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Agile Data Management System for Smart Banking (ADMS)

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Abstract

Purpose: The main objective of this research is to present an agile data management system for the intelligent banking industry, by leveraging agile principles, the proposed system aims to support banks in generating data-driven value and smart banking.

Method: The research is grounded in the principles of systems thinking, data-centricity, lean thinking, and the agile manifesto. With a practical and developmental purpose, it employs deduction and exploration to draw conclusion. The methodology combines design science and meta-synthesis. Following the design science process, explaining the problem, describing the solution, designing initial solution (using meta-synthesis) validating the solution, and then sharing the results were all steps in the study.

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Findings: The results consist of codes organized into four-tier structure: design domain, theme, category, axial code, and open code. These are presented as a conceptual model-compromising level zero and level one-which serves as the reference model for an agile data management system for smart banking.
Conclusion: An agile data management system, like any other system, it is essential to consider the data management system as having four elements: input (goals), processing (enablers), output (results), and feedback (based on agile and lean thinking). The banking industry has been slow to adopt new technologies, with many banks still reliant on mainframes. This hesitation stems partly from increased caution due to rising cyber-attacks and partly from concerns about regulatory requirements. The proposed model addresses banks' concerns by demonstrating how to integrate agile methods into a data management system for a smart bank.

Keywords: Agile Data Management, Smart Banking, Systems Thinking, Agile Manifesto, Lean Thining

Introduction

In the current era, we encounter systems from the backbone of creation and flow of data. These systems are inherently transformative, and data-driven digital transformation is achieved through managing data flows in these systems. Figure 1 demonstrates the conceptual framework of data-driven digital transformation from the perspective of cyber-physical-social systems (Amini et al., 2022). The banking industry is no exception, and data is recognized as strategic asset for banks.

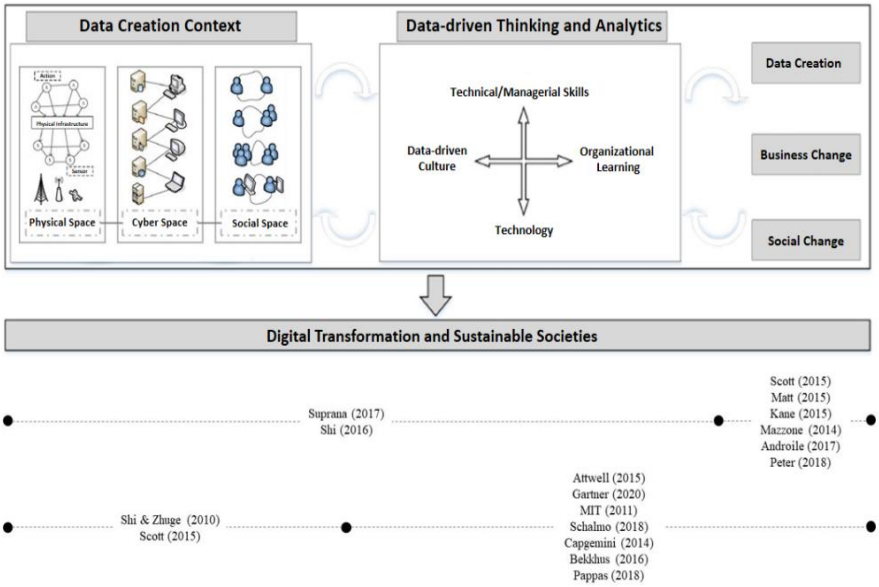

Figure 1. Proposed Framework for Data-driven Digital Transformation (Amini, Padidarfard, Garshivaz , 2022)

The adoption of digitalization by other industries has led banks to face an additional challenge: data management, alongside security risks. The days when they were concerned merely with managing their own data in secure closed databases. Digital transformation across industries has opened new gateways. Now, open banking is a critical strategy that drives all banks to share their data with third-party actors providing banking and beyond-banking services through API exchanges. All organizations have welcomed this interoperability and co-creation, but for banks, this transformation requires radical re-engineering of security protocols and data management strategies (Hand, 2024). The linkage of data across industries results in the integration of the value chain and the blurring of

ecosystem boundaries. Economic actors are striving to optimally manage data to create sustainable added value for their stakeholders.

Agile data, on one hand, enables platform interaction across different ecosystems, and on the other hand, serves as high-quality fuel for business intelligence capabilities, enabling continuous innovation in service delivery with maximum data-driven interoperability. Agility empowers intelligence, and businesses have learned from their digital transformation initiatives that merely making processes, technology, and tools agile is not enough for being agile, just as all members of a relay team must be agile to win. Therefore, the concept of agility must necessarily be considered comprehensively and interactively on an appropriate scale, and the necessary mechanisms for agile data management and value creation from agile data must also be provided (Padidarfard et al., 2024).

Moreover, the necessity of agility in today's fast-paced, uncertain, complex, and ambiguous world has led to the emergence of agile thinking and fundamental changes in classical management systems (PMI, 2017). As organizations move towards intelligence with increasing digital maturity, banks have also adopted data-centricity as a strategic competency to achieve intelligence. The key success factor for attaining this competency is an agile data management system.

Having an agile data management system for intelligent banking is important for the following reasons:

Data is the fuel for the digital transformation of banks;

-Timely and quick access to information for agile decision-making and decision-taking.

-High success rate of agile approaches in management systems and initiatives.

-Increasingly critical nature of data security issues in banks;

-High importance and necessity of scalability in management solutions.

-Significant savings in time and financial costs for the banking business.

-The emergence of new paradigms in the logic of banking business such as open banking and beyond banking;

-Customer demand for highly digital and customized products and services.

-Requests from banks' business partners for data exchange, interoperability, and value co-creation. (Monetary and Banking Research Institute, 2023)

Banks have historically employed various approaches to manage their data and have learned that using multiple programs and tools adds

complexity of management and requires more personnel for supervision. This approach leads to increased costs and risks, which ultimately do not align with the strategic plans for digital transformation.

Implementing multiple and successive data management system deployment projects not only fails to improve comprehensive perspectives, customer behavior understanding, and future trend prediction, but also makes them more difficult and introduces security risks. Integrating agile methods and data management platforms reduces these risks and costs. Meanwhile, standardizing and reducing transfer points and data concentration among programs minimizes potential entry points for hackers and cyberattacks. Practically speaking, using a unified agile data management solution also allows viewing all related data points in a hybrid world on a single pane of glass, and makes gathering, digesting, interpreting, and providing an appropriate data management system as a service to internal and external data consumers much easier (Habibi, 2023).

Reviewing research related to data management and agile domains revealed that there is no specific reference system tailored not only for the banking industry but for any industry. Therefore, the issue is that an agile data management system tailored to the banking industry is necessary to reap the aforementioned benefits. Such a customized system would ultimately ensure intelligence for the bank.

The maturity of data-centric technologies, such as hybrid clouds, may increas the acceptance of agile data management systems and resolve many previous doubts in the banking industry. A hybrid cloud infrastructure combines public cloud technologies, private clouds, and discrete internal architecture, allowing data engineers to keep some services and systems (for instance, those with sensitive information) within their premises while transferring other systems to external environments. This is an agile and cost-effective solution for balancing security, leanness, scalability, and ultimately intelligence.

Therefore, the main goal of this research is ultimately to design a data management system that, by using the agile manifesto and systems thinking, leads to the success of banks in their journey towards achieving smart banking.

Literature Review

A review of studies in the field of data management and agility reveals that the healthcare industry has the highest inclination towards agility in data

management. Some studies related to data management have addressed the importance of agility to some extent but not comprehensively and purposefully. Regarding the concept of agility, the proposed methods are mostly designed at the team and project level, with less attention given to the scalability and customization of the method for a specific management system (Padidarfard, et al. 2024). In the banking industry, there are also few studies that have addressed agile data management. Therefore, we first had to separately review the research background related to smart banking, data management, and then agility. Subsequently, to better organize the research background, the studies have been divided and briefly reviewed in three sections: smart banking, data management, and agility.

Research Background Related to Smart Banking

Overview of the Smart Banking Concept

Smart banking involves the collection, storage, and processing of customer data and the provision of banking services to create a unique financial experience. This approach represents the latest revolution in the banking industry, aiming to simplify and make financial transactions more accessible to customers (Monetary and Banking Research Academy, 2023).

For smart banking, the following definition has been provided: "Smart banking involves the collection, storage, and processing of customer data and ultimately the provision of banking services to create a unique financial experience." (Habibi, 2023).

This information goes beyond textual, audio, and visual data and includes sensory and environmental data. Proper management of this data deluge, which originates from multiple sources, requires the correct implementation of data-related strategies and technologies (Zarei, 2018). Thanks to digital technologies, collecting real-world and digital data allows banks to know who their customers are, where they are, and what they are doing. This, in turn, means that banks can provide more relevant, targeted, and ultimately more attractive products and services to customers (Muscad, 2023).

Modern Data Community in the Smart Banking Ecosystem

The AWS Institute of Amazon refers to the distribution of data-related work as the modern data community. instead of having a single department (consider a bank department) responsible for data collection, data quality, platform management, and insight generation, delegates responsibilities to

a set of departments (Figure 2), thereby increasing independence, ownership, and speed (The Modern Data Community, 2023).

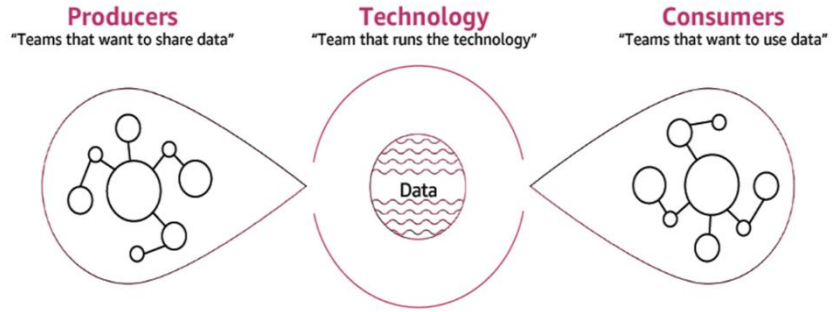

Figure 2 . Schematic Represenation of the Medern Data Community (The Modern Data Community, 2023)

Moving Towards a Product-Centric Operational Model: Data as a Product

Amazon believes that traditional and centralized data departments should restructure the solutions they build and the services they offer with a product-centric approach. Data products should be shared by both business and IT with the common goal of distributing high-quality and reliable data across the organization to enable fast and scalable actions (The Modern Data Community, 2023).

Migration from Mainframe to Data Mesh and Data as a Product in Smart Banking

Leading banks are striving to create data as a product by developing a data mesh that connects their data sources to a new domain-based architecture model. Each domain contains grouped data, which is then assigned to a set of stakeholders to be shared with other departments and applications. Consequently, data mesh becomes a foundational technology necessary for implementing smart banking. "Data as a product is more than just a mere implementation of technology. In fact, it is a cultural shift and requires the adoption of a governance framework often referred to as data mesh" (Bialek et al., 2022).

Research Background Related to Data Management

Latest Scientific Achievements and Systems Related to Data Management

In the literature review it is shown that the evolution of data management in organizations includes three phases:

– from 1980 to 1990 – Data Monitoring

– from 1990 to 2010 – Quality-Oriented Data Management

– from 2010 to the present – Expansion to Strategic Data Management (Legner et al., 2020).

Overview of Management Life Cycles

The main logic for defining the framework of a management system is its life cycle. For example, the Software Development Life Cycle (SDLC) is used for the production and development of software, and the Project Life Cycle (PLC) is used for project management (PMI, 2017). In the DMBOK 2.0 guide, the data life cycle is also introduced as the framework for data management (DAMA, 2009). However, today this linear view of management has been challenged by the Agile Manifesto. Agile methods claim that in complex and unpredictable contexts, the more suitable approach is to use iterative and incremental methods for lean management of the value chain (PMI, 2017). According to the SAFe framework, value streams are recognized as a set of steps that an organization creates to deliver continuous value flow to the customer (SAFe, 2018).

Review of IT Service Management System Based on ITIL 4.0

Various management systems have recently explicitly mentioned the importance of agility in their new editions and have incorporated the concept of agility into their proposed systems. For example, one of the widely used management systems is the IT service management system ITIL 4.0 (Figure 3). This system has also introduced the service value system as its core management system (AXELOS, 2019).

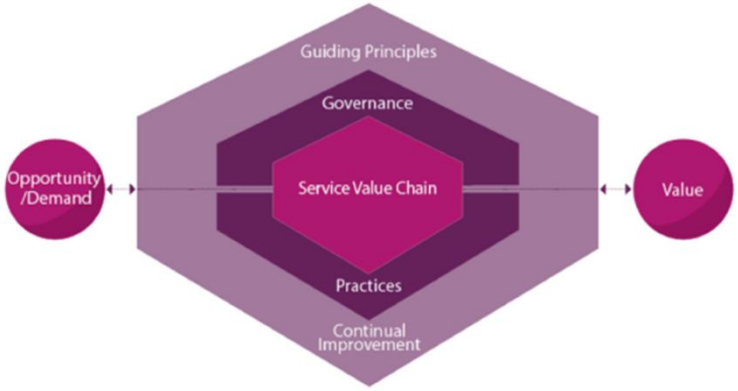

Figure 3. Service Value System (SVS) in ITIL 4.0

outputs. Value chain analysis can help identify barriers to reaching the final goal and high-value stages that require more effort, or suggest ways to reduce resource expenditure in low-value activities. The value chain model is as applicable to the production and use of intangible goods like data as it is to physical products (Open Data Watch, 2014).

Research Focused on Data Production and Supply

Padidarfard, et al. (2024) have shown that the project management constraint triangle has shifted focus from scope management to time and resource management, just as Frankova et al. (2016) concluded in their comparative assessment between program-centric and agile approaches. In response to the question of what is the appropriate approach for managing big data projects, they noted that if we consider the comparison based on the triple constraints of the project as per Figure 4, we can determine that the agile approach is preferable. This is due to the continuously changing needs. Frankova and colleagues recommend starting with small elements in the implementation of big data projects, embracing small failures that propel us forward, and continuing this iterative approach.

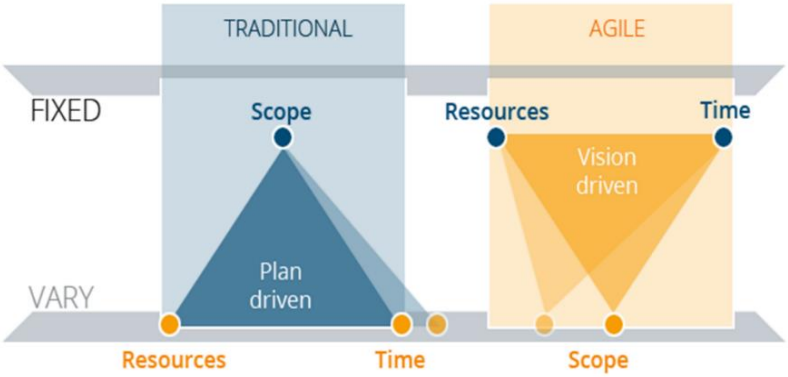

Figure 4. Shifting focus in the project management constraint triangle (PMI, 2017)

McKinsey & Company has emphasized the importance of viewing data as a product. In an article titled "Applying Agile to Accelerate Data Transformation" (McKinsey & Company, 2016), it is stated that agile data is similar to agile software development and heavily relies on collaboration between business and IT. Cross-functional teams work in "data labs" focused on generating reliable insights from data sources. Instead of waiting for "perfect" solutions to emerge, these labs develop minimally viable products and systems to deliver data.

Edgar et al., (2023) explored in their study titled "Integrating Design Thinking and Agile Methods in Analytics Tools Development at Aginic" how the use of agile methods and design thinking in analysis contributed to Aginic's value creation. This research identified key factors that lead to the successful integration of agile values and design approaches, providing an opportunity to gain a deep understanding of how such integration can facilitate the development of innovative data analysis products.

Padidarfard, et al. (2024) recognized the need to rethink their operations to enhance agility, eliminate dependencies, and allow innovation across the organization. To achieve this, they had to envision their world as a product and then break it down into modular components or features (instead of integrated platforms). This led to the reorganization of teams away from integrated departments, forming cross-functional, independent teams focused on specific products, known as "two-pizza teams." This name reflects the idea that the team size would not exceed the number of people that two pizzas can feed (Figure 5).

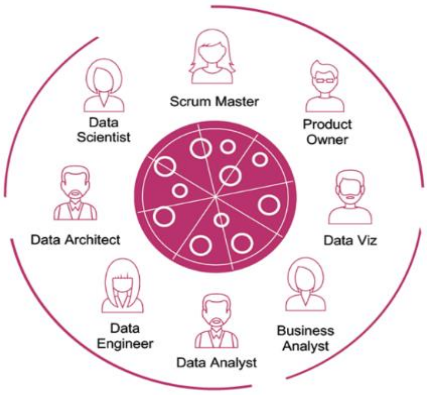

Figure 5. Example of a two-pizza data team at Amazon (The Modern Data Community, 2023)

Research Focused on Data Production, Integration, and Storage

In a study by Vestues et al. (2022) titled "Agile Data Management in the NAV Organization (Norwegian Labour and Welfare Administration)," it was noted that to meet the analytical data needs in digital service development, many organizations use data warehouses and more recently, data lake architectures. These architectures have traditionally been associated with centralized organizational models, where a single unit is responsible for collecting, transforming, and accessing analytical data.

However, such centralized models presuppose stability and are incompatible with agile software development, where applications and databases are continuously updated. To achieve more agile forms of data management, some organizations have begun experimenting with distributed data management models such as data meshes.

Research Focused on Data Demand and Consumption

A study titled "Requirements of Data Management Systems in Healthcare" stated that healthcare data management systems have undergone disruptive transformations over the years, from paper to computer, web, cloud, IoT, big data analytics, and ultimately blockchain (Ismail et al., 2019).

Emerging trends regarding the use of analytics in agile environments are taking shape. In the specialized literature, the concept of "data mesh" has been proposed as a new tool for data management. This study, quoting Dehghani, argues that data should be managed around "domains" (Bialek et al., 2022).

Research Background Related to Agile Management

The Emergence of the Agile Manifesto

According to the Agile Alliance, there is a need to replace bureaucratic processes in other business disciplines and today's organizations. They believe that stakeholders do not want to make difficult decisions, so through imposing decision-making risk with the help of bureaucratic tools and techniques, they impose their unreasonable demands and risks on other stakeholders. This issue is not just a problem in software development but exists in all hierarchical, classical, and bureaucratic organizations.

The Agile Alliance defines the Agile Manifesto as follows:

We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value. (Highsmith, 2001).

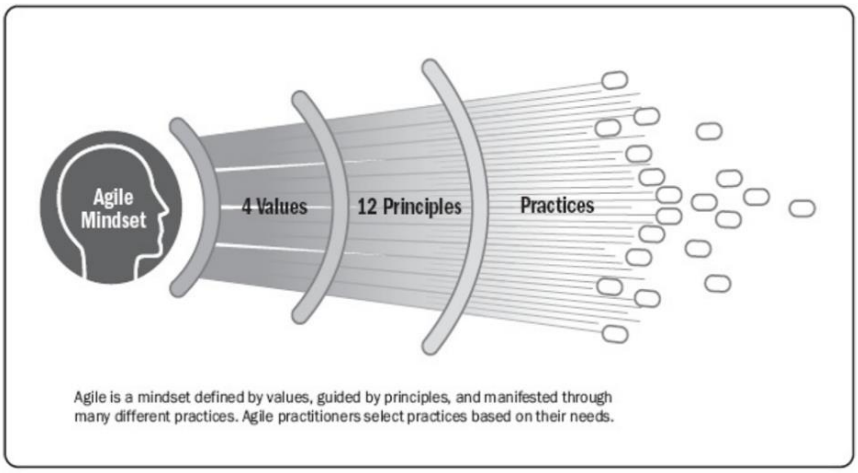

Figure 6. The relationship between values, principles, and common practices of the Agile Manifesto (PMI, 2017)

The 4 values of the Agile Manifesto are:

- Individuals and interactions over processes and tools
- Working software or product over comprehensive documentation;
- Customer collaboration over contract negotiation;
- Responding to change over following a plan (PMI, 2017).

The 12 principles of the Agile Manifesto are:

- Our highest priority is to satisfy the customer through early and continuous delivery of valuable software;
- Welcome changing requirements, even late in development. Agile

processes harness change for the customer's competitive advantage;
- Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale;
- Business people and developers must work together daily throughout the project;
- Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done;
- The most efficient and effective method of conveying information to and within a development team is face-to-face conversation;
- Working software is the primary measure of progress;
- Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely;
- Continuous attention to technical excellence and good design enhances agility;
- Simplicity—the art of maximizing the amount of work not done—is essential;
- The best architectures, requirements, and designs emerge from self-organizing teams;
- At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly (PMI, 2017).

Overview of the Agile Forest

In his article titled "A Bird's Eye View of the Agile Forest," (Portman, 2020) mentioned that over 50 agile frameworks and methodologies have been introduced for management at the portfolio, program, project, and team levels. He categorized these frameworks or agile methods into two main sections: "single-use programs/projects" or "ongoing/uncertain business." Some of them fall into both categories, thus spanning this wide range (Figure 7).

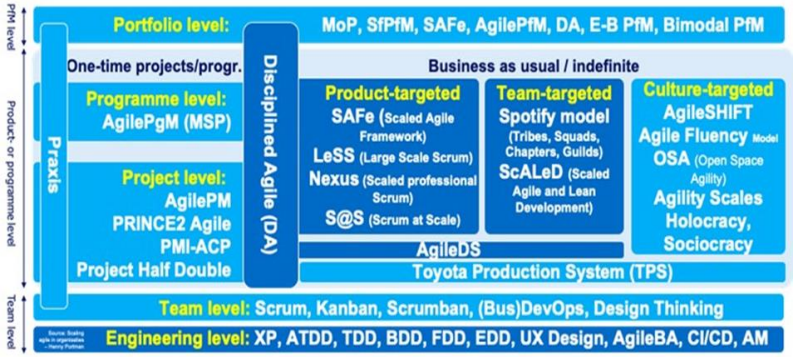

Figure 7. An overview of the Agile Forest by Portman (Portman, 2020)

Application of Agile Methods in Practice

We need to examine how others have done it. They studied teams that adopted agile practices and then committed to continuously evaluating and improving their work methods. Those teams preferred to create agile-based practices tailored to their specific needs rather than using predefined methods (Julian et al., 2019).

In a report titled "Is Kanban a More Suitable Agile Approach in Regulated Environments?" written by Heil and published by Deloitte, it is claimed that the use of agile methods for product development or operational tasks is gaining popularity, and the trend towards digitization and workflow automation has led to the adoption of lean and agile practices. All these approaches have common overarching principles, including:

- Experimental methods with formal feedback loops;
- Pull principle and WIP (Work In Progress) control;
- Continuous process improvement.

Heil claims that even with the similarities between Scrum and Kanban, there is a key difference between the two that must be understood before deciding which approach to choose:

-Scrum focuses on iterative product development;

-Kanban is more focused on monitoring and improving the team's workflow. This method involves considerable effort to visualize and educate the team about flow, performance measurement, and quality (Heil, 2022).

Method

The paradigm governing this research includes systems thinking, data-

centricity, and the agile manifesto. Its purpose is practical and developmental. The nature of this research is qualitative, and it is considered mixed for validation. Data collection methods are both library-based and field-based, with the tools for data collection including document studies, semi-structured interviews, and field observations. For conclusion drawing, deduction and exploration are used through design science methodology (Peffers et al., 2007) and meta-synthesis (Sandelowdky & Barroso, 2007). The reliability of the results was assessed using Cohen's Kappa coefficient and the final validation was carried out through the fuzzy Delphi method (Ishikawa, et al., 1993), (Figure 8).

Identifying the Problem Definition Framework

According to the design science method, in the first step, initial insights into the research concepts were obtained using reputable scientific databases. To ensure that all aspects of the problem were addressed, semi-structured interviews were conducted with five experts in smart banking, data management, and agile concepts, selected using non-random sampling in Iran. These experts provided interpretative analysis of the concepts, resulting in the consolidation of past research, related theories, and recognized global frameworks and standards. Finally, a problem definition framework for agile data management in the smart banking industry was established. The output of this step included understanding concepts related to data management, agility, and smart banking, and becoming acquainted with new notions such as lean thinking and scalability.

Developing the Artifact Specifications List

In the second step of the design science method, semi-structured interviews were used to define the solution objectives and identify the list of artifact features. Given the complexity of this phase and to enhance the results, the objectives of the final solution were organized into two broad categories: the problem space (for a deep understanding of the problem's nature and requirements) and the solution space (for identifying the main features needed for the solution's design). Ultimately, to ensure that all aspects of the problem were considered, the list of artifact specifications was mapped to the parameters of the problem definition framework.

Designing and Developing the Artifact Using Meta-Synthesis

In the third step, the design science method employed meta-synthesis from

systematic review (the selected statistical population included seven global databases: Scopus, Web of Science, Google Scholar, Wiley, SAGE, Taylor & Francis, and Elsevier, along with reference models and standards based on consultation with experts, considering accessibility indices and for covering almost all non-repetitive studies to identify and gather related studies. This included a total of 709 initial articles, books, reports, and dissertations, which were eventually narrowed down to a sample of 77 after screening) to identify selected sources and use coding and labeling for analysis and synthesis of the extracted codes. In this research, efforts were made to propose a conceptual model (at the level of layer one) using design thinking and creative thinking methods (Peffers et al., 2007). Given the need for continuous improvement of the proposed framework during the research, the conceptual model was reviewed and improved through five iterations with expert feedback.

Evaluation and Validation

The evaluation and validation of the research were conducted from three aspects: evaluation of results, reliability assessment, and final model validation.

Publication of Research Findings

With the aim of formalizing the findings, a doctoral dissertation, book translation, and articles derived from it were written.

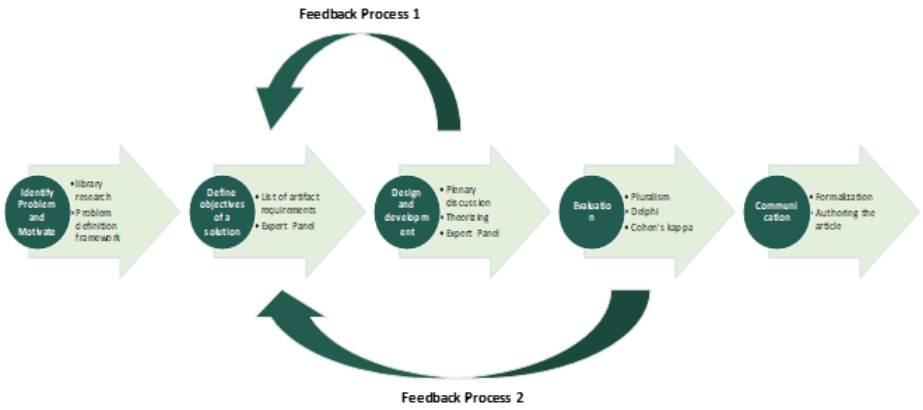

Figure 8. Research Steps Combining Design Science Methodology and Meta-Synthesis Methodology (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007)

Findings

The proposed system, based on the last sprint of the design step, has been derived from theories, methods, standards, guides, frameworks, and other systems related to the disciplines of data management, information science, knowledge management, project and agile management, technology management, financial engineering and banking, systems engineering, strategic management, quality management, and even corporate governance, inspired by Levitt's theory updated by Gold, Harper, and Katz in 2023. The main elements of the system are categorized according to the systems perspective into four groups: input (objectives), processing (enablers), output (results), and feedback (agile and lean paradigm) (Gold et al., 2023). Based on the hybrid methodology of design science and meta-synthesis, this section aims to design, develop, and introduce a conceptual model named the Agile Data Management System (ADMS) for smart banking, grounded in a series of logical arguments. The process of achieving the research findings is explained below.

Step One: Identifying the Problem Definition Framework

In the first step, using semi-structured interviews with experts and texts, the research motivation was analyzed from various dimensions, and the results were organized. It is noteworthy that during the research sprints and upon receiving experts' feedback, the information in this step was updated whenever there was a need to refine or clarify issues and motivations.

The dimensions of the problem analysis and explanation in this step included: theoretical and practical aspects of the research, initial scope and application domain, understanding theoretical bases, defining roles of research team members, outlining sample issues and problems, initial questions, type and definition of the intended artifact, and explaining the required conceptual framework.

Step Two: Developing the Artifact Specifications List

In the second step, based on insights gained from exploring various aspects of the problem, an initial list of objectives for the artifact was defined and how the artifact would help solve the problem was reviewed by experts. Thus, inspired by research findings (Legner et al., 2020) and aiming to clearly explain the solution space from four perspectives: ontology, capability creation, reorientation, and agile paradigm, a list of 13 requirements (R) and nine design considerations (DD) and artifact characteristics were identified and mapped accordingly (Figure9).

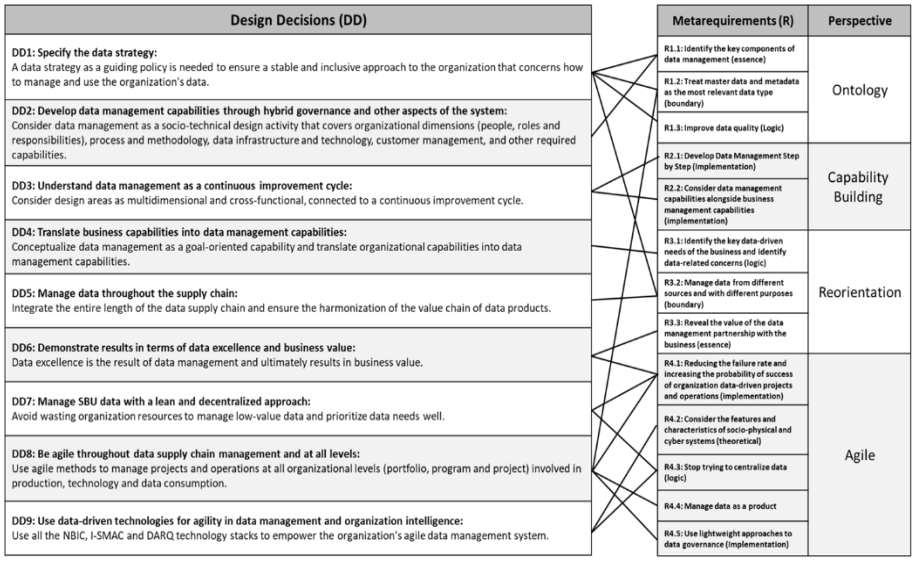

Figure9. Meta-Requirements and Design Decisions Mapping (Padidarfard, et al., 2024)

Step Three: Designing and Developing the Artifact Using Meta-Synthesis

As there is no prescribed method for design in design science methodology, as explained in the methodology section, we had to use another methodology for the design step. Based on the nature and expert opinion of the research team, meta-synthesis methodology was employed for this step. The stages of the meta-synthesis methodology are briefly explained below.

Answering Meta-Synthesis Questions

Although the necessary examinations for identifying various aspects of the problem were conducted in the first and second steps of the methodology, the following supplementary questions were discussed for better precision and optimal research orientation:

- Question One: What? (Since the formulation and explanation of questions were done earlier in step one, this stage was deemed unnecessary)
- Question Two: Who? (Study population: dissertation, book, report, and article)
- Question Three: When? (Study period: up to the year 2024)
- Question Four: How? (Meta-synthesis method, which in this research

was chosen based on the acceptance and popularity of Sandelowski and Barroso's model)

Findings from Systematic Literature Review

According to the meta-synthesis methodology, this step itself includes three stages: searching for adequate related sources, selecting keywords, and introducing databases. The search results and the screening of articles are presented as the final result of the systematic review in the Figure 10).

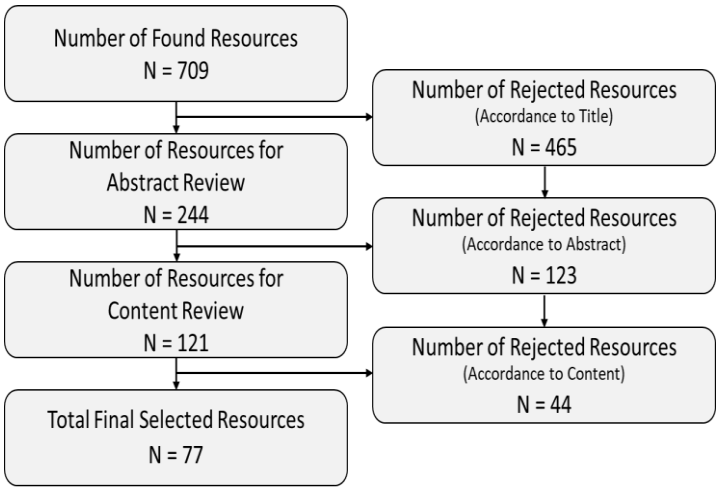

Figure 10. Systematic Review Flowchart (Trend Chart)

Findings from Information Extraction from Texts

In this stage, the content of the sources was precisely reviewed, and codes related to keywords were selected and labeled. By studying the findings from the selected sources, the research team's attention was drawn to 130 key phrases that, after labeling, were identified as open codes. The obtained open codes were classified based on content similarity, resulting in 32 axial codes. Categories and domains are derived from the combination of axial codes. Due to the high number of axial codes (32), this research also employed the definition of categories and domains, which are broader than axial and open codes. Subsequently, by reviewing and analyzing the axial codes, 12 key categories or domains were identified, which are detailed in (Table 1).

Table 1. Definition and Explanation of Extracted Categories (Domains)

No.	Code	Category (Domain)	Definition
1	O1	Multi-Level and Scalable Modeling	Considering that data management and agility are both concepts within complex socio-physical-cyber systems, the decision was made to design the model assuming multi-level and scalability.
2	O2	Project Management Architecture	The concept of agility stems from the need to change project management methodologies. Analysis of selected sources indicates the need to view agile management and scalability from the perspective of project management architecture.
3	P1	Continuous Improvement	Continuous improvement is an ongoing process of identifying, analyzing, and making incremental improvements in systems, processes, products, or services. Its goal is to increase efficiency, improve quality, and deliver value while minimizing waste, variation, and defects.
4	P2	Agile Manifesto	Given the foundational role of agile values, principles, and methods in the sources, it was decided to aggregate and name these three elements as a separate component called the Agile Manifesto, encompassing concepts such as empiricism, pragmatism, transparency, and democracy.
5	X1	Agile Smart Banking Strategy	Various reputable sources claim that data management is entirely strategic and should begin with strategy. It must be aligned with all strategic initiatives and designed with an organizational strategy in mind.
6	X2	Agile Data Management Strategy	The agile data management strategy is a flexible and scalable approach that combines short-term projects with long-term planning. This approach supports aligning quick wins with strategic objectives.
7	Y1	Enablers: People, Process, and Technology	Considering the frequent mention in various selected sources of empowering the pillars of people, process, and technology in all initiatives related to data management, agility, and smart banking, it was decided that this triangle should be regarded as an enabler.

8	Y2	Knowledge Area of Agile Data Management	All reviewed sources related to the discipline of data management emphasize the introduction and organization of data management knowledge domains, whether from a capability-focused perspective or a maturity enhancement perspective, as the backbone of data management.
9	Y3	Data Production and Consumption Chain	Given the importance and high-level nature of the core code identified as the data production and consumption chain, as introduced earlier in the axial codes section, it was decided to consider this core code as a separate category or domain.
10	Y4	Intelligent Core	Given the frequent mention and emphasis on concepts such as modern technology architectures, the necessity of applying modern technologies, and equipping with smart technology stacks, it was decided that this domain be regarded as one of the key components of the system.
11	Z1	Business Value	It is clear that success in any managerial initiative requires the creation of ultimate value for the entire business, and the agile data management system is no exception.
12	Z2	Excellence and Intelligence in Agile Data Mgmt.	The ultimate goal in data management systems and intelligent data-centric banks is the same, and this goal is to achieve excellence and intelligence through agile data for the business.

Findings from the Analysis and Synthesis of Codes

In this step, the final classification of qualitative findings was carried out. The analysis and synthesis of qualitative findings were conducted in two stages: theme formation and logical categorization of qualitative findings, which are introduced below:

Stage One: Theme Formation

Given the relatively high number of categories or domains (12 in total) and with the aim of more concise and simpler organization, the theme category was formed through deeper review and analysis. The themes are introduced and explained in Table 2. These themes subsequently served as the basis for designing the intended artifact, with some implicitly employed as design approaches and others explicitly as the main building

blocks of the intended system. Therefore, as the final stage of theme classification, we categorized the themes into two groups: "problem space" and "solution space," and named this category "design domain."

Table 2. Definition and Explanation of Extracted Themes

No.	Design Domain	Code	Theme	Definition
1	Problem Space	O	Complex and Multi-Level Modeling	Based on the frequency and emphasis of various references, we realized that the intended system requires complex modeling and needs a multi-level model for clarity and scalability.
2	Solution Space (Level Zero)	P	Fundamental Paradigm (Feedback)	Agile values and principles, as well as the application of agile methods, are key elements of an agile system. These are frequently mentioned in reference models.
3		X	Objectives (Input)	In system design, objectives and inputs should be clearly stated. Considering the research goal, our intention is specifically the smart banking strategy and data strategy.
4		Y	Enablers (Process)	Enablers are the processing and agile interaction platforms of the system. They include the triangle of people, processes, smart technologies, and the knowledge necessary for managing the data production and consumption chain with continuous and incremental improvement.
5		Z	Results (Output)	The outcomes of this system, as the final tangible output, are the business value for smart banking and the intelligent data excellence alongside enhancing data intelligence.

Stage Two: Categorization and Organization

In the final stage, the research team, considering the problem definition framework, the list of artifact specifications, the design requirements, and the design decisions made in step one, and utilizing creative thinking, organized and categorized the final qualitative findings obtained from the research.

As reviewed earlier, the categorizations used for organizing the codes include open codes, axial codes, categories (domains), themes, and ultimately design domains as the broadest classification class. This organization guided us in designing the intended artifact considering the

macro elements of a system (level zero) which includes input, processing, output, and feedback system. The main elements for designing level one of the intended artifact were considered to be the themes. Generally, the categorization and organization are presented in table format, and in this research, the results are also presented as a table of organized findings (Table 3).

Table 3. Organization of Meta-Synthesis Findings

Design Area	Theme	Category (Domain)	Axial Codes	nu (f)	Source Code
PS - Problem Space	O - Complex and Multi-Level Modelling	O1 - Complex and Scalable Modelling	O11 - Diversity in Agile Practices	3	S30-S62
			O12 - Complex Modeling	4	S1-S7-S34
			O13 - Multi-Level Modeling	3	S38-S49-S71
		O2 - Project Management Architecture	O21 - Project Management	2	S37-S38
			O22 - Program Management	4	S15-S36-S37
			O23 - Portfolio Management	2	S30-S43
SS - Solution Space	P - Fundamental Paradigm	P1 - Continuous Improvement	P11 - Empiricism	2	S33-S35
			P12 - Pragmatism	3	S33-S68-S77
		P2 - Agile Manifesto	P21 - Agile Value	4	S11-S21-S72
			P22 - Agile Principles	9	S11-S29-S61-S64-S70-S74
			P23 - Agile Practices	10	S15-S9-S23-S31-S39-S40-S41-S43-S69
			P24 - Transparency and Democracy	3	S9-S21-S46
	X - Objectives	X1 - Agile Smart Banking Strategy	X11 - Strategic Alignment with Business Strategy	2	S4-S17
			X12 - Strategic Agility	2	S6-S22
		X2 - Agile Data Management Strategy	X21 - Data-Driven Strategy	2	S12-S16
			X22 - Strategic Agile Data Management	4	S5-S15-S17-S49
	Y - Enablers	Y1 - Enablers: People,	Y11 - People, Process, and Technology	4	S7-S25-S65-S71

		Process, Technology	Y12 - Cross-Functional Collaboration	3	S13-S31-S47
		Y2 - Knowledge Domains of Agile Data Management	Y21 - Agile Data Governance	2	S42-S50
			Y22 - Knowledge Domain as an Element of the Management System	4	S18-S27
			Y23 - Capabilities of Agile Data Management	3	S44-S67
		Y3 - Data Production and Consumption Chain	Y31 - Data Production and Consumption Platform	2	S64-S67
			Y32 - Data Production and Consumption Chain	12	S1-S8-S24-S25-S26-S28-S52-S56-S58-S59
		Y4 - Technology and Data Core	Y41 - Intelligent Technologies	3	S3-S45-S76
			Y42 - Application of Modern Technologies	7	S16-S28-S43-S49-S50-S57-S75
			Y43 - Modern Data Architecture	10	S9-S10-S51-S56-S58-S66-S67-S75
	Z - Results	Z1 - Business Value	Z11 - Increased Productivity and Improvement	3	S14-S19-S73
			Z12 - Lean Thinking	2	S32-S35
			Z13 - Customization and Added Value	3	S16-S45-S48
		Z2 - Excellence and Intelligence in Agile Data	Z21 - Data Management Maturity	2	S22-S47
			Z22 - Data as a Product	4	S53-S54-S60-S67
			Z23 - Data-Centricity as the Core of Smart Banking	7	S2-S8-S16-S20-S50-S55
Total	**5**	**12**	**32**	**130**	**77**

Design and Development of the Final Solution

In this stage, the findings are represented. There is no specific criterion for presenting findings in the meta-synthesis methodology, and the final organization of findings is primarily based on the creativity of the research

team. However, the key point that must be maintained is simplicity and clarity. For optimal representation, the final result is presented as a conceptual model.

According to the meta-synthesis findings at the highest level (referring to the design domain), two domains were identified as design domains: the first domain related to the "problem space" and the second domain related to the "solution space." In fact, the findings of the problem space mainly encompass implicit assumptions influencing the design, while the findings of the solution space serve as explicit and tangible building blocks of the final artifact. Ultimately, a conceptual model for the Agile Data Management System (ADMS) for smart banking was designed and illustrated with the consultation of the research team, as shown in Figure 11.

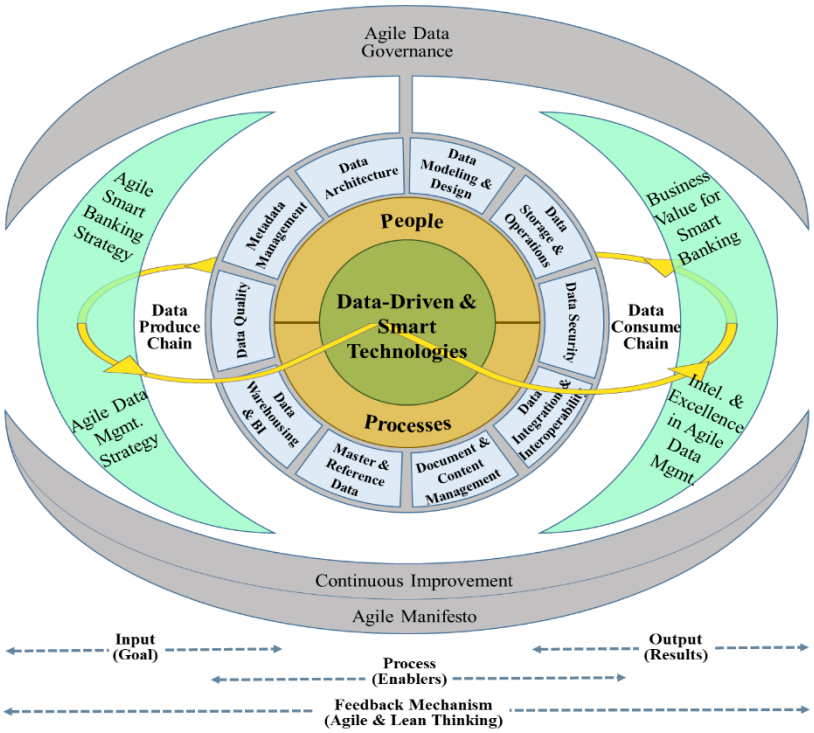

Figure 11. Conceptual Model of Agile Data Management System for Smart Banking (Level 1)

Step Four: Evaluation and Validation

For this purpose, methods of comparing the artifact with predefined specifications for the artifact in step two, as well as conducting a survey on

expert satisfaction with the validity and reliability of the artifact, were utilized. In simpler terms, the evaluation was conducted in three dimensions for the artifact:
- Dimension One: Evaluation of Results
- Dimension Two: Reliability Assessment
- Dimension Three: Model Validation

Dimension One: Evaluation of Results
In qualitative methods such as meta-synthesis, to answer the question of whether the results align with the research objectives, a specific criterion or questionnaire is usually not used, and the general opinion of subject matter experts is typically obtained. However, to ensure more precision in this evaluation, each of the main stages of the meta-synthesis method was reviewed by three experts in terms of alignment with the research objective. Ultimately, of the 184 sub-sections (components) defined, 87 percent were found to be aligned with the research objective according to the experts' opinions, indicating an acceptable level of accuracy.

Dimension Two: Reliability Assessment
To ensure that the results and findings were properly coded, organized, and designed, this evaluation was carried out by calculating Cohen's kappa coefficient by distributing a checklist (a questionnaire consisting of 18 questions derived from the stages of meta-synthesis methodology) and obtaining feedback from three experts. These responses are the criteria for calculating the kappa coefficient. Cohen's kappa coefficient for this study was 0.66, which indicates acceptance of the research's reliability (an acceptable value for Cohen's kappa coefficient is at least 0.6).

Dimension Three: Model Validation
To further ensure the research findings, a fuzzy Delphi method (Ishikawa, et al., 1993) was designed, and a questionnaire (including 12 questions derived from the substance of the identified categories) was sent to 88 experts related to the research topic, with 57 experts participating in the survey (participation rate of 65%).

The fuzzy Delphi analysis conducted in the first round shows that all twelve categories identified by the research team were recognized as key and confirmable factors in designing the agile data management system for smart banking. The fuzzy and definite means for each of these items indicate high expert agreement on the importance of each category.

The fuzzy and definite means and the status of the indicators showed that all items had scores higher than 0.7 (the acceptable value for the fuzzy and definite means is at least 0.7).

Step Five: Publication of Research Findings

As the final step of the research methodology, the manner of publishing and presenting the findings is described. The findings were formalized through the writing of this doctoral dissertation, book translation, several articles, and inviting interdisciplinary researchers in other industries to reflective thinking regarding the findings of this research.

Conclusion

In this research, we aimed to present a customized system for agile data management in smart banking by drawing on global frameworks and standards and using a hybrid methodology combining design science and meta-synthesis. This system integrates, from an applied and developmental perspective, integrates data management and agile concepts with an iterative approach for the next generation of banking, i.e., smart banking. The proposed system at Level zero includes four main elements: input (goals), processing (enablers), output (results), and feedback (agile and lean paradigm). Given the changes in the banking industry, data management has never been more critical. Topics such as open banking, the demand of digital-native generations, the influx of fintechs and other new players in the monetary and banking ecosystem are changing market rules. On the other hand, we cannot overlook cybersecurity threats and the risk of non-compliance with regulations from authorities like the FCA and central banks. These reasons compel us to be leaders and, more importantly, agile in data management strategy and the application of modern data-driven technologies.

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