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# Improving sustainable management through an AI-based strategic transition: A policy that promotes firms to use AI advancements in the Industry 4.0 era

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## ABSTRACT

**Due to the severe effects of the Fourth Industrial Revolution and environmental disasters or subsequent pandemics, the digital infrastructures of businesses need drastic and constant changes. As a result, many companies are actively implementing innovative digital strategies to accelerate digital adjustments throughout the scale of their organizational structures. Since artificial intelligence (AI) has demonstrated its success in a wide range of fields, including both business processes and daily activities, it has gained extreme interest in corporate ecosystems. Business management techniques could be transformed by the integration of AI for more productivity, cost-effectiveness, and overall efficiency. AI is strategically incorporated into businesses to help them engage with their target consumers more effectively, giving them an edge over their digital competitors. Additionally, AI has the potential to revolutionize corporate operations, enabling the creation of novel ideas, the completion of complex tasks, and the acceleration of significant economic growth. To achieve thorough optimization, it is necessary to carefully adjust AI integration tactics to the unique requirements at each stage of development. In this study, we present a strong strategy to hasten the conception, alignment, and prioritizing of developing activities, supporting a smooth transition to more effective and sustainable management methods.**

**Keywords:** ***Artificial intelligence, Strategy, Transition, Industry 4.0, Maturity Model, Management.***

## I. INTRODUCTION

The global economy has grown extraordinarily over the last few decades, a development that has greatly improved management frameworks. For business management, this evolution has had significant ramifications, notably in the area of strategic business operations. Although these transformations are moving in a hopeful direction, it is still difficult to achieve operational efficiency, which leads to higher operational costs and heightened competitive pressures. Consumers' unrelenting desire for cost-effectiveness, exceptional quality, and shorter lead times is a dynamic that is always expanding and is driving quick changes in the competitive environment. The spread of breakthrough technology along with the rising desire for customized goods and services all work together to intensify market competition [1,2]

Companies are forced to face these difficulties head-on in the present business environment. Despite the steps taken to improve managerial infrastructures, there is a pressing need to increase operational efficiency to cut costs and gain a competitive edge. To meet changing customer expectations, a concentrated effort must be made to streamline operations, improve workflow, and incorporate cutting-edge technologies. Businesses must also balance cost factors with product quality, utilizing modern technologies to boost production while ensuring the delivery of high-quality goods and services [3].

The capacity to customize offerings to specific client preferences assumes critical relevance in this intensely competitive environment. Businesses must strengthen their administrative structures as well as concentrate on maximizing operational efficiency, a requirement that assumes greater importance as the global economy quickens its growth. Businesses can prosper and maintain long-term success in this highly competitive climate by deftly responding to the rising demands for pricing, quality requirements, timeliness, technical improvements, and customized experiences [1, 4].

Businesses encounter a wide range of difficulties as a result of ongoing changes in market trends. The design of clever strategies that grant the capacity to react to the dynamic vagaries of the marketplace quickly and swiftly [2, 3, 4] is a crucial challenge. In the world of business, it has become abundantly clear that starting a project does not automatically ensure its longevity, importance, or even stability. As a result, businesses are rigorously investigating a variety of models that enable product customization, so improving their ability to cater to changing client needs. Importantly, businesses understand that the rise in customer expectations demands a dual emphasis on cost reduction and expedited lead times, while also enhancing their innovation capabilities.

To address these imperatives, fresh organizational paradigms have developed, each one distinctively focused and strategically coordinated:

• Sustainable business models: Stewardship of the environment is highlighted in this category [5]. These organizations work to balance the financial sustainability of their operations with the principles of environmental preservation, with a focus on reducing ecological effects. The adoption of sustainable methods places them in a position to successfully meet public demands while preserving the ecology.

• Lean organizations relentlessly seek and reduce superfluousness in their operations, resulting in cost reduction, increased responsiveness, and the nurturing of better performance [6]. Process efficiency and the reduction of inefficiencies accomplish a steadfast commitment to continual improvement and prudent resource utilization.

• Companies equipped with ambidextrous abilities negotiate the dual responsibility of efficiently managing routine duties while also pursuing pioneering, paradigm-shifting initiatives [7]. They establish a harmonious balance between exploration and exploitation by fostering an environment that supports creativity and adaptation. This dynamic equilibrium allows for the continuation of continuing innovation while also satisfying existing market demands.

