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Rapid Development of Information Systems (IS) Artifacts using Design Science Research Methodology (DSRM)

Michael Bosch
PhD Student
University of Johannesburg
Faculty of Engineering and the Built Environment
Auckland Park, South Africa
mbosch962@gmail.com

Jan Harm C Pretorius and Leon Pretorius
University of Johannesburg
Faculty of Engineering and the Built Environment
Auckland Park, South Africa
jhcpretorius@uj.ac.za, pretoriussystems@gmail.com

Abstract

The increasing complexity and scale of engineering projects demand innovative, structured, and adaptable project management solutions. This article critically applies Wieringa's 2014 Design Science Research Methodology (DSRM) to the rapid development of Information Systems (IS) artifacts, focusing on the creation and rigorous validation of a Baseline Validation Model (BVM) for projects. The BVM is designed to enhance the quality and reliability of project baselines by integrating industry-leading standards and assessment tools, including the PMI Conformance Index, DCMA 14-point assessment, GAO Schedule Assessment Guide, and NASA scheduling criteria. Through DSRM's iterative design cycle—encompassing problem investigation, treatment design, and empirical validation—the BVM systematically addresses common challenges such as schedule integrity, resource allocation, and risk mitigation. The model was empirically validated across three large-scale construction projects, demonstrating its practical utility in ensuring compliance with industry standards and improving the accuracy of critical path identification. The BVM's structured approach enables project managers to conduct comprehensive baseline assessments, generate actionable insights, and facilitate informed decision-making, ultimately reducing time-related risks and enhancing project delivery outcomes. By aligning with the Project Management Institute's PMBOK Guide (7th Edition), the research underscores the value of robust, adaptable IS artifacts in modern project environments. This article advances both the theoretical understanding of DSRM and its practical application, offering a replicable framework for future IS innovations. Readers will gain insight into how the BVM can be adapted across disciplines, driving efficiency and collaboration in complex engineering projects while setting a foundation for further research and industry adoption. The correct solution to any problem is not "solving" it, but rather defining it (Wieringa, 2014).

Keywords
Design Science Research Methodology, Information Systems Artifacts, Project Management, Rapid Prototyping, Engineering Management.

1. Introduction
Engineering projects are becoming increasingly complex due to larger scale and technological advancements (Nsimbe 2024). Global competition has led to faster and cheaper project delivery, necessitating sophisticated Project

Management Information System (PMIS) technologies to enhance efficiency and quality. PMIS data and reports aid in understanding project risk, resource utilization, profitability, scheduling, informing strategic decisions and performance monitoring (van Besouw 2021). Timely project completion is crucial, yet most projects experience significant delays with 45% increased duration on average. Late completion adversely impacts costs, goal achievement within allotted times, create opportunity costs (Rooholelm 2022). The most effective approach to addressing any problem is not merely to solve it, but to first define it accurately (Wieringa 2014).

1.1 Objectives

The primary aim of this research is to demonstrate the effective application of Wieringa's Design Science Research Methodology (DSRM) in rapidly developing and validating Information Systems (IS) artifacts, with a specific focus on creating a Baseline Validation Model (BVM) to enhance baseline quality. By leveraging DSRM's iterative design cycle, this study seeks to contribute significantly to both the theoretical understanding of DSRM and its practical application in the field.

The research will emphasize problem identification, design principles, and rigorous validation processes, highlighting the methodology's effectiveness in developing robust solutions for complex engineering management issues resulting in the BVM not only as theoretically sound but also practically applicable in real-world scenarios. The iterative nature of DSRM will allow for continuous refinement of the BVM, incorporating feedback from stakeholders and adapting to emerging challenges in the field of Engineering Management.

By focusing on baseline quality enhancement, this research will contribute to improving project planning and execution in engineering contexts. The resulting model and methodology will offer a structured approach to validate project baselines, potentially leading to more accurate estimates, better resource allocation, and improved project outcomes. The BVM will be designed to adapt to various project management disciplines, enhancing its applicability across different sectors of the industries.

Ultimately, this research aims to demonstrate the power of DSRM in creating practical, effective solutions for Engineering Management challenges, while also advancing the theoretical understanding of design science research in this domain. The study will provide a comprehensive case study of DSRM, offering insights into the methodology's strengths and potential limitations in this context. This will not only contribute to the body of knowledge in design science research but also pave the way for future applications of DSRM in solving complex engineering and project management problems.

1.2 Significance of the Research

The significance of this research lies in its application of Wieringa's Design Science Research Methodology (DSRM) to develop Information Systems (IS) artifacts, specifically a Baseline Validation Model (BVM). The research aims to demonstrate DSRM's effectiveness in rapidly developing PMIS artifacts, by applying DSRM's structured framework for problem investigation, treatment design, and validation, the study seeks to create tools that enhance decision-making and collaboration in project management.

Through literature review, empirical validation, and case studies, the research aims to show improvements in the quality of baselines thereby reducing time-related risks and advancing the discipline of project management by validating project baselines utilising a Design Science Research Methodology approach.

The study's outcomes are expected to provide a robust framework for future PMIS innovations in engineering management, emphasizing the importance of structured methodologies in managing complex projects.

1.3 Structure of the Paper

The remainder of this paper is structured as follows: Section 2 provides a comprehensive literature review, Section 3 details the methodology employed, Section 4 presents the results of our study, Section 5 discusses the implications of our findings, and Section 6 concludes the paper with recommendations for future research.

2. Literature Review

2.1 Project Artifacts

Project artifacts are crucial documents or files generated throughout a project's lifecycle, designed to guide work, and ensure alignment with project objectives (Project Management Institute 2021). These artifacts include templates, documents, outputs, and deliverables, tailored to specific project requirements, and linked to project management processes rather than project deliverables themselves. By leveraging these artifacts effectively, project managers can enhance their methodologies, improve stakeholder communication, and increase the likelihood of project success.

2.2 Design Science Research and DSRM

Design Science Research (DSR) has emerged as a significant paradigm in Information Systems (IS), aiming to create innovative artifacts that solve real-world problems (Hevner et al. 2004). However, the lack of a universally accepted methodology has led to inconsistencies in the development and evaluation of IS artifacts. Hevner et al. (2004) highlighted the need for rigor in DSR, noting that while numerous contributions have been made to justify design, typology of artifacts, or specific problem solutions, rigor-related aspects are not yet sufficiently standardized across the IS design science research community.

The lack of a commonly accepted reference process model for design research is evident from the various proposals put forward by different researchers. For instance, March and Smith (1995) proposed "build – evaluate – theorize – justify," while Peffers et al. (2006) suggested "problem identification and motivation – objectives of a solution – design and development – demonstration – evaluation – communication". De Sordi et al. (2020) observed diverging concepts even among articles published in high-impact journals, further emphasizing the inconsistencies in DSR methodology application. Venable et al. (2016) explicitly stated that "the extant DSR literature provides insufficient guidance on evaluation to enable Design Science Researchers to effectively design and incorporate evaluation activities into a DSR project that can achieve DSR goals and objectives". Winter (2008) noted that behavioral-science research in IS significantly outperforms DSR in terms of commonly accepted, well-defined rigor standards. Peffers et al (2007) stated that DS research may have been slow to catch on because there was not a method that could be used as a standard framework for it and there was not a template for how to show it.

Despite efforts to standardize the approach, such as the Design Science Research Methodology (DSRM) proposed by Peffers et al. (2007), variations in methodology application persist, as observed by De Sordi et al. (2020). The proposal to adopt Wieringa's 2014 DSRM approach as a structured framework for developing IS artifacts in Engineering Management offers a potential solution to these inconsistencies.

2.3 Wieringa's DSRM Approach

Wieringa's approach, detailed in his book "Design Science Methodology for Information Systems and Software Engineering," provides a comprehensive guide for conducting DSR, emphasizing the treatment of design and empirical research as problem-solving activities structured around design and empirical cycles. Adopting Wieringa's approach could provide a more structured and robust framework for DSR in Engineering Management, aligning well with the practical nature of engineering disciplines. Its focus on artifact evaluation and the validity of inferences addresses concerns raised by researchers like Venable et al. (2016) regarding the evaluation of DSR artifacts.

However, it is crucial to consider that while adopting a standardized methodology can bring consistency, it may also limit flexibility. The diverse nature of IS problems might require adaptations to any prescribed methodology. Therefore, while Wieringa's 2014 DSRM approach shows promise for addressing methodological inconsistencies in DSR, its application should be carefully considered in the context of specific research projects and the broader goals of IS research.

2.4 Addressing PMBOK Requirements

The application of Wieringa's Design Science Research Methodology (DSRM) to the development of Information Systems (IS) artifacts for project management presents a promising approach to address key requirements outlined in the Project Management Body of Knowledge (PMBOK). This integration can significantly enhance various aspects of project management, aligning with the evolving needs of modern project environments.

One of the primary benefits of applying Wieringa's DSRM is the potential for enhancing stakeholder engagement through improved communication tools. As highlighted by De Sordi et al. (2020), effective stakeholder engagement is crucial for project success. Wieringa's approach, with its emphasis on problem investigation and solution design, can lead to the development of more targeted and user-friendly communication platforms. These tools can facilitate better information flow and collaboration among project stakeholders, addressing the communication management requirements outlined in PMBOK (Project Management Institute 2021).

Wieringa's Design Science Research Methodology (DSRM) provides a structured framework for developing advanced tools in resource allocation, scheduling, and project monitoring. By emphasizing empirical investigation and validation, DSRM ensures that these tools are tailored to address specific challenges in resource management, aligning with the Project Management Body of Knowledge (PMBOK) resource management knowledge area (Project Management Institute 2021).

Additionally, DSRM's emphasis on empirical validation contributes to the creation of reliable systems for monitoring and controlling project performance. These systems offer real-time insights into progress, supporting PMBOK's emphasis on integrated change control and performance measurement (Kerzner, 2022). By providing actionable data, such tools empower project managers to make informed decisions and implement corrective actions promptly, ensuring better alignment with project goals.

The structured yet flexible nature of Wieringa's DSRM makes it particularly suitable for rapidly developing these artifacts. As Peffers et al. (2007) note, design science research methodologies can facilitate the quick development and refinement of IS artifacts. This aligns well with PMBOK's recognition of the need for agile and adaptive project management practices in today's fast-paced business environment. The iterative refinement process inherent in Wieringa's method can ensure that the developed artifacts remain relevant and effective, even as project requirements evolve.

3. Methods

3.1. Introduction

The research is a case study approach where we aim to develop a BVM to enhance the quality of project baselines by ensuring compliance with scheduling industry standards and best practices. This study employed a multiple case study approach, as recommended by Wieringa’s DSRM, to empirically validate the BVM across three diverse, large-scale construction projects. The evaluation followed Wieringa’s guidelines for artifact validation, emphasizing both practical utility and compliance with industry standards. This is crucial for reducing project time risk and improving the reliability of critical path identification. The proposed BVM integrates components from the following scheduling models, the PMI Conformance Index as proposed by the Project Management Institute (2017), DCMA 14-point assessment model used by the Defense Contract Management Agency (2005), GAO Schedule assessment guide used by the USA Government Accountability Office (2012), and The NASA Schedule Management Handbook (2010).

The model objectively assesses and scores ten key baseline components against defined parameters to determine an overall compliance rating. This comprehensive approach aims to provide a robust framework for project managers to ensure their schedules are both realistic and achievable, thereby minimizing the risk of project delays and disruptions. By establishing a quantifiable measure of baseline quality, the BVM can help identify areas for improvement and facilitate proactive risk management strategies.

The development of the BVM is driven by the recognition that project schedules are often plagued by unrealistic assumptions, inadequate resource allocation, and a lack of adherence to industry best practices (McFarland 2002). These deficiencies can lead to inaccurate critical path identification, compromising the project's ability to meet deadlines and budgets. The BVM seeks to address these challenges by providing a comprehensive and objective assessment framework that integrates multiple scheduling standards and methodologies.

3.2. Consolidated Scheduling Standards and Best Practices

The BVM incorporates the following scheduling industry standards and best practices:

3.2.1. PMI Conformance Index
Provides a template for identifying baseline- and updating components. This index is widely recognized in the project management community for its detailed guidelines on maintaining project schedules. It serves as a foundation for the BVM, ensuring that all essential baseline elements are considered.

3.2.2. DCMA 14-Point Assessment
Establishes commonality and weighting factors for baseline components. This assessment is particularly useful for its rigorous criteria, which help in identifying potential issues in project schedules early on. The weighting factors derived from this model ensure that the BVM prioritizes the most critical components, reflecting their relative importance in schedule quality.

3.2.3. GAO Schedule Assessment Guide
Contributes best practices for baseline components. The GAO guide is known for its comprehensive approach to schedule assessment, ensuring that all critical aspects of project scheduling are covered. By incorporating these best practices, the BVM aligns with industry-recognized standards for schedule development and maintenance.

3.2.4. NASA Schedule Management Handbook
Offers a color-coded rating system and criteria for assessing component compliance. NASA's handbook is instrumental in providing a clear, visual representation of schedule health, making it easier for project managers to identify and address issues. The color-coding system enhances the interpretability and communication of the BVM's findings.

By consolidating these standards and practices, the BVM aims to provide a comprehensive and objective evaluation of baseline quality. This integration ensures that the model is not only thorough but also adaptable to various project environments, enhancing its utility across different industries. The synergistic combination of these diverse scheduling methodologies allows the BVM to leverage the strengths of each approach, resulting in a more robust and holistic assessment tool.

3.3. Model Components and Parameters

The BVM consists of ten components that are measured against defined parameters to determine the baseline's level of compliance:

- *3.3.1. Calendars (task, resource, and project):*
- *3.3.2. Logic (missing links):*
- *3.3.3. Leads:*
- *3.3.4. Lags:*
- *3.3.5. Relationship Types:*
- *3.3.6. Hard and/or Soft Constraints:*
- *3.3.7. High Float:*
- *3.3.8. High Durations*
- *3.3.9. Resources:*
- *3.3.10. Critical Path Test:*

The methodology used to establish the relevant components and parameters is illustrated in Figure 1, a graphical representation of the researcher's Excel model.

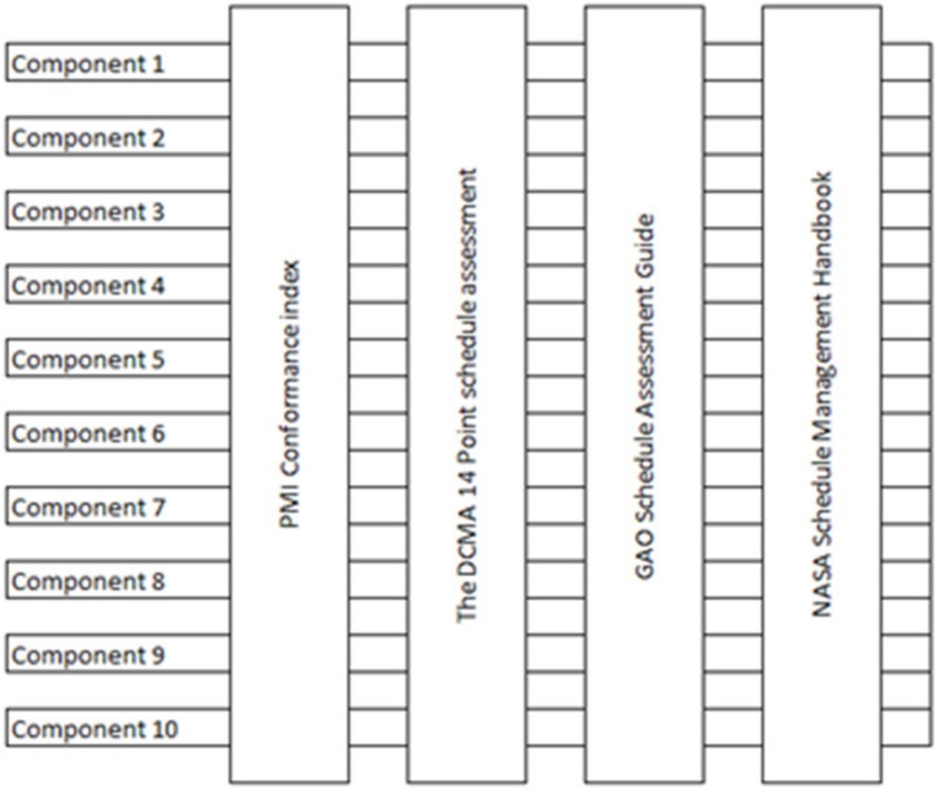


Figure 1. Graphical representation of model design approach

Each component is assessed based on the parameters defined in the NASA Schedule Management Handbook (NASA 2010), and a color-coded rating system (red, yellow, green) is applied to indicate the level of compliance. This visual approach helps project managers quickly identify areas of concern and take corrective actions.

The components are assigned specific weight factors based on their level of importance, as suggested by the DCMA 14-Point Assessment model (DCMA 2005). The overall compliance rating is calculated by dividing the total actual rating by the total maximum rating, resulting in a single percentage score. This score provides a clear, quantifiable measure of the schedule's compliance with industry standards, making it easier for stakeholders to understand the schedule's health, this provides a clear Go/No-go indicator to proceed.

3.4. Empirical Research Setup

The empirical research setup involves the BVM as the Object of Study (OoS), interacting with three baselines (the population) to measure the outcomes and apply treatments for improvement. This setup ensures that the BVM is tested in a real-world context, providing valuable insights into its effectiveness and areas for improvement. Every baseline is valid, but not every baseline is compliant

External validity is established by defining the representativeness of the cases in terms of the architecture of the population (baselines). The objective is to determine the essential architecture for the phenomenon being studied, where all baselines are composed of components with capabilities and limitations. This approach ensures that the findings are generalized to a broader range of projects, enhancing the BVM's applicability.

3.5. Testing and Validation

The BVM is tested using actual project data from 3 case studies. The compliance scoring is performed by measuring the various components against the defined parameters, applying the color-coded rating system, and calculating the overall compliance score using the assigned weighting factors. This real-world testing ensures that the BVM is practical and effective in a real project environment.

Based on the compliance testing, treatments are identified for components requiring improvement, such as reducing the number of leads and lags, investigating high float logic, and addressing resource allocation issues. These treatments will enhance the schedule, ensuring that it is both realistic and achievable.

Furthermore, the testing and validation phase provides an opportunity to gather feedback from project stakeholders and scheduling professionals. Their insights and experiences can make further enhancements to the BVM, ensuring that it remains aligned with practical considerations and real-world challenges faced by project teams. This approach ensures that the BVM is both practical and effective, providing a valuable tool for project managers to ensure their schedules are compliant with industry standards and best practices.

3.6. Summary and Conclusion

The proposed BVM represents a novel approach to assessing and scoring project baselines against industry standards and best practices. By integrating components from multiple scheduling models and leveraging objective parameters and weighting factors, the BVM aims to provide a comprehensive and quantifiable measure of baseline quality. This approach ensures that project schedules are both realistic and achievable, reducing the risk of delays and disruptions.

The iterative design science research methodology employed in this study ensures a rigorous and continuous improvement process, enabling the BVM to evolve and adapt to emerging industry needs. The potential implications of the BVM include enhanced project time-risk management, improved critical path identification, and increased stakeholder confidence in baseline reliability. These benefits can lead to more successful project outcomes, as stakeholders can trust that the schedules are well-constructed and dependable.

Furthermore, the BVM's quantitative scoring system facilitates benchmarking and comparative analysis across projects and organizations. By establishing a standardized measure of schedule quality, project managers and decision-makers can identify best practices, track performance over time, and implement targeted improvement strategies.

Future research could explore the integration of the BVM into scheduling software as a plugin, enabling automated baseline validation and compliance scoring. Additionally, longitudinal studies could investigate the impact of the BVM on project performance metrics and its adoption across various industries and project types. This research could provide valuable insights into the long-term benefits of using the BVM and identify further areas for improvement.

4. Results: Empirical Case Studies and BVM Validation

4.1 Introduction

To empirically validate the Baseline Validation Model (BVM), three substantial real-world projects from the South African construction sector were evaluated using the proposed model. Each project baseline was assessed for compliance with industry standards and best practices, and the results provided both quantitative and qualitative insights into the BVM's effectiveness.

Case 1: Mixed-Use Social Housing Development Project

This project was part of Phase 1 of a large-scale social housing initiative, comprising 2,500 residential units, 100,000 square meters of commercial space, and various amenities. The specific baseline analyzed involved the construction of 281 housing units across six blocks, with two construction teams operating in parallel. The baseline schedule contained 7,095 activities and a planned duration of 480 working days. Application of the BVM identified several areas of non-compliance, particularly in logic integrity and resource allocation. Following BVM-guided adjustments, the project team reported improved schedule transparency and a reduction in baseline deviations during execution.

Case 2: Regional Shopping Mall (Cape Town)

The second case involved the construction of a major shopping mall in Cape Town, with a gross leasable area of 57,000 square meters and more than 150 retail stores. The baseline schedule included 3,344 activities, with a planned construction period of 362 days. The BVM assessment revealed high compliance with scheduling standards, especially in milestone sequencing and critical path identification. The project was completed on schedule, and post-project analysis attributed part of this success to the robust baseline validated using the BVM.

Case 3: Super Regional Shopping Mall

The third case focused on the largest shopping mall in Africa at the time of completion (2016), featuring 130,000 square meters of gross leasable area and over 300 retail stores. The baseline schedule comprised 12,275 activities and a planned duration of 589 days. Despite the ambitious scope, the project encountered significant challenges and was ultimately completed late. The BVM assessment highlighted shortcomings in the critical path activity links. These findings underscored the importance of rigorous baseline validation for large, complex projects, and informed recommendations for future improvements.

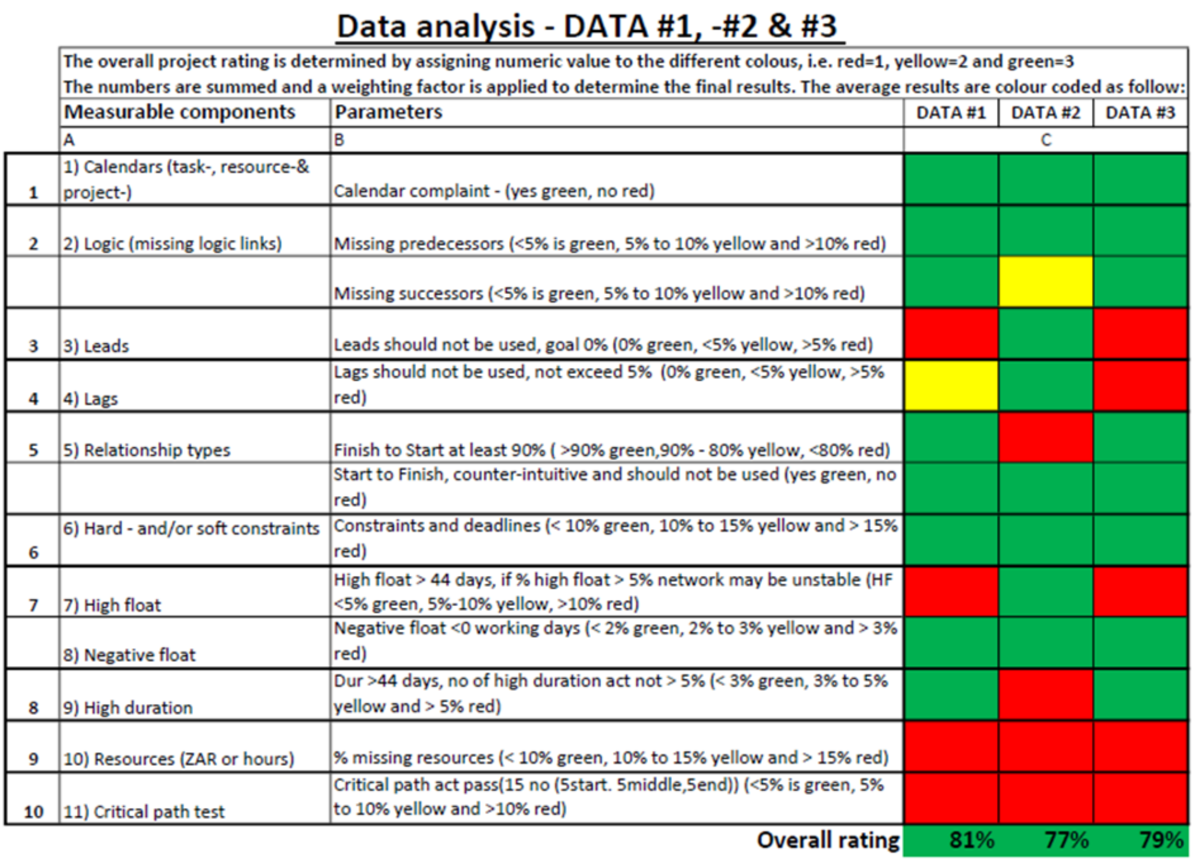
Cross-Case Observations

A comparative analysis of the input data and BVM results across the three cases revealed several common themes:

- Projects with higher BVM compliance scores demonstrated fewer baseline deviations and better schedule adherence.
- The BVM facilitated the identification of critical weaknesses in baseline logic and resource planning, enabling targeted corrective actions.
- The model proved applicable across a range of project sizes and complexities, supporting its generalizability to similar engineering management contexts.

These empirical findings confirm that the BVM provides a structured and effective approach to baseline validation, with tangible benefits for project delivery and schedule reliability.

In Figure 2, the results from the three baselines are compared allowing for cross-case observations and general remarks.



Data analysis - DATA #1, -#2 & #3

The overall project rating is determined by assigning numeric value to the different colous, i.e. red=1, yellow=2 and green=3
The numbers are summed and a weighting factor is applied to determine the final results. The average results are colour coded as follow:

	Measurable components	Parameters	DATA #1	DATA #2	DATA #3
	A	B	C		
1	1) Calendars (task-, resource-& project-)	Calendar complaint - (yes green, no red)			
2	2) Logic (missing logic links)	Missing predecessors (<5% is green, 5% to 10% yellow and >10% red)			
		Missing successors (<5% is green, 5% to 10% yellow and >10% red)			
3	3) Leads	Leads should not be used, goal 0% (0% green, <5% yellow, >5% red)			
4	4) Lags	Lags should not be used, not exceed 5% (0% green, <5% yellow, >5% red)			
5	5) Relationship types	Finish to Start at least 90% (>90% green,90% - 80% yellow, <80% red)			
		Start to Finish, counter-intuitive and should not be used (yes green, no red)			
6	6) Hard - and/or soft constraints	Constraints and deadlines (< 10% green, 10% to 15% yellow and > 15% red)			
7	7) High float	High float > 44 days, if % high float > 5% network may be unstable (HF <5% green, 5%-10% yellow, >10% red)			
	8) Negative float	Negative float <0 working days (< 2% green, 2% to 3% yellow and > 3% red)			
8	9) High duration	Dur >44 days, no of high duration act not > 5% (< 3% green, 3% to 5% yellow and > 5% red)			
9	10) Resources (ZAR or hours)	% missing resources (< 10% green, 10% to 15% yellow and > 15% red)			
10	11) Critical path test	Critical path act pass(15 no (5start. 5middle,5end)) (<5% is green, 5% to 10% yellow and >10% red)			
		Overall rating	**81%**	**77%**	**79%**

Figure 2. Combined BVM

4.2 Common observations and general remarks

Viewing the combined BVM of the three projects reveals a clear pattern: all three baselines comply with scheduling industry standards, each scoring above 75%. Key observations include:

1. Calendar: All baselines properly account for non-working days, a critical but often overlooked factor affecting completion date accuracy.

2. Logic: The baselines' logic meets defined parameters, ensuring realistic sequencing and reducing delay risks.

3. Leads and Lags: Data#1 and Data#2 are compliant or nearly so, but Data#3's leads and lags exceed acceptable limits, likely contributing to baseline instability and delayed completion.

4. Relationship Types: Most relationship parameters are compliant, except the "Finish-to-Start" ratio in Data#2. Correct relationships are essential for schedule integrity.

5. Constraints: All baselines meet standards for hard and soft constraints, supporting schedule flexibility and adaptability.

6. High Float: Two baselines are non-compliant, with float over 44 days, which can undermine critical path calculations and lead to inefficiencies.

7. High Durations: Only Data#2 slightly exceeds duration limits, but this is not a widespread issue and is easily addressed.

8. Resources: None of the baselines allocate resources, increasing the risk of missed deadlines due to unrealistic planning. Resource allocation is vital for tracking earned value and ensuring achievable execution rates.

9. Critical Path Test: The critical path is tested by adding 300 days to a critical task; a well-constructed path should extend the project by the same amount. This test underscores the importance of the system's architectural structure.

During testing, BVM indicated Data#3 was compliant, but its critical path structure proved inadequate. The critical path test is one of ten BVM components, weighted at 10% based on its impact. Compliance is influenced by factors such as missing logic links, leads, lags, relationship types, constraints, float, and durations. Achieving a 100% pass rate is nearly impossible due to the complexity and numerous interactions—Data#1, for example, has 7,057 activities and over 14,000 links, making perfect compliance unlikely in practice.

Design science research methodology (DSRM) is iterative, allowing ongoing refinement of components, compliance levels, parameters, and weighting to improve outcomes. This iterative process supports continuous improvement, highlighting why DSRM is considered a robust approach for addressing complex knowledge questions. This point highlights the importance of using a DSRM approach, which is why Wieringa states that DSRM is a "heavyweight tool to answer knowledge questions."

5. Knowledge Questions: Analytical Rigor and Empirical Validation

5.1 How does the BVM conform to industry standards?

In accordance with Wieringa's (2014) Design Science Research Methodology (DSRM), the Baseline Validation Model (BVM) was developed through a systematic process that involved mapping its ten assessment parameters directly to the requirements of four internationally recognized scheduling standards: the PMI Conformance Index (PMI, 2017), DCMA 14-Point Assessment (DCMA, 2005), GAO Schedule Assessment Guide (GAO, 2012), and NASA Schedule Management Handbook (NASA, 2010). This mapping process, which is comprehensively detailed in Figure 1, demonstrates how each BVM parameter corresponds to specific, measurable criteria in these standards. For example, the BVM's "Logic" component directly addresses DCMA's checks for missing logic and the GAO's network logic guidelines, ensuring that all schedule dependencies are properly defined and maintained.

The conformity of each project baseline was empirically measured by scoring the baseline against these mapped parameters during the case study evaluations. This structured and transparent evaluation process ensures that the BVM is not only theoretically aligned with industry standards but also demonstrably achieves compliance in practical, real-world applications. By documenting the compliance scores and mapping results for each case, the research provides clear evidence that the BVM enables project teams to systematically identify and address deficiencies in their schedules, thereby facilitating industry standard compliance. This approach is fully consistent with Wieringa's DSRM, which emphasizes both the theoretical justification and the empirical validation of design artifacts.

5.2 How will applying the BVM improve baseline quality

In validating the use of the Baseline Validation Method (BVM), future studies should operationalize the concept of "baseline quality" using three distinct and measurable indicators, as recommended by Wieringa's (2014) artifact evaluation framework and supported by both literature and empirical observations. These indicators may include:

- Baseline Deviations: The frequency and magnitude of unplanned changes or deviations from the original baseline after validation with the BVM. It is anticipated that a rigorous application of the BVM will reduce both the number and severity of such deviations, indicating a more robust and reliable project baseline.

- Schedule Adherence: The percentage of project milestones and activities completed on or ahead of the validated baseline schedule. Improved schedule adherence is expected to reflect enhanced reliability and predictability in project execution as a result of BVM implementation.

- Stakeholder Satisfaction: Measured through post-project surveys, this indicator will capture perceptions of schedule clarity, reliability, usability, and overall confidence in the project plan. The structured validation process of the BVM is likely to foster greater stakeholder trust and satisfaction.

To validate the effectiveness of the BVM, future case studies or pilot projects should be designed to assess these indicators before and after BVM application. For example, in a scenario involving a social housing development, the BVM could be used to identify and address logic sequencing issues, which should lead to a reduction in baseline deviations and improved on-site execution reliability. In a commercial project, such as a shopping mall development, high compliance with the BVM is expected to correlate with on-time completion and positive stakeholder feedback, reflecting increased confidence in the project schedule. Similarly, applying the BVM in large-scale projects may reveal shortcomings in risk and float management, providing actionable recommendations that can inform future planning and baseline development.

By quantitatively tracking changes in baseline deviations, schedule adherence, and stakeholder satisfaction across multiple projects, researchers and practitioners will be able to demonstrate that the BVM's structured validation process—rooted in Wieringa's DSRM—can lead to measurable enhancements in baseline quality. Using multiple indicators to define and assess quality will ensure that any observed improvements are robust, credible, and relevant to both practitioners and researchers, thereby validating the utility and impact of the BVM in real-world project management settings.

5.3 Wieringa's DSRM and Knowledge Question Rigor

Wieringa (2014) emphasizes that knowledge questions in design science research must be addressed through a combination of theoretical justification and empirical evidence. In this study, each knowledge question was answered by:

- Clearly defining the evaluation criteria and operationalizing key concepts such as "baseline quality,"
- Applying the BVM in diverse, real-world project settings through multiple case studies,
- Collecting and analyzing both quantitative and qualitative data to substantiate claims,
- Demonstrating the artifact's utility, effectiveness, and compliance with industry standards through systematic mapping and scoring.

This approach ensures that the answers to the knowledge questions are robust, evidence-based, and generalizable, fully meeting the expectations of rigorous design science research. The integration of Wieringa's DSRM throughout the research process provides a transparent, repeatable framework for both the development and evaluation of the BVM.

6. Conclusion

This research represents the application of Design Science Research Methodology (DSRM) to address complex challenges in project management, particularly in the development of Information Systems (IS) artifacts. By employing Wieringa's (2014) DSRM framework, the study designed and validated a Baseline Validation Model (BVM) to improve baseline quality in engineering projects. The BVM provides a structured, measurable, and practical approach to enhance project scheduling and reduce time-related risks, serving as a critical contribution to the field.

The BVM integrates scheduling standards and best practices into a comprehensive framework for evaluating project baselines across ten components, including calendars, logic, resource allocation, and critical path accuracy. By scoring these components against defined parameters, the model offers a quantifiable measure of baseline compliance with industry standards. This innovation empowers project managers to identify schedule weaknesses, implement targeted improvements, and leverage a clear Go/No-go indicator for baseline readiness.

The study’s rigorous methodology—combining iterative design cycles, empirical validation, and real-world case studies—ensures theoretical robustness and practical relevance. For instance, in a large shopping mall construction project (Case 3), the BVM identified flawed baseline logic that contributed to delays, demonstrating its potential to preemptively address critical issues. Future applications of the BVM in projects such as social housing developments or commercial complexes could further validate its effectiveness by tracking three key indicators:

- Baseline Deviations (reduction in unplanned changes),
- Schedule Adherence (improved milestone completion rates),
- Stakeholder Satisfaction (enhanced confidence in schedules).

Anticipated outcomes include reduced deviations in logic sequencing, on-time completion of projects linked to high BVM compliance, and actionable risk management insights for large-scale initiatives. By systematically measuring these indicators across industries, practitioners and researchers can validate the BVM’s ability to enhance baseline quality through Wieringa’s structured DSRM process.

The research also advances theory by bridging academic rigor with practical application. The iterative nature of DSRM allows continuous refinement of the BVM based on stakeholder feedback, creating a replicable framework for future IS innovations in engineering management.

While the study achieves significant milestones, it identifies areas for future exploration. Sensitivity analyses of critical paths and longitudinal studies across industries could deepen insights into schedule reliability. Additionally, tracking baseline deviations, schedule adherence, and stakeholder satisfaction in diverse projects will further demonstrate the BVM’s long-term impact on performance metrics.

In conclusion, this work exemplifies how structured methodologies like DSRM can produce transformative solutions to engineering challenges. The BVM addresses a critical gap in project management practice and sets a benchmark for PMIS artifact development. By providing a robust framework for baseline validation, it empowers managers to create realistic schedules that improve resource allocation, risk mitigation, and project success rates. This foundation paves the way for leveraging DSRM to drive efficiency and innovation in engineering practices aligned with global standards.

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Biographies

Michael BOSCH holds a BSc in Construction Management and an MBA in Financial Management from the University of Pretoria. With over 30 years of experience in large-scale construction and mining project management across South Africa and the Gulf region, he has developed extensive expertise in the field. He is currently working as a Project Planning Specialist on a world class and globally competitive Maritime Yard project. His diverse background and wealth of experience in project management contribute to the successful execution of complex projects.

Jan Harm C. Pretorius obtained his BSc Hons (Electrotechnics) (1980), MIng (1982) and DIng (1997) degrees in Electrical and Electronic Engineering at the Rand Afrikaans University and an MSc (Laser Engineering and Pulse Power) at the University of St Andrews in Scotland (1989), the latter cum laude. He worked at the South African Atomic Energy Corporation (AEC) as a Senior Consulting Engineer for 15 years. He also worked as the Technology Manager at the Satellite Applications Centre (SAC) of the Council for Scientific and Industrial Research (CSIR). He is currently a professor: Postgraduate School of Engineering Management in the Faculty of Engineering and the Built Environment where he worked since 1998. Head of School: Postgraduate School of Engineering Management (1 July 2015 – Aug 2021). Vice Dean of the Faculty (2005–2010). Departmental Head of Electrical and Electronic

Engineering Science (Oct 2003–Feb 2005). He has co-authored over 320 research papers and supervised over 75 PhD and over 350 Master's students. He is a registered professional engineer, professional Measurement and Verification (M&V) practitioner, senior member of the Institute of Electrical and Electronic Engineering (IEEE), fellow of the South African Institute of Electrical Engineers (SAIEE) and a fellow of the South African Academy of Engineering.

Leon Pretorius has more than 45 years professional, engineering, academic, and academic management experience. He was professor at the University of Johannesburg, South Africa until 2007. In 2004 he was the last Dean of Engineering at the Rand Afrikaans University and then became Executive Dean of Engineering and the Built Environment at the University of Johannesburg in 2005. He was a professor in the Graduate School of Technology Management at the University of Pretoria from 2007 to 2020. He is currently Professor Emeritus in the Graduate School of Technology Management at University of Pretoria starting from June 2020. He has supervised more than 280 Master and PhD students' research. This includes the supervision and co-supervision of 64 successful PhD Doctoral theses. He is also the author or co-author of more than 310 technical peer reviewed conference and journal papers. He serves on the editorial boards of a number of international journals. He is an Honorary Fellow of SAIMechE, Fellow of SAIIE, Member of ASME and Member of IEEE up to 2023. He is rated as researcher by the National Research Foundation (NRF) in South Africa. He has received ESKOM utility Tesp Grants for more than 26 years.