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ASSESSING THE ALIGNMENT OF BUSINESS PROCESS MANAGEMENT LIFECYCLE MODELS WITH THE PDCA CYCLE FOR DIGITAL TRANSFORMATION: A COMPARATIVE ANALYSIS

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ОЦІНКА ВІДПОВІДНОСТІ МОДЕЛЕЙ ЖИТТЄВОГО ЦИКЛУ УПРАВЛІННЯ БІЗНЕС-ПРОЦЕСАМИ ЦИКЛУ PDCA В РАМКАХ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ: ПОРІВНЯЛЬНИЙ АНАЛІЗ

The article examines the compliance of 14 Business Process Management (BPM) lifecycle models with the principles of the PDCA (Plan-Do-Check-Act) cycle and determines their conceptual proximity. The study aims to identify models that best reflect the philosophy of continuous improvement and have the potential to effectively support the digital transformation of business processes.

The research methodology includes a comprehensive literature review, resulting in the selection of 14 BPM Lifecycle models proposed by various scholars and professional organizations. For each model, compliance with the PDCA cycle phases was evaluated using a 1-5 scale, with the overall compliance level determined based on the average score across all phases. Additionally, a pairwise comparison matrix was formed to determine the models' conceptual proximity, with each cell containing the number of common stages between two respective models. Before forming the matrix, stage names were modified to unify terminology and ensure accurate comparison.

The study's results can benefit researchers and practitioners in the field of business process management by providing a better understanding of the potential of existing BPM lifecycle models in supporting continuous improvement and digital transformation. The findings can guide decision-makers in selecting the most suitable models for their specific needs and context, considering factors such as the organization's strategic goals, process maturity level, and industry specifics.

This research contributes to the field by offering a comprehensive comparative analysis of BPM lifecycle models' compliance with the PDCA cycle principles and their conceptual proximity to each other.

Future research could explore the practical application of the recommended BPM lifecycle models in various organizational settings, considering factors such as company size, industry, and cultural context. Additionally, the integration of emerging technologies, such as process mining and robotic process automation, with the identified models could be investigated to further enhance their potential for supporting digital transformation initiatives.

У статті досліджено відповідність 14 моделей життєвого циклу управління бізнес-процесами (BPM) принципам циклу PDCA (Plan-Do-Check-Act)

та визначає їх концептуальну близькість. Метою дослідження є визначення моделей, які найкраще відображають філософію постійного вдосконалення та мають потенціал ефективно підтримувати цифрову трансформацію бізнес-процесів.

Методологія дослідження включає всебічний огляд літератури, в результаті якого було відібрано 14 моделей життєвого циклу BPM, запропонованих різними науковцями та професійними організаціями. Для кожної моделі відповідність фазам циклу PDCA оцінювалась за шкалою від 1 до 5, а загальний рівень відповідності визначався на основі середнього балу за всіма фазами. Крім того, була сформована матриця попарних порівнянь для визначення концептуальної близькості моделей, де кожна комірка містила кількість спільних етапів між двома відповідними моделями. Перед формуванням матриці назви етапів були модифіковані для уніфікації термінології та забезпечення точності порівняння.

Результати дослідження можуть бути корисними для науковців та практиків у галузі управління бізнес-процесами, оскільки вони дозволяють краще зрозуміти потенціал існуючих моделей життєвого циклу BPM у підтримці постійного вдосконалення та цифрової трансформації. Отримані дані можуть слугувати орієнтиром для осіб, які приймають рішення, при виборі найбільш оптимальних моделей для їх конкретних потреб та контексту, враховуючи такі фактори, як стратегічні цілі організації, рівень зрілості процесів та специфіку галузі.

Це дослідження робить внесок у галузь, пропонуючи всебічний порівняльний аналіз відповідності моделей життєвого циклу BPM принципам циклу PDCA та їх концептуальної близькості між собою.

Майбутні дослідження можуть вивчати практичне застосування рекомендованих моделей життєвого циклу BPM у різних організаційних умовах, враховуючи такі фактори, як розмір компанії, галузь та культурний контекст. Крім того, можна дослідити інтеграцію новітніх технологій, таких як Process Mining та Robotic Process Automation, з визначеними моделями для подальшого підвищення їх потенціалу підтримки ініціатив цифрової трансформації.

Keywords: *business process management, BPM lifecycle, PDCA cycle, continuous improvement, digital transformation, conceptual proximity.*

Ключові слова: *управління бізнес-процесами, життєвий цикл BPM, цикл PDCA, постійне вдосконалення, цифрова трансформація, концептуальна близькість.*

General statement of the problem and its connection with important scientific or practical tasks. Business Process Management (BPM) is crucial to the success of organizations in the digital transformation era. BPM allows companies to optimize their operations, increase efficiency, improve customer service, and quickly adapt to changing market conditions. Effective business process lifecycle management is a key factor in the successful implementation of digital transformation initiatives and ensuring the sustainable development of organizations. The PDCA Cycle is particularly attractive for application in the context of business process management.

The PDSA Cycle (Plan-Do-Study-Act) is a systematic process for gaining valuable learning and knowledge for the continual improvement of a product, process, or service. Also known as the Deming Wheel, or Deming Cycle, this integrated learning - improvement model was first introduced to Dr. Deming by his mentor, Walter Shewhart of the famous Bell Laboratories in New York. [15]

BPM lifecycle models that follow PDCA principles are especially relevant within the context of digital transformation. Due to the rapid development of technologies and the changing business environment, these models allow organizations to effectively improve their business processes, adapt to changes, and make data-driven decisions. Ultimately, these factors are key to success in the digital age.

Numerous BPM lifecycle models have been developed over the past two decades, each offering a different view of the stages and activities required for effective business process management. These models differ in the number of stages, their names, and content, reflecting the diversity of approaches to business process management.

The purpose of this study is to assess the compliance of existing BPM lifecycle models with the principles of the PDCA cycle, and to determine their conceptual proximity. This will help identify models that best reflect the philosophy of continuous improvement and have the potential to effectively support the digital transformation of business processes.

Analysis of recent studies and publications. In the scientific literature, there are various Business Process Management (BPM) lifecycle models, each offering a different perspective on the stages and actions necessary for effective business process management. These models differ in the number of stages, their names, and content, reflecting the diversity of approaches to managing business processes.

Some models pay more attention to the strategic aspects of business process management, emphasizing the alignment of processes with the organization's strategic goals and consideration of external factors. This approach may be particularly relevant for organizations seeking to ensure the strategic alignment of their business processes and adapt to a changing business environment. Strategic alignment of business processes allows organizations to effectively allocate resources, quickly respond to changes in market conditions, and maintain competitiveness in the long run.

Other models focus on the operational aspects, such as process execution and control, which may be more relevant for organizations with a higher level of process maturity. The operational focus enables organizations to optimize process performance, reduce costs, improve product or service quality, and ensure compliance with regulatory requirements.

The variety of BPM lifecycle models indicates the active development of this field and the search for optimal approaches to business process management. Researchers and practitioners strive to develop models that best meet the needs of organizations and allow for effective management of business processes in the context of digital transformation and constant changes in the business environment. Table 1 summarizes the BPM lifecycle models selected for analysis in this study.

Table 1: BPM Lifecycle models selected for analysis from publications

AUTHORS	1	2	3	4	5	6
1. ABPMP	Planning & Strategy	Analysis	Design & Modelling	Implementation	Monitoring & Controlling	Refinement
2.Weske	Design & Analysis	Configuration	Enactment	Evaluation		
3.Hallerbach et al.	Modelling	Instantiation/Selection	Execution	Optimization		
4.Pourshahid et al.	Discovery & Remodelling	Validation & Simulation	Deployment & Execution	Performance Monitoring & Management	Improvement	
5. Di Ciccio and Marrella	(Re)Design	Configuration	Enactment	Diagnosis		
6. Van Der Aalst	Design	System Configuration	Enactment	Diagnosis		
7. Bernardo et al.	Analysis	Design & Modelling	Implementation	Monitoring & Controlling	Refining & Planning	
8.Dumas et al.	Identification	Discovery	Analysis	Redesign	Implementation	Monitoring & controlling
9. Macedo De Morais et al.	Initial Process Planning & Strategy	Analysis	Design & Modeling	Implementation	Monitoring & Controlling	Refinement & Planning Review
10. Houy et al.	Strategy Development	Definition & Modelling	Implementation	Execution	Monitoring & Controlling	Optimization & Improvement
11. Netjes et al.	Design	Configuration	Execution	Controlling	Diagnosis	
12. Schulte et al.	Evaluation	Design & Analysis	Configuration	Enactment	Evaluation	
13. Verma	Define Organization Objectives	Classify Processes	Select n-th Process	Define Tools	Implement Process	Monitor Process
14. Zur Muehlen and Ho	Goal Specification/ Environmental Analysis	Design	Implementation	Enactment	Monitoring	Evaluation

Source: compiled by the author based on [1]-[14].

Presentation of the main research material. The table below contains the results of a comparative analysis of 14 BPM Lifecycle models in terms of their compliance with the PDCA (Plan-Do-Check-Act) cycle.

The table presents the scores for each phase of the PDCA cycle on a scale from 1 to 5, where higher values indicate a higher level of model compliance with the principles of that phase. In addition, the overall level of correspondence for each model is determined based on the average score across all phases, which allows classifying models as having a high, moderate or low level of alignment with the PDCA cycle.

Table 2: The compliance of BPM Lifecycle models with PDCA principles

MODEL	PLAN	DO	CHECK	ACT	OVERALL CORRESPONDENCE
1. Association Of Business Process Management Professionals (ABPMP)	4	4	5	3	Moderate
2. Mathias Weske	3	3	3	2	Low
3. Alena Hallerbach et al.	4	3	2	3	Moderate
4. Alireza Pourshahid et al.	4	4	5	3	Moderate
5. Claudio Di Ciccio and Andrea Marrella	4	3	3	2	Moderate
6. Wil M. P. Van Der Aalst	4	3	3	2	Moderate
7. Ronaldo Bernardo et al.	4	4	5	4	High
8. Marlon Dumas et al.	4	4	5	4	High
9. Macedo De Morais et al.	4	4	5	4	High
10. Constantin Houy et al.	4	4	5	3	Moderate
11. Mariska Netjes et al.	3	3	3	2	Low
12. Stefan Schulte et al.	2	2	2	1	Low
13. Naresh Verma	3	4	5	2	Moderate
14. Zur Muehlen and Danny Ting-Yi Ho	4	4	4	2	Moderate

*Source**:** compiled by the author based on [1]-[14].*

Description of the scores:

- ***5:*** the phase is clearly represented in the model and fully follows the PDCA principles.
- ***4:*** the phase is clearly represented in the model and mostly follows the PDCA principles, although it may have minor limitations.
- ***3:*** the phase is represented in the model, but has some limitations or does not fully comply with the PDCA principles. However, these limitations are not critical and can be overcome by adapting the model.
- ***2:*** the phase is poorly represented in the model or has significant deviations from the PDCA principles. Significant changes or additions are needed to apply the model effectively.
- ***1:*** the phase is not represented in the model or contradicts PDCA principles.

Overall compliance was determined based on the average score for each phase:

- ***High:*** the average score for all PDCA phases is 4 or higher, indicating that the model aligns well with the principles of continuous improvement across all phases.
- ***Moderate:*** the average score for all PDCA phases is between 3 and 4 (not including 4), indicating that the model generally aligns with the principles of continuous improvement, although some phases may need improvement.
- ***Low:*** the average score for all PDCA phases is below 3, indicating that the model does not align well with the principles of continuous improvement and that some changes are needed to effectively apply the PDCA cycle.

Thus, the analysis of the results of the evaluation of 14 BPM Lifecycle models based on their compliance with the PDCA (Plan-Do-Check-Act) cycle allows us to draw the following conclusions.

Among the studied models, only 3 (models 7, 8 and 9) demonstrate a high level of compliance with PDCA principles. These models, proposed by Ronaldo Bernardo et al., Marlon Dumas et al. and Macedo de Morais, can be recommended to

organizations seeking to implement an effective and comprehensive approach to business process management based on continuous improvement.