• Agile firms, founded on autonomous decision-making and structural scalability, demonstrate the ability to adapt to changing market conditions [8]. They have the ability to quickly recalibrate goals

and operations within an ever-changing business environment by encouraging cooperation, knowledge dissemination, and adaptive structures.

Through the deployment of these new organizational frameworks, businesses may manage the complexities of today's business environment with ease. Businesses position themselves for success by being attentive to client expectations, stimulating innovation, and maintaining practical efficacy, either through ethics, processes, optimized procedures, versatility, or agility.

With the rapid development of digital technologies like big data, AI, data science, Internet of Things (IoT), and cyber-physical systems [10, 11, 12], the paradigm of Enterprise 4.0 [9], which builds on established ideas and taps the potential of developing industrial advancements, has quickly gained prominence in recent years. The work of bridging the divide between the physical sphere, with all its inherent complexity, and the digital domain, however, continues to be a significant problem within the changing dynamics of the growing industrial environment [10, 13]. To overcome this challenge, businesses adopted managerial innovation and integrated intelligent management systems into their processes. These tools act as a bridge between the physical sphere's dynamism and volatility and the virtual world. These clever management solutions enable businesses to use complex algorithms and cutting-edge analytics to make data-driven decisions and improve processes in real-time. These solutions reveal potential areas for improvement, offer insightful information on the operation of industrial systems, and enable quick adjustments to changing circumstances.

Intelligent management software's advent marks a fundamental paradigm shift for many different businesses. Today's businesses are equipped with powerful technologies that let them take advantage of digital development's potential while yet retaining a strong connection to the real world. These instruments promote higher productivity, effectiveness, and flexibility in industrial processes, which stimulates the development of smart factories and releases Industry 4.0's full potential. In a broader context, the incorporation of intelligent management technology symbolizes a significant step forward in the field of industrial evolution since it solves the crucial problem of seamlessly fusing the physical and digital worlds. By embracing these revolutionary tools and ushering in innovative opportunities, businesses may chart a path toward enduring success in the Enterprise 4.0 environment, which is marked by rising interconnection and data-driven dynamics.

In the wake of constant technical developments and the introduction of fresh IT tools, the parameters of the managerial process underwent a revolutionary metamorphosis. This technological development has aided automation and brought about real-time communication between various processes or divisions. This ability to transform results in continuous real-time monitoring of discrepancies, seamless information distribution, and the assessment of process efficacy. As a result, companies are in a position to significantly improve their capacity for developing unique products and services, optimizing resource allocation, and automating workflow customization. Embracing Paradigm 4.0 necessitates the active participation of all management levels and the adoption of a comprehensive logic that benefits all stakeholders. To make this change, each aspect of the organizational journey demands careful study and examination. It is necessary to thoroughly evaluate the requirements and translate them into clear internal imperatives to concretize workable solutions. Quantifiable benchmarks must be linked to these strategies, while also taking into account the organization's capabilities and resources.

Our manuscript's main goal is to give a thorough process that enables businesses to smoothly make the transition to "management of the future." This transformation demands a thorough assessment of performance levels concerning the corporate goals as a whole. Our study makes several important contributions, such as:

A modern-day overview: We present an in-depth examination of the current problems and challenges that businesses confront during this transformational period. Organizations can navigate the path to the future of management by knowing these impediments.

Smart management areas include: To optimize the whole managerial process, we identify the important sectors within smart management where transformation should occur. Companies can efficiently streamline their operations and increase efficiency by focusing on these areas.

Models for assessing organizational maturity regarding smart management: We investigate the existing models for measuring operational maturity concerning smart management. Companies can learn about business best practices and adapt them to their own needs by examining these models.

Assessment approach: Our research presents a solid assessment methodology to help businesses undertake self-assessments. This methodology assists in prioritizing smart transition plans based on the unique activities and objectives of the firm.

Methodology implementation: We offer practical advice on how to put the suggested evaluation methodology into action. Companies may efficiently perform the evaluation process and acquire useful insights to drive their transformation path by following our instructions.

We believe that our study will provide organizations with the knowledge and abilities they require to navigate the complexities of the changing management landscape and implement changes that are in line with their core business activities. The structure of our paper is as follows: The background of the subject of the research is briefly covered in Section 2, the transition plans are described in Section 3, the transition diagnosis is discussed in Section 4, all the facts are discussed in Section 5, and our perspectives are expressed in Section 6.

