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An Information Systems Agility Model: A Systematic Literature Review and Double Case Study

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Abstract

Purpose : This study addresses the challenge of effectively measuring Information Systems (IS) agility amid intricate methodologies. The objective is therefore to suggest and test an effective enough method to evaluate IS agility.

Design/ methodology : First, literature was reviewed through a systematic literature review using PRISMA guidelines to extract dimensions of IS agility. A matrix was built and empirically tested in 2 state-owned enterprises. To strengthen the contextualization of the matrix, a qualitative study of an admitted method of IS agility evaluation (5+1 software architecture model) was administered, and both results were compared.

Findings : The systematic literature review and analysis of the 10 main frameworks of IS agility evaluation concludes to the fact that available IS agility evaluation models are too complex for studies willing to analyze this variable among others. Hence the introduction of the IS agility matrix, offering a streamlined approach for IS agility assessment. The matrix evaluates flexibility and adaptability, and collaboration through evaluating the time an IS takes to adapt to new requirements and propagate the need and the changes to collaborators, providing actionable insights into agility levels.

Practical implications : The matrix is mainly addressed to researchers in IS agility. It serves as a simple yet effective benchmarking and ranking tool. This research fills a void in IS agility evaluation methods, offering a practical evaluation method.

Keywords: Agility; information system; IS agility measurement.Systematic review

Introduction

In the rapidly evolving landscape of modern business operations, achieving and maintaining a competitive advantage demands more than just increased productivity (Beuren et al., 2013). Success now goes beyond maximizing profit but rather requires focusing on the internal environment of the firm. A company is, therefore, required to adapt quickly, be flexible, and be ready to seize opportunities. In other words, it needs to "be agile." This concept, recognized as a transformative paradigm for enterprises since the 1990s (Kidd, 1995), embodies the ability to excel in a dynamic environment characterized by continuous and unforeseen changes. Central to this agility is the capability of information systems (IS) to swiftly adapt to new needs and challenges (Booto Ekionea et al., 2011)and prevent firms from performing effectively amidst the pressure of rapidly evolving economies.

As firms adapt to the principles of agility, it becomes evident that information systems are integral components of this transformation (de Camargo Fiorini & Jabbour, 2017). In this context, IS agility transcends beyond technological prowess and efficiency; it underscores an organization's capacity to reconfigure and compose its information flow to align with partners (Peljhan et al., 2018), automate processes (Zeng et al., 2022), facilitate communication (Han et al., 2022), and cater to specific business requirements (Huck-Fries et al., 2023). Furthermore, the agility of a company is deeply interconnected with the agility of its IS and its components (Guetat & Dakhli, 2016; Imache et al., 2012; Ouarhim & Baïna, 2019). In fact, it has been shown that agile IS development

(ISD) could positively influence employees' job satisfaction, fostering employee empowerment, collaboration, and adaptability, and positively impacting job satisfaction through meaningful engagement and a supportive work environment (Huck-Fries et al., 2023). An agile IS consequently allows organizations to sense and respond to changes promptly, making it a key element for firms' performance nowadays. However, the challenge lies in accurately measuring this agility. Existing research provides valuable insights into various dimensions of IS agility evaluation, yet it also reveals complexities that hinder practical implementation.

In our research, the challenge was to find a simple and efficient method for evaluating IS agility. Many existing methods lack practical implementation guidelines for their proposed models or are designed for specific contexts, such as urbanized software solutions, service-oriented architectures, and supply chain management. This gap served as the motivation for our review, where the importance of effectiveness, simplicity, optimality, real-time relevance, and usability for researchers interested in investigating IS agility is emphasized.

In this article, a literature analysis was conducted following PRISMA guidelines for systematic reviews to extract dimensions of IS agility and utilize existing IS agility models. A straightforward and effective model was then introduced as an alternative for evaluating IS agility in organizations. The methodology involved analyzing existing methods, identifying gaps, consulting IS experts, and proposing the matrix for professional testing and comparison. Ultimately, the goal of this research is to contribute by providing a more streamlined and enhanced approach to IS agility evaluation, assisting businesses in accurately and effectively assessing their agility. The systematic literature review : The concept of agility and available IS agility models

In this section of the article, the primary goal is to identify the core dimensions of IS agility. The analysis of these works has allowed for the identification of the gap that forms the foundation of our reasoning. Various available methods for evaluating IS agility will also be introduced. The literature review can be considered a research project (Cooper, 1988). The table below presents Cooper's taxonomy, which was used to guide our systematic literature analysis.

	IS agility review	IS agility evaluation models
Characteristics	Categories	
Focus	Theories	Research methods Practices or applications
Goal	Integration **a.** Generalization	Criticism
Perspective	Neutral representation	Epousal of position
Coverage	Representative	Representative
Organization	Conceptual	Methodological
Audience	Academic specialists	Academic generalists

Table 1 - Cooper's taxonomy of literature reviews

This article is primarily intended for researchers who cannot dedicate their full attention to the evaluation of IS agility alone. In other words, when conducting a study where IS agility is just one variable among many, it is practically impossible to assess the variable with over a hundred items independently. Therefore, this work is addressed to academic generalists.

Methods

To conduct our review, PRISMA guidelines (Pahlevan-Sharif et al., 2019) were used. A was extracted from 3 data bases : Google Scholar, Cairn and ScienceDirect.

Identification: This phase involves identifying all potential documents available on the chosen platforms. The ScienceDirect database, Cairn and GoogleScholar were selected and on which the following equations were respectively administered: ("information system agility") and ("information system agility" AND "evaluation model"). The goal through this review was to identify available IS agility models. This step led to the identification of 16 documents on ScienceDirect, 4 on cairn and 25 on GoogleScholar.

Screening: This step involves using filters to narrow down the search. Given the small number of articles, their eligibility was tested individually.

Eligibility: In this step, the task is to identify suitable articles based on their abstracts. The goal is to retain articles that provide models for evaluating IS (Information Systems) agility. The title, abstract, and keywords were compiled into an MS Excel spreadsheet. Two separate reviewers independently assessed the titles and abstracts of the records. Articles were considered eligible if they presented any type of evaluation model for IS agility. The list of eligible articles was then exported to Zotero to maintain a separate database for this systematic review. This approach made accessing, analyzing, and keeping track of the review simpler. Initially, 37 documents were eligible (books were excluded, and thesis were included).

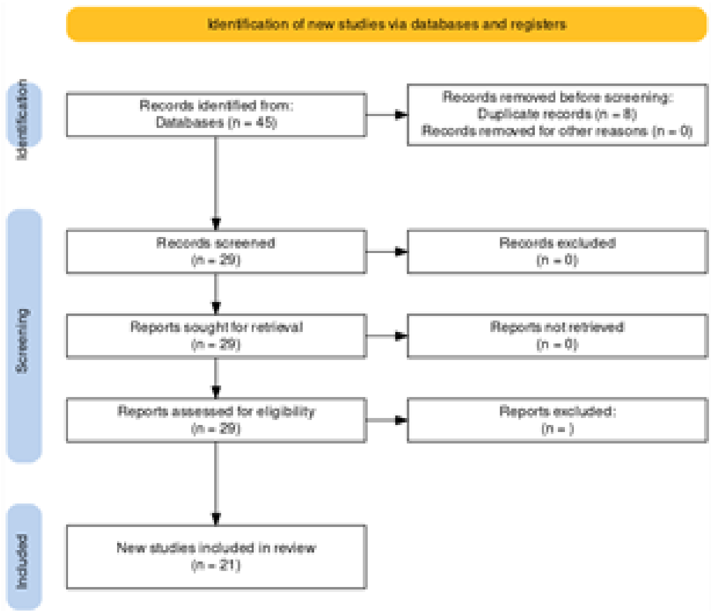

Figure 1 - The PRISMA flow Diagram

Inclusion: This step is where the final number of articles is set. The final number was stabilized after both authors read the conclusions and discussions of all the 37 documents thoroughly. The final number of articles studied was 21.

The four steps were executed twice. After establishing eligibility criteria, both authors carried out the procedures that resulted in a list of 21 articles. Any inconsistencies were resolved through discussions between the two reviewers. Subsequently, a comprehensive review of all the included papers was undertaken to meticulously extract and categorize the evaluation models.