8 models (models 1, 3, 4, 5, 6, 10, 13, and 14) have an average level of compliance with the PDCA cycle. They require some adaptation and refinement to fully implement the principles of continuous improvement. Organizations considering these models should analyze their weaknesses and develop optimization strategies.

3 models (models 2, 11, and 12) got a low level of compliance with the PDCA cycle. For their effective application, certain modifications and additions are required.

The analysis of the distribution of scores for each PDCA phase within the studied models revealed the following patterns.

The Plan phase is represented at a high level (score of 4) in 10 out of 14 models, indicating a general attention to planning and designing business processes.

The Do phase received a score of 4 in 8 models, which indicates a sufficient level of implementation and execution of business processes in most of the approaches reviewed.

The Check phase is the strongest aspect of the analyzed models, with a score of 5 in 7 out of 14 models. This demonstrates a high level of monitoring, control and evaluation of business process performance.

The Act phase turned out to be the weakest, receiving a score of 4 in only 3 models and a score of 2 in 6 models. This indicates the need to strengthen the mechanisms of continuous improvement and feedback in most of the studied BPM Lifecycle models.

The next step is forming a matrix of pairwise comparisons of 14 BPM Lifecycle models, which complements the previous analysis of the compliance of these models with the PDCA (Plan-Do-Check-Act) cycle.

Whereas the PDCA compliance table allows to evaluate how well each model reflects the principles of continuous improvement, the pairwise comparison matrix considers models in terms of their conceptual proximity.

The logic of the pairwise comparison matrix is that each cell at the intersection of a row and a column contains the number of common stages or phases between the two respective models. The more common stages two models have, the higher their conceptual proximity and potential compatibility. For example, if model A has 5

stages in common with model B, and model C has only 2 stages in common with model B, then we can assume that models A and B are more closely related and potentially compatible than models C and B.

However, it is worth highlighting that BPM Lifecycle models may have slightly different names for certain similar stages or use synonyms. This can complicate the process of comparing models and determining their conceptual proximity. Therefore, before forming the matrix of pairwise comparisons, certain modifications were made to the names of the model stages to unify terminology and ensure correct comparison.

These adjustments include the following points:

1.The phases “Planning & Strategy”, “Initial Process Planning & Strategy” and “Strategy Development” have been replaced with “Planning” to align terminology and emphasize the common focus on planning.

2.The stages “Enactment” and “Implementation” have been unified to “Implementation” to simplify comparison and emphasize the common content - the implementation of the planned changes.

3.The “(Re)Design” stage has been shortened to “Design” to align with other models that use the term “Design” to describe similar activities.

4.The word “Process” or “Processes” has been removed from the stage names to focus on the key activity or phase, regardless of its relationship to the concept of process.

5.The stages “Performance Monitoring” and “Process Monitor” have been unified to “Monitoring” to emphasize the common focus on tracking and monitoring process performance.

6.The “Implement Process” stage was shortened to “Implementation” to be consistent with other models and to facilitate comparison.

7.The stages “Define Organization Objectives” and “Goal Specification/Environmental Analysis” have been combined under the name “Goal Specification” to emphasize their common goal of defining goals and considering external factors.

8. If a stage name included two actions, such as Refining & Planning, they were split into two stages

Table 3: Pairwise comparison matrix of the BPM Lifecycle models proximity

	ABPMP	***Weske***	***Hallerbach et al.***	***Pourshahid et al.***	***Di Ciccio Et and Marrella***	***Van Der Aalst***	***Bernardo et al.***	***Dumas et al.***	***Macedo De Morais et al.***	***Houy et al.***	***Netjes et al.***	***Schulte et al.***	***Verma***	***Zur Muehlen and Ho***
1. Association Of Business Process Management Professionals (ABPMP)	-	3	1	2	2	2	7	4	7	4	3	3	2	3
2. Mathias Weske	3	-	1	1	3	2	3	2	3	1	3	6	1	3
3. Alena Hallerbach et al.	1	1	-	1	1	1	1	1	2	3	1	1	1	1
4. Alireza Pourshahid et al.	2	1	1	-	1	1	2	3	2	3	1	1	2	2
5. Claudio Di Ciccio and Andrea Marrella	2	3	1	1	-	3	2	1	2	1	4	3	1	2
6. Wil M. P. Van Der Aalst	2	2	1	1	3	-	2	1	2	1	3	2	1	2
7. Ronaldo Bernardo et al.	7	3	1	2	2	2	-	4	6	4	3	3	2	3
8. Marlon Dumas et al.	4	2	1	3	1	1	4	-	4	3	2	2	2	2
9. Macedo De Morais et al.	7	3	2	2	2	2	6	4	-	5	3	3	2	3
10. Constantin Houy et al.	4	1	3	3	1	1	4	3	5	-	2	1	2	2
11. Mariska Netjes et al.	3	3	1	1	4	3	3	2	3	2	-	3	1	2
12. Stefan Schulte et al.	3	6	1	1	3	2	3	2	3	1	3	-	1	4
13. Naresh Verma	2	1	1	2	1	1	2	2	2	2	1	1	-	3
14. Zur Muehlen and Danny Ting-Yi Ho	3	3	1	2	2	2	3	2	3	2	2	4	3	-
SUM	***43***	***32***	***16***	***22***	***26***	***23***	***42***	***31***	***44***	***32***	***31***	***33***	***21***	***32***

*Source**:** compiled by the author based on [1]-[14].*

The most conceptually similar models are:

- ABPMP and Macedo De Morais et al. (7 common steps)
- ABPMP and Bernardo et al. (7 common steps)
- Weske and Schulte et al. (6 joint steps)
- Bernardo et al. and Macedo De Morais et al. (6 joint steps)

The least conceptually close models were:

- Hallerbach et al. and most other models (1-2 common steps)
- Verma and most other models (1-2 common stages)

These models have the least number of common steps with other models, which may indicate their uniqueness or complexity. Organizations considering these models should pay attention to their features and assess how well they fit their needs and context.

Models with the highest total number of common steps:

- Macedo De Morais et al. (44)
- ABPMP (43)
- Bernardo et al. (42)

These models have the largest number of common stages with other models, which may indicate their universality.

Accordingly, the models with the lowest total number of common stages:

- Hallerbach et al. (16)
- Verma (21)

Conclusions and prospects for further reserch in this area. This research aimed to assess the compliance of 14 BPM Lifecycle models with the principles of the PDCA (Plan-Do-Check-Act) cycle and determine their conceptual proximity. The results of the analysis showed that only 3 of the 14 models studied (Ronaldo Bernardo et al., Marlon Dumas et al. and Macedo de Morais) demonstrate a high level of compliance with the PDCA cycle, which makes them the most recommended for organizations seeking to implement an effective and comprehensive approach to business process management based on continuous improvement.

Most models (8 out of 14) have an average level of compliance with the PDCA cycle, which indicates the need for their adaptation and refinement to fully implement the principles of continuous improvement.

Three models (Mathias Weske, Netjes et al., and Schulte et al.) have a low level of conformity, which indicates the need for significant modification to be effectively applied in the context of the PDCA cycle.

The analysis of the conceptual proximity of BPM Lifecycle models using the pairwise comparison matrix showed that the ABPMP, Macedo De Morais et al. and Bernardo et al. models have the largest number of common stages with other models, which indicates their universality. At the same time, the Hallerbach et al. and Verma models have the least number of common stages, which may indicate their specificity or uniqueness.

The results obtained allow concluding that the models of Ronaldo Bernardo et al., Marlon Dumas et al. and Macedo de Morais et al. are the most effective and comprehensive in terms of compliance with the principles of the PDCA cycle and conceptual proximity to other models. These models can be recommended to organizations seeking to transform their business processes in the context of digital transformation and ensure continuous improvement.

Prospects for further research in this area include conducting empirical studies to validate the effectiveness of the recommended BPM Lifecycle models in real-world organizational settings. Future research could also explore the integration of these models with other quality management frameworks and methodologies, such as Six Sigma and Lean, to develop even more robust and comprehensive approaches to business process management. Additionally, investigating the role of emerging technologies, like process mining and robotic process automation, in enhancing the implementation and monitoring phases of the BPM Lifecycle could provide valuable insights for organizations striving to optimize their processes in the digital age.

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