## II. RELATED WORKS

The global market serves as a large conduit for data flow, allowing businesses to get insightful and important understanding across a variety of elements, including client preferences, logistical issues, market potential, and current trends. This vast repository offers a nuanced breakdown of management and financial trajectories, identifying important players, typologies, applications, and current market dynamics. Despite these opportunities, many businesses, particularly small and medium-sized businesses (SMEs) and very small businesses (VSEs) struggle with the challenges of implementing the 4.0 paradigms. Therefore, any organization must conduct a thorough reflection of its activities across multiple dimensions to successfully navigate the 4.0 era. Setting clear, attainable goals that align with the organization's basic values is necessary before embarking on this transformative path. These objectives should be supported by a thorough plan that appropriately considers both the human and financial components. The definition of an acceptable strategy, along with skillful risk identification and mitigation, is equally important. Enterprises can successfully manage the complexities involved in the shift to the 4.0 paradigms by orchestrating this diagnostic procedure and skillfully embracing a finely designed plan. By doing this, they guarantee a smooth and effective transformation that is in line with their overall objectives.

### *A. Potentials of artificial intelligence*

Due to the increased possibility of errors, the size of an organization in the business world frequently correlates with the vigilance applied to invoice and supply management. These large-scale businesses have been evolving their resources over time, integrating AI approaches to enable workflow automation and information management. It is important to remember that the time between reaching a goal and implementing this automation determines the level of a company's maturity [14]. This artificial and digital transformation is inextricably linked to the emergence of Industry 4.0, an engine that is constantly transforming the global economy.

Several strategies have been developed to successfully navigate the multifaceted nature of contemporary management structures [15]. These systems struggle with the complexities that develop, such as producing unique things without sacrificing quality or driving up costs, when put in contrast with customer requests [16]. As a result, adaptability that is dynamic and focused on the needs of the client is essential for achieving management goals. Therefore, the need for intelligent management platforms become mandatory given the enormous

customization that Industry 4.0 advocates. These technological characteristics have been thoroughly investigated in the study literature [17, 4, 18].

The term "smart" describes how technical elements come together to create a perceptive environment that is capable of learning [19, 3]. The Internet has played a crucial role in business since the 1990s, culminating in the creation of the IoT." Due to this growth, businesses now have access to a wide range of intelligent technologies that promote quicker processing, greater efficiency, and adaptability. Information systems have become ingrained in the corporate fabric as a result of this realization, deftly utilizing cutting-edge approaches to build and maintain a smart management structure that functions within a digital environment and is defined by autonomy and synergy with Lean concepts [20].

Decision-making can be guided through complex analyses that eliminate the need for human involvement at every stage of the management spectrum, enhancing the benefits of smart management while also achieving cost and space efficiencies. Only 16.8% of organizations use an operational measurement system, and of those, less than half believe their indicator system is acceptable, according to a German study by Lichtblau and Stich [21]. As the business's scale grows, this promotes an ideology that emphasizes the growing demand for performance measurement and indicator systems, which is consistent with the progression of emerging technical advances.

However, there is little discussion of the practical applications and management 4.0 manifestations in the already available literature. The contours of smart management about real-time Big Data analytics (BDA) features are explained by Strandhagen et al. in their study [22]. For instance, streamlined routing, reduced storage requirements, real-time information sharing, and autonomously robotic systems for tracking, assessing, and decision-making all contribute to optimized inventory control. whereas Barreto et al. [4] explore how creative approaches and managerial paradigms can coexist. A revolutionary direction toward software-oriented management is also articulated by Timm and Lorig [23] as smart management.

### B. *Maturity Levels*

CMMI (Capability Maturity Model Integration) is a pioneering and important framework that heralds a fresh method for evaluating the maturity tiers in the Eastern Hemisphere. This approach, which the Software Engineering Institute (SEI) conceptualized and painstakingly created in the early stages of 2001, has caused a paradigm change in the field of evaluation. Process capability is given a careful classification by the SEI, a pioneer in the field of software engineering, and is defined along a granular six-level continuum. In parallel, the CMII model, an offshoot of this paradigm, painstakingly reveals a compendium of 25 different processes, each outlining a trajectory covering the full spectrum of states, including incompleteness, clearly defined articulation, tactical execution, diligent management, and comprehensive documentation, leading up in an apex of optimization. Following this, a rigorously defined five-level hierarchy has been created, symbolizing the inevitable process of business maturation: the initial stage, adaptive changes, systematic discipline, and wise management, with a continuous trajectory of perpetual optimization.

A flood of studies has been methodically analyzing the mechanics of measuring corporate performance within the confines of Industry 4.0's present context, which is characterized by its revolutionary impact on the industrial landscape. The idea put forth by Lichtblau, K. [21], who introduced the 4.0 Readiness Model in conceptual harmony with the CMMI, is noteworthy among these. This model reflects the complex stratification entrenched in CMMI, converging onto six escalating tiers of maturity: the foreigner, neophyte, medium, seasoned adept, skilled expert, terminating in the summit performer. The 4.0 Readiness Model throws a critical eye on six crucial areas: Policy and structure, Data-Based services, smart Operations, the smart factory, innovatively designed products, and employees, who play a crucial role in the workforce.

A comprehensive five-tier analysis model has been developed recently by scholars Haberer et al. [13] and is specifically designed for the field of EMS (Environmental Management Systems). To create a thorough diagnostic framework, a variety of

stratifications, including standardization, the use of big data, the application of smart data analytics, an introspective route into the world of the dark factory, and the overall scope of the industrial ecosystem, come together. The five unique and interconnected business areas covered by this evaluation structure are business management, growth, manufacturing, the management structure, and finally service supply, which serves as the foundation.

An intricate picture of how businesses traverse the shifting crosscurrents of industrial paradigms emerges from the furnace of these scientific endeavors. The wider direction of organizational growth comes into sharper focus as the CMMI and its conceptual competitors, like the 4.0 readiness Model and the EMS measurement structure, converge and diverge, exposing the complex relationship of process refinement, strategic movement, and continuous pursuit of excellence across the weaving of industrial fields.

### C. *The 4.0 Strategic Transition Areas*

Numerous academic studies have started a thorough analysis of the transformational repercussions sparked by Industry 4.0 breakthroughs in the field of management. These academic activities highlight the importance of adopting a broad perspective to fully grasp this profound upheaval by illuminating the many facets of this paradigm shift.

In-depth technological implications are explored by Barreto et al. [4], who expose their effects across a variety of operational terrains. They provide concrete examples of these effects in critical areas like scheduling, and strengthening data security. The Just in Time environment is explored by Hoffman and Rüsch [12], who shed light on the complex prospects that decentralization, increased efficiency, and self-regulation present in the context of Industry 4.0.

Concurrently, Tjahjono et al. [18] create a comprehensive framework for evaluation that takes into account the nuances of purchasing, shipping, sales dynamics, and warehouse operations. Their strategy adheres to strict technological standards and is in line with the principles of Industry 4.0. In a deft intellectual move, Blanchet and Bergerried [24] divide the characteristics of Industry 4.0 into six separate axes under the common canopy of World 4.0. These axes cover the areas of product-process design, control systems, manufacturing processes, services supply, the big data analytics environment, and the intricate web of work organization.

Additionally, Hermann et al. [11] deconstruct the fundamental elements that support Industry 4.0's transformational trajectory in a landmark contribution. The IoT, the Internet of Services, Cyber-physical Systems, and the development of Smart Factories are highlighted in their explanation as four fundamental pillars. They also elaborate on the fundamental ideas that must be diligently absorbed to plan a seamless integration of 4.0 services within businesses. These guidelines, which incorporate the ideas of virtualization, interoperability, real-time capabilities, decentralization, service orientation, and modularity, provide a road map for effective implementation.

In an intellectual triumph, Hankel & Rexroth [25] present the RAMI 4.0 (Reference Architectural Model Industrie 4.0), a complex three-dimensional design. The areas of functionality, business dynamics, communication networks, information infrastructure, asset management, and Integrated frameworks are the six key features that this paradigm simplifies the complicated orchestration of Industry 4.0. While doing so, Schumacher et al. [26] follow a thorough trajectory and present a novel maturity model. Their paradigmatic framework encompasses not only the technological details but also the intricate relationship of human and cultural factors inside the Industry 4.0 transformational landscape.

These academic endeavors form a fascinating journey into the complex area of management's impact from Industry 4.0. The academic mosaic demonstrates a profound grasp of this epochal transition as they weave together various aspects ranging from technical consequences to architectural structures, needing a full and holistic understanding.

## III. TRANSITION STRATEGY FORMULATION

Four unique realms of scrutiny have been identified following the all-encompassing

perspective held by organizations regarding the variety of difficulties they face. These areas act as crucial turning points in the growth of management that can lead to intelligent management. The intricate details of goods and services design, the sophisticated coordination of manufacturing and upkeep within the context of smart management, the definition of creative and strategic managerial paