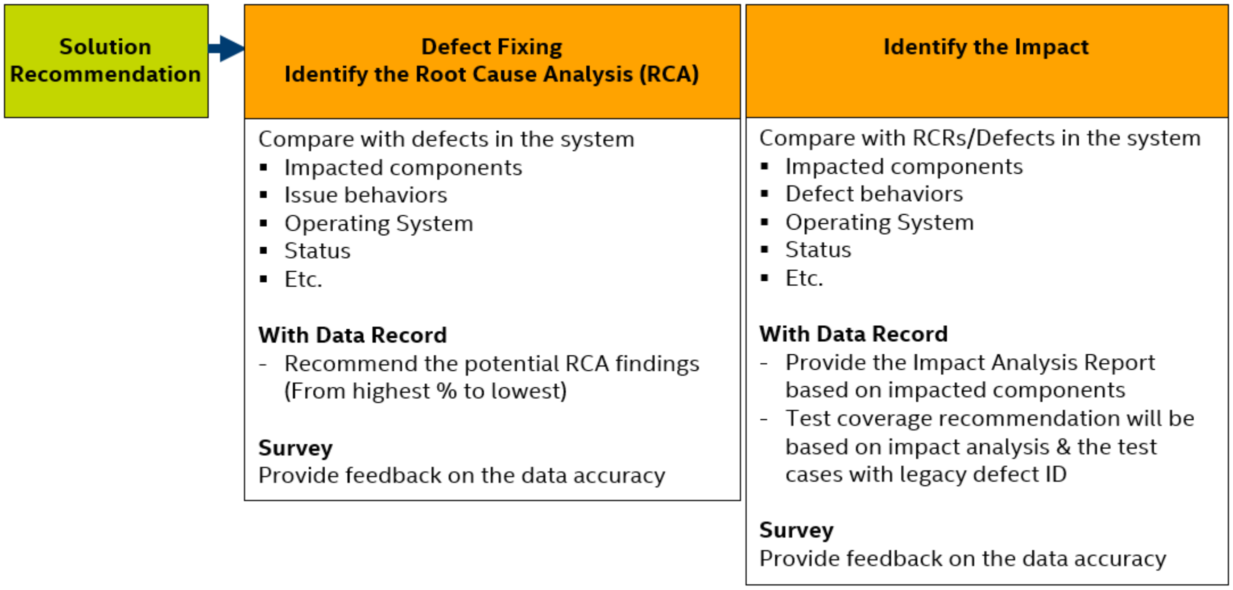
i) Similarity of impacted components & defect behaviors
ii) Defect severity

If a data record is found, the SDMS will identify the defect priority and defect fixed date based on the reverse counting of the "Targeted Milestone Release Date" with the reference of legacy "defect fixed duration". The "Targeted Milestone Release Date" normally means the actual planned release date for the software.

If no data record is found, then the SDMS will analyze the impacted components with their level of complexity and estimate the defect priority and fixed date.

The SDMS must be intelligent enough to assess the defect priority level based on the defect severity. If the defect severity is high (might gate the milestone release), then the priority also needs to be high to get immediate attention to fix the defect as soon as possible.

2.2.4 Defect Root Cause Analysis & Recommendation

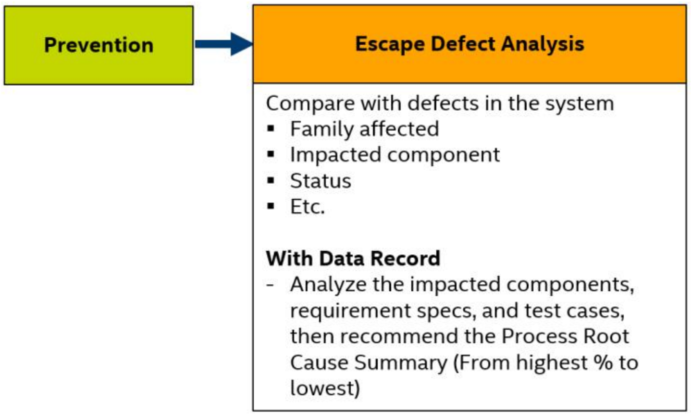


The focus of SDMS under Solution Recommendation will be on 2 areas which are identifying the defect root cause analysis (RCA) and impact analysis. The SDMS will intelligently identify the potential root cause analysis for the defect and recommend them based on similarity percentage (%). Once the RCA is adopted by the user, then the SDMS will generate the impact analysis report and recommend the test coverage based on:

i) Test type (Unit testing, Functional testing, Stress testing, etc.)
ii) Test case priority (1, 2, 3 & 4)
iii) Test cases with legacy defect ID (Ensure no breakage on the legacy fixes)

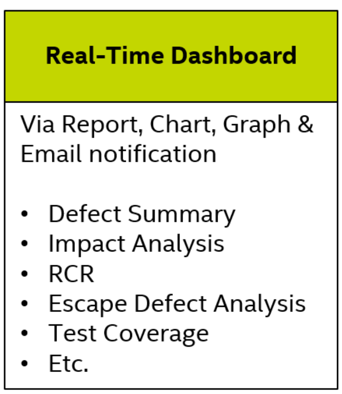
The user will conduct a review session with all the respective stakeholders (Such as the program manager, software architect, validation manager, etc.) to review the recommended RCA & impact analysis to ensure it is officially bought into before implementing it. If the information provided does not 100% fit the request, SDMS should have the ability to gather user feedback for continuous improvement.

2.2.5 Defect Prevention Recommendation



The aim of prevention is to strengthen the validation process based on the lesson learned from the escape defect. When the defect ticket is identified as an escape (reported by the customers), the SDMS will analyze the impacted component, requirement specifications, and existing test cases. After all the evaluations, the SDMS will then recommend the most related improvement process to the user.

2.2.6 Defect Real-Time Dashboard



A defect real-time dashboard provides real-time visibility and insights into the status and progress of defects. It offers a centralized view of the defects identified during testing, development, or operational stages and presents relevant metrics and information in a graphical format. The main purpose of a defect real-time dashboard is to provide the stakeholders with up-to-date information on the current state of defects.

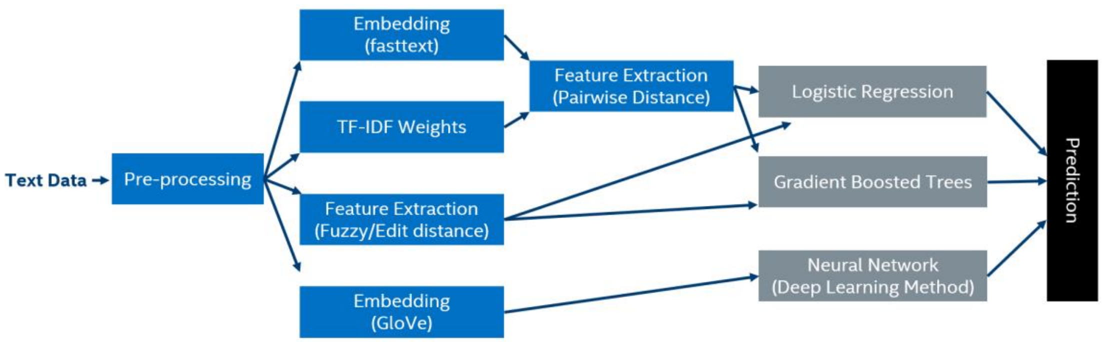
The benefits of the dashboard will be:

i) Live updates
ii) Metrics & trends
iii) Visualization
iv) Filtering & sorting
v) Collaboration & communication
vi) Decision-making support

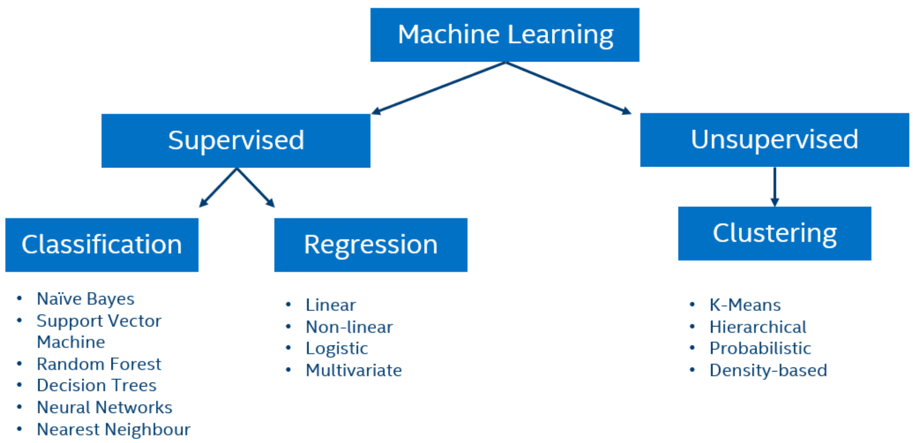
2.3 Machine Learning Methodologies

Machine learning uses computational algorithm methods to learn information directly from data. Various machine-learning approaches are used to design, develop, and implement the SDMS. These methodologies provide a structured and systematic way of solving problems and extracting insights from data using machine learning algorithms.

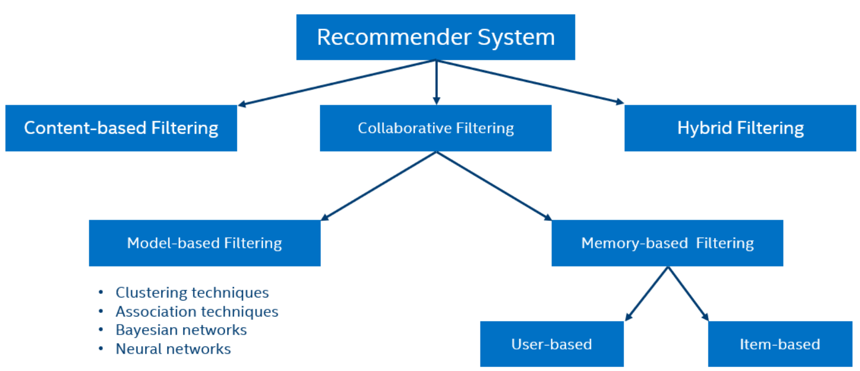
2.3.1 Identifying Similarity - Can be used for defect classification, Scrubbing & Prioritization



2.3.2 Prediction – Can be used for Resolution recommendations & Prevention



2.3.3 Recommender - Can be used for Resolution recommendations & Prevention



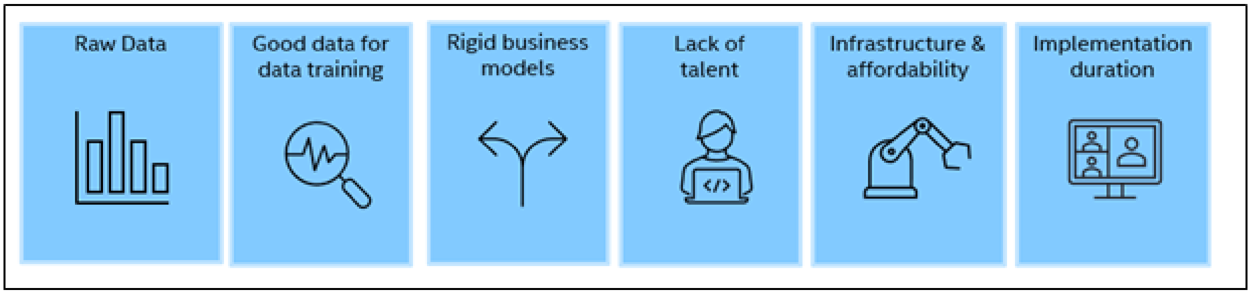
3.0 Estimated Benefits

The results we use to measure the SDMS benefits can be categorized into 4 areas based on our actual study and were measured by various methods and metrics.

Our plan is to establish a baseline at the beginning of the project to serve as a reference point. Throughout the project, we will try to compare the actual resources utilized, time spent, and costs incurred against the baseline to determine the reduction achieved. This is done through regular progress tracking & reporting. Meanwhile, we also want to define the specific KPIs related to resources, time & costs for the project to measure and compare at different stages of the project to assess the reduction achieved. It is also very important to gather feedback from the relevant stakeholders to understand their perception of resource, time, and cost savings. This feedback can provide insights into the perceived benefits and efficiency improvements resulting from the project.

- In the automated and consolidated environment, we estimate at least 30% resource, time, and cost savings.
- Based on the shorter turnaround time for defect analysis & solution recommendation, we foresee at least a 40% Reduction in debugging time.
- At least 3 times of Improvement on Traceability because we have consolidated all the report & result in the One-Stop-Shop (OSS) dashboard.
- Instead of the user logging on to a different tool or application to generate the defect analysis report, escape defect analysis report, etc, and now they can collect them all in one place.
- Lastly, we also expect to have at least 3 times Faster Dashboard, and Report creation to improve data consistency & integrity because the real-time data is hosted in the cloud.

4.0 Challenges



Companies all over the world are progressively exploring "SMART" solutions to reduce business challenges and provide innovative solutions. Even though "SMART" benefits are becoming more apparent, many companies are still facing challenges in the adoption:

- Good data is needed for data training/defect analysis. To obtain the huge amounts of data required, we need time and effort to go through multiple iterations to gather the data
- For rigid business models, we need to pay extra attention to convince them to make a move and transform from a traditional defect management system to a SMART defect management system
- For lack of talent/expertise and Infrastructure & affordability, system architecture/cloud expertise is needed to set up a "SMART" defect management system and make sure the flow is smooth. Additionally, we need to consider the expenses and readiness of the infrastructure e.g., setting up a cloud server within the organization. Companies with sufficient budgets and capabilities may consider forming a team to own this "SMART" defect management system, else we also can consider joining forces with a 3rd party software house
- And lastly, for implementation duration we need to take care of the transition risk and total time & effort needed to implement the SMART defect system. Hence, it is crucial to be transparent and align the expectations with the stakeholders frequently.

5.0 Conclusion

Today, we are in a rapid pace environment that requires digesting a humongous amount of info, the traditional defect management system which included a lot of manual work without integrity is no longer able to fulfill a company's needs. Hence, we need to find a "SMART" way to process and analyze all data more quickly than ever before to help us to make faster and more accurate decisions.

The AI-powered Smart Defect Management System is bringing a revolution in the fight to produce better quality software as it is able to:

- Provide flexibility & mobility
- Increase fast decision-making capability
- Improve quality, cycle time, effort & cost
- Avoid potential risks

There are significant advantages to be gained in owning a smart defect management system for the organization. All the parties involved such as developers, project leads, validation engineers, Software Quality Engineers, etc. can deposit their defects here and obtain instant solutions (Based on recommendation). All the defects handling processes are thus considerably simplified.

6.0 References

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