The research process unfolded through a series of stages. Initially, a structured Word document was employed to centralize every definition of "agility" found in the 21 articles. The main author played a central role in this phase. Subsequently, these definitions were analyzed to extract the key dimensions of agility, requiring active involvement from both authors and fostering collaborative synergy. This phase led to the synthesis of agility dimensions. The following step involved extracting the models of IS agility evaluation found and manually categorizing them by the two authors. Any discrepancies were resolved through constructive dialogues. To enhance precision and thoroughness, meticulous bibliographic details were attached to each data point within the document. This meticulous and cooperative approach ensured the refinement of data organization, analysis, and interpretation throughout the research process.

Results

The findings of the systematic review were divided into two key components. First, the analysis of definitions resulted in a finite list of dimensions. Second, the 10 models found were analyzed and categorized.

Information system agility definition

To achieve a neutral representation of the definition of agility, both authors analyzed and discussed the extracted data. Organizational agility emphasizes the continuous readiness of firms to rapidly create, embrace, and learn from change while enhancing perceived customer value (Conboy, 2009). The concept unfolds as an organization's ability to swiftly perceive and respond to dynamic shifts in its operational environment (Chatfield & Reddick, 2018). Beyond the ability to react, agility also ensures internal and external stability (Laufer et al., 2015). This encapsulates agility as the capability to promptly perceive and respond to environmental changes (Guetat & Dakhli, 2016). Agility is what enables organizations to seize opportunities, mitigate risks, reduce costs, and enhance service quality. This definition situates agility within the operational sphere, highlighting its practical implications in facilitating organizational dynamism. The range of definitions from scholars (Chatfield & Reddick, 2018; Conboy, 2009; Guetat & Dakhli, 2016; Pinho et al., 2022; Tallon et al., 2019) collectively illuminates agility's essence. It emerges as an organizational attribute characterized by dynamic flexibility, rapid responsiveness, adaptability, and interoperability, creating value for users. The word cloud below provides a clear view of the three dimensions.

Figure 1 - Word cloud for agility definitions

Applying the definition of agility mentioned earlier, an agile information system is one that can swiftly sense, respond to, and learn from environmental changes within a dynamic business context (Guetat & Dakhli, 2016). This agility is defined as the capability of business processes within organizations to operate with speed, precision, and reduced operating costs, while also effectively seizing opportunities for innovation and competitive action. It emphasizes proactively exploring opportunities, adapting target processes, mitigating risks, reducing costs, and enhancing service quality. Such a system is primed to deftly respond to various types of changes, uncertainties, and evolving requirements in a rapidly evolving business landscape. This agility translates into adaptability, where the system can nimbly accommodate new features, modifications, or even deletions in requirements (Huck-Fries et al., 2023).

Drawing from these perspectives, an agile information system embodies an array of attributes that enable an organization to stay ahead in an ever-evolving business ecosystem (Cigref, 2011). The system's capacity to promptly sense, adapt, and respond to changes ensures that it evolves alongside user needs, technological advancements, and market shifts (Al-Emran et al., 2018). This adaptability ensures that the organization remains flexible and can proactively tackle challenges while seizing new opportunities.

In the ideal scenario, an agile information system should enable firms to reach maturity where communication is carried out through a range of innovative communication mechanisms and practices among top executives, employees, suppliers, and stakeholders (such as clients, regulators, etc) in order to enhance performance (Zamuda et al., 2019). Through an analysis of this proposition, an agile information system (IS) can be characterized as a comprehensive assemblage of technologies, processes, and practices that empower an enterprise to adapt to market changes and challenges swiftly and effectively. Engineered for flexibility, adaptability, and responsiveness, an agile IS possesses the capability to swiftly integrate new functionalities, address evolving stakeholder requirements, and facilitate intricate communication processes.

Frameworks of Information system agility evaluation

Evaluating IS agility is a complex process. Only a few authors have attempted to create frameworks that enable firms to assess IS agility. In this section of the article, the main methods of IS agility evaluation will be presented. The analysis of these methods has revealed that there are four categories of IS agility evaluation methods: Cost, Time, Robustness, and Scope of changes (CTRS).

- Simplicity, Speed and Scope of changes (3S)
- Hierarchy Process (AHP)
- Fuzzy Mathematics Analytic

Table 2 - The 10 models of IS agility evaluation in literature

The method /Author	Category	Details about the method or framework
A fuzzy logic knowledge based (Tsourveloudis & al 2002)	Fuzzy Mathematics Analytic	a fuzzy logic knowledge-based framework is presented for the assessment of manufacturing agility. The combined measure incorporates certain operational parameters, their variations, and their effect on the value of agility. The necessary expertise used to quantitatively determine, and measure agility is represented via fuzzy logic terminology, which allows for human-like knowledge representation and reasoning. Emerging standards for distributed simulation and virtual reality are utilized to implement a distributed simulation testbed. The testbed is used to simulate, measure, and evaluate agility and its parameters. The simulation testbed integrates the modeling of agility infrastructures, simulation of an enterprise through its infrastructures, real-life data, and a virtual reality-based interface. High Level Architecture (HLA) and Virtual Reality Modeling Language (VRML) are standards selected for the implementation of the testbed.
Framework Conceptual agility (Oosterhout & al. 2006)	Cost, Time, Robustness and Scope of changes (CTRS)	Authors propose a process that begins with the analysis of internal and external change factors that can create the need for agility in IS (Information Systems). Then, the determination of IS's agility readiness is carried out based on the company's agility capabilities. Agile IS architectures can be examined from four distinct perspectives within the business network: these include the hardware and systems infrastructure, IS application software, the management of individual businesses, and the dynamic control and governance of the overall business network. Legacy IS systems are linked with the utilization of intricate and frequently outdated architectural structures.
Degrees of IS agility (Lui et Piccoli , 2006) .	Simplicity, Speed and Scope of changes (3S)	The information system is composed of two subsystems: a technical system and a social system. This conceptualization of information systems allows for the analysis and evaluation of agility using four elements: technological agility, which assesses the flexibility of IT components; process agility, which measures the ability to adjust business processes; human agility, which evaluates the skills and training of personnel; and finally, structural agility, which depends on organizational flexibility and rapid decision-making. This approach helps to understand how these components interact to influence the agility of information systems.

The fuzzy axiomatic design (FAD) (Büyüközkan & Arsenyan, 2009)	Fuzzy Mathematics Analytic	The fuzzy axiomatic design approach integrates fuzzy logic and multi-criteria decision-making techniques to provide a systematic way of evaluating the agility of information systems for supplier selection in agile supply chains. This approach considers the uncertainties and imprecisions in the assessment process, as well as the input from multiple decision-makers. The ranking of alternatives helps in identifying the most suitable agile suppliers based on the defined criteria and requirements. The fuzzy axiomatic design approach involves several key steps. First, the author defines seven evaluation criteria for agile supplier selection, such as custom job configuration and marketability costs. Next, four supplier alternatives are identified. Fuzzy TOPSIS methodology is applied to assign weights to the evaluation criteria. Expert opinions on the performance of alternatives are gathered and expressed in linguistic terms using fuzzy numbers. The fuzzy axiomatic design technique is then used to compute common areas and design ranges for each criterion. After obtaining results, fuzzy TOPSIS is applied to compare performance, calculating normalized matrices and distances from ideal reference points. Finally, the alternatives are ranked based on the outcomes of both the fad and fuzzy TOPSIS techniques.
POIRE (Rabah IMACHE, 2011)	Cost, Time, Robustness and Scope of changes (CTRS)	This approach is based on two major principles: continuous improvement and the urbanization of the Enterprise Information System (SIE). The principle of continuous improvement requires adherence to configuration management and good governance, and urbanization allows for a better structuring, a priori, of the enterprise information system architecture. The process requires comparison between target agility and actual agility is done through the response to 172 questions distributed across 5 dimensions on 2 occasions (Process, Organization, Information, Resources, and Environment, hence the acronym POIRE).
A fuzzy logic based assessment applied by (Imache et al., 2012)	Fuzzy Mathematics Analytic	This method evaluates information system agility by proposing an agility fuzzy logic evaluation, regulation, and preservation framework based on two main principles: urbanization and continuous improvement. The assessment model evaluates the agility of five dimensions that constitute any enterprise information system (EIS) and result from the urbanization process. The evaluation of these dimensions allows organizations to strategize for agility production, consumption, and preservation. The model is applied to estimate the agility of a tour operator enterprise, showing the correlation and coherence of the different models of the proposed conceptualization. The author acknowledges that the presented model neglects mutual interactions between the different dimensions, factors, and criteria of the EIS, and discusses plans to improve the precision of calculation by studying these interactions and their effects on agility. The goal is to apply the model to various industrial enterprises' information systems and e-government information systems, along with further studies on producing agility at different levels of the EIS.
(E-GIS) Aggoune (2012)	Hierarchy Process (AHP)	This framework serves as an evaluation tool for measuring the agility of e-government information systems (E-GIS). The core concept of this framework involves merging the fundamental components of E-GIS with their operational characteristics to assess the overall agility of the system. A notable advantage of this practical framework is that it evaluates

		agility parameters using quantitative metrics, enabling decision-makers to scrutinize and compare various systems across varying agility levels. It's important to note that the framework presented is currently theoretical in nature.
The 5+1 software architecture model (Guetat & Dakhli, 2012)	Hierarchy Process (AHP)	The author proposes to evaluate information system agility through the implementation of a software architecture model called the "5+1 software architecture model." this model aims to help organizations build urbanized software solutions that align with the principles of information systems urbanization. The model consists of six architecture layers: Interface layer; Navigation layer; Orchestration and choreography layer ; Services layer and Data access layer. The process of evaluation requires a qualitative evaluation of each of the layers.
The four spaces model (Guetat & Dakhli, 2016)	Hierarchy Process (AHP)	The author suggests measuring information systems (IS) agility through a framework called the "four spaces model" for the governance of services in the case of applying the service-oriented architecture (SOA) style to urbanized information systems. This model addresses the operational aspects of services exchanges governance within and between different information systems. The process involves evaluating IS (Information Systems) agility through two key concepts: "Information Systems Urbanization" and the "Service-Orientation Paradigm." The former emphasizes the need for governance based on loose coupling and strong consistency, viewing information systems as cities with private and common parts. The latter introduces services, service providers, consumers, and intermediaries, emphasizing the role of an enterprise services bus (ESB) for communication. The process comprises four spaces (Consumption, Production, Intermediation, and Governance) and associated repositories to support services governance, focusing on policies, monitoring, and enforcement.
Quantitative evaluation (Edegbe & Onianwa, 2022)	Simplicity, Speed and Scope of changes (3S)	This research created an improved agility assessment model for quantitatively measuring legacy information systems in an educational institution, focusing on agility factors such as Speed, Robustness, and Complexity. By employing a quantitative metrics approach, this will result in a precise measurement of the student information system.

Discussion

In the research, relevant and relatively efficient methods were encountered for evaluating IS agility. However, a gap was sensed that needed to be filled:

- Holistic Evaluation: Existing methods primarily focus on specific aspects or dimensions of information system agility, such as urbanization, architecture layers, service governance, and supplier selection. Nevertheless, there appears to be a lack of a comprehensive and integrated approach that covers all dimensions of agility in a holistic manner.
- Applicability to Different Contexts: Some of the existing methods are tailored to specific contexts, such as urbanized software solutions, service-oriented architectures, and supply chain management.
- Practical Implementation and Usability: The current methods may lack practical guidelines for implementing and utilizing the proposed models or frameworks.
- Real-time Adequacy: While these methods offer steps to evaluate IS agility, they tend to be too complex and time-consuming. Such evaluations could take several weeks, rendering real-time evaluation unfeasible.

For these reasons, the approach considered involved analyzing agility by returning to its origins to develop a simple matrix that could be efficient enough.

IS agility matrix

The analysis of definitions and available frameworks has led to the extraction of 2 key elements that identify agility which are:

- Adaptability and flexibility : an information system is considered agile when it enables adaptability through its capacity to swiftly adjust to changing circumstances and requirements. This adaptability could be achieved by incorporating flexible technologies, processes, and practices that allow the system to quickly integrate new functionalities, address evolving needs of stakeholders, and effectively support complex communication processes.
- Collaboration: an agile information system supports seamless collaboration among various stakeholders, facilitates the collection, analysis, and sharing of pertinent information, and enables rapid and accurate communication during disruptions or crises.

Taking this into careful consideration, it is thought that a matrix showcasing the state of the IS agility could easily provide an idea about how flexible, adaptable, and collaborating the firm's IS is.

The proposed model will, therefore, assess the time needed for the information system of the firm to adapt to a new need and for the change to reach all the concerned collaborators.

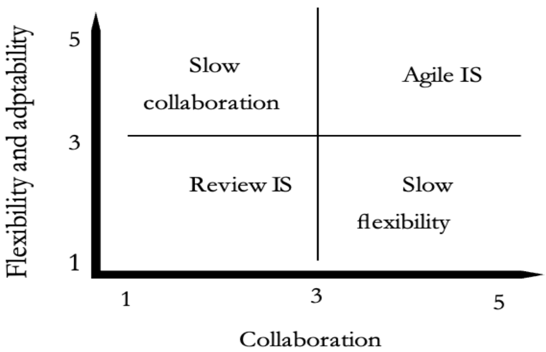

Figure 2 - The matrix of IS agility

Technically speaking, the process would involve an expert evaluation of the level of flexibility and the level of collaboration on a Likert measuring system. The next step to pinpoint how agile the IS on the matrix. Collaboration refers to the time needed for all the collaborators to know that there is a new “need” had been brought to light. Flexibility and adaptability refer to how long or short is the time needed for the IS to integrate the new need in the system.

There are 4 possibilities :

1. **Sow flexibility and adaptability/ Slow collaboration** : In this case, it can be stated that the IS is not agile. The firm needs to review its communication system and the tools used for dissemination.
2. **Sow flexibility and adaptability / high collaboration** : the company must capitalize on the human dimension of the IS and introduce adequate tools
3. **High flexibility and adaptability / Slow collaboration** : The IS isn’t adapted to the firm’s information architecture
4. **High flexibility and adaptability / high collaboration** : The IS is on first evaluation agile

The proposed matrix is designed to assess the agility of an IS. It evaluates the time required for the IS to adapt to a new need and for the resultant change to propagate among all relevant collaborators. Our reasoning is that this matrix is relevant enough since it gives insight about the 3 key elements:

- Flexibility: The matrix evaluates flexibility by measuring the speed at which the IS can adjust to new requirements, reflecting its ability to incorporate changes effectively.

- Adaptability: The matrix directly assesses adaptability by quantifying the time taken for the IS to adapt to new needs, indicating its responsiveness to dynamic circumstances.
- Collaboration: The matrix evaluates collaboration by considering the time taken for the change to be communicated to all relevant collaborators, reflecting the system's efficiency in facilitating collaboration during transitions.

Application to a case study : contextualization in 2 firms

To test the matrix, it was applied to 2 public companies in Morocco, Al Omrane and ONDA (Morocco's airports). These companies were selected to test the matrix on two different types of organizations: one with a well-structured IS and another with a complex information system. After obtaining approval from relevant managers within both companies, the first step was to identify a new requirement for each company that the managers would agree to implement:

- For ONDA: The requirement was to enable digital traceability in the IS.
- For Al Omrane: The requirement was to publish audit recommendations to all relevant collaborators.

Once this initial step was initiated, counting of days began until the last collaborator had knowledge of the new feature.

For ONDA: The manager initially estimated that the process would take 40 days in theory. However, a decision was made to delve deeper into the details, and the process took 32 days. The company had a complex information system and a strict hierarchy. Despite the prominent need, it was not digitized. The solution involved scanning all documents and storing them on a common online drive for various groups. Consequently, a surveillance plan was created to trace information flows and identify internal groups more clearly. Subsequently, a training program was conducted because there was no centralized database to publish the new procedure. Identifying the groups took 11 days, after which an email was sent to the concerned groups. Establishing the surveillance plan took 3 days, collecting all the necessary documentation and agreements took 10 days, and the training took 3 days, involving 3 groups of 18 people.

For Al Omrane: Similarly, the manager initially assumed that the process would take a week. However, the implementation took 8 days. The company uses a variety of software solutions for various business needs, including enterprise resource planning (ERP), customer relationship management (CRM), supply chain management, and more. The need was promptly communicated on the platform, and everyone was made aware of the new requirement. The process included 3 days to obtain supervisor approval, 2 days for the company's technician to implement the feature, and 1 day for it to reach all platform users.

In conclusion, Al Omrane exhibited high flexibility (4) and strong collaboration (5), while ONDA showed moderate collaboration (3) and very low flexibility (2). The positioning on the matrix would look like this:

To compare the IS agility matrix method to other ones, the IS agility of the same companies was evaluated using the "5+1 software architecture model." A questionnaire was developed for this purpose.

5+1 software architecture model: applied to ONDA.

The analysis of the questionnaire responses from ONDA reveals critical insights into the current state of the organization's information system and its alignment with the "5+1 software architecture model." The responses highlight challenges and limitations that contribute to a non-digitized and complex system, hindering agility and efficient information flow.

- Interface Layer: The responses indicate that the interface layer lacks standardization and graphical consistency. Users struggle with different technical communication channels and encounter difficulties in data validation and syntax control. This inconsistency affects user experience and contributes to a tangled communication process.
- Navigation Layer: Participants describe a convoluted screen navigation process, leading to confusion among end-users. The lack of proper routing to local printers and kinematic management exacerbates navigation

issues. The navigation layer's inefficiencies hamper effective interactions between the software system and users, impacting agility.

- Orchestration and Choreography Layer: The orchestration and choreography layer seem underdeveloped, with limited examples of effective organizational process management. Participants highlight challenges in exposing services to external systems and orchestrating sequences of tasks. This layer's inadequacies impede seamless service exchanges and hinder organizational adaptability.
- Services Layer: Responses indicate that the services layer lacks comprehensive rules and functions, affecting data processing. Participants point out instances of data inaccuracy and a lack of reliability. The services layer's limitations hinder the system's ability to accommodate evolving business needs and contribute to operational inefficiencies.
- Data Access Layer: The data access layer appears to struggle with maintaining separation between data processing and physical data models. Participants express concerns about data integrity and the effectiveness of data selection, update, and deletion operations. This layer's shortcomings contribute to the overall complexity of the information system.
- Technical Services Layer: The technical services layer is mentioned as being nonexistent in several responses. This absence leaves the software system vulnerable to security threats, network issues, and middleware-related challenges. The lack of technical services impedes the organization's ability to integrate and collaborate effectively.
- Alignment with Urbanization Principles: Responses overwhelmingly suggest a lack of alignment with the principles of information systems urbanization. Participants acknowledge challenges in implementing the "5+1 software architecture model" due to the current system's complexity and hierarchical rigidity. The absence of an optimized collaboration and integration mechanism further hampers agility and adaptability.

In summary, the responses portray Company A's information system as non-digitized, complex, and lacking in alignment with the proposed architecture model. The tangled communication, rigid hierarchy, and absence of technical services contribute to a system that struggles with agility and efficient information flow. The findings underscore the need for strategic digitalization efforts, hierarchical restructuring, and the adoption of principles from the "5+1 software architecture model" to enhance the organization's overall information system agility.

5+1 software architecture model: applied to AL Omrane

Interface Layer: The company's software system demonstrates proficiency in handling interactions with end-users across different technical communication channels. Responses indicate that methods for managing the visual aspects and presentation of the user interface are well-defined. The system effectively ensures proper data syntax and validation for user inputs, contributing significantly to enhancing user experience and ease of use.

- **Navigation Layer**: The progression of screen navigation is efficiently managed within the software system. The navigation layer effectively routes information to local printers and other technical communication channels, ensuring smooth information flow. The layer's facilitation of interactions between the software system and human end-users contributes to guiding users through various tasks and processes.
- **Orchestration and Choreography Layer:** The organizational process flow within the software system is well-managed. Examples provided in responses showcase successful control of information and service exchanges with other software systems. The orchestration and choreography layer effectively initiates and completes sequences of tasks, and the ability to expose services to external systems enhances coordination between services.
- **Services Layer:** The services layer hosts a range of rules and functions to process informational entities. The layer demonstrates a strong commitment to ensuring the accuracy and reliability of data processing. Examples highlight the layer's substantial support for the functionality and overall capabilities of the software system. Additionally, the layer's adaptability in incorporating new rules and functionalities aligns well with evolving business needs.
- **Data Access Layer:** The data access layer effectively provides access to operational persistent data. Maintaining the separation between data processing and physical data models is a priority, and the layer ensures

data integrity during various data operations. The layer's support for data selection, update, deletion, creation, and joins indicates a comprehensive approach to data management.

- **Technical Services Layer:** The integration of technical services into the technical services layer significantly contributes to the overall reliability and security of the software system. Responses illustrate how these services effectively support other layers in achieving their goals. The layer's enhanced ability to integrate with external systems and networks demonstrates a commitment to staying current with technological advancements.
- **Overall Alignment with Urbanization Principles:** The company's software system showcases a notable alignment with information systems urbanization principles. Challenges in implementing the "5+1 software architecture model" have been addressed effectively, with successes evident in responses. Steps taken to optimize collaboration and integration between different layers highlight the organization's commitment to achieving adaptability, flexibility, and collaboration.

In conclusion, the questionnaire responses from Al Omrane suggest a positive overall implementation of the "5+1 software architecture model" within the organization's information system. The employment of a technician to implement new features showcases the company's dedication to enhancing software capabilities and aligning with urbanization principles. The software solutions employed across various business needs demonstrate robustness and alignment with the architecture model's layers, fostering adaptability, reliability, and effective collaboration.

Implications and conclusion

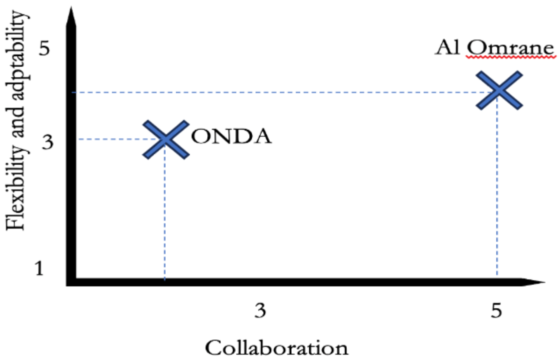

Figure 3 - positioning the examples on

It is undeniable that applying the 5+1 software architecture model has given more insight about the IS of both companies. However, in terms of comparison, both methods lead to the same result: the information system of Al Omrane is more agile than the information system of ONDA. The IS agility matrix could have also been based on the managers' assumptions, which were accurate. That would have been enough to compare both companies and rank them. Getting results from managers with the IS agility matrix could have taken a few minutes, whereas applying the 5+1 software architecture model took days of preparation, questioning, and then analyzing the answers and is still based on assumptions and qualitative evaluations made by the managers. When choosing methods of evaluating IS agility, researchers should have clear objectives about what they are looking for.

By introducing the IS agility matrix, gaps in literature affecting the evaluation of IS agility are addressed (Prange, 2021). The real-time relevance of this matrix meets the urgency of modern decision-making, enhancing its practical significance. Additionally, the matrix's focus on adaptive speed connects with user experience, minimizing disruptions and elevating user satisfaction. The review's objectives include simplifying agility evaluation and exploring the integration of flexibility, adaptability, and optimality.

Perspectives and limitations

The IS agility matrix facilitates continuous improvement by providing organizations and researchers with a tool to assess the efficiency of there IS adaptation processes over time. Through consistent monitoring of position changes on the matrix, areas for enhancement can be identified, and strategies can be devised to bolster agility.

Additionally, the matrix serves as a valuable benchmark, enabling comparisons of agility across various IS within the same organization or even across different firms. These comparisons yield insights into best practices and areas warranting improvements. Moreover, the IS agility matrix results offer vital input for decision-making processes encompassing software development, system upgrades, and strategic planning. By shedding light on the potential time implications of proposed changes, stakeholders gain a better understanding of their effects. This matrix's efficiency lies in its ability to provide meaningful rankings or comparisons with relatively minimal investment of time and energy. In other words, it could be used as the “alarm” matrix.

Nonetheless, it's important to acknowledge the matrix's limitations. It lacks the capacity to account for the contextual complexities that shape adaptation time. Variables such as the nature of the change, the IS's complexity, and the organization's size can significantly influence results and their interpretation. Moreover, the matrix may not provide a comprehensive overview of the IS and might not fully enable the identification of gaps within the system.

Although the matrix holds promise across various scenarios, its true applicability requires validation through further testing in different fields. This step is essential to ascertain the breadth of its usefulness and refine its role in assessing IS agility.

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- Diouri Soumaya, Quality management at ONDA Marrakesh, Morocco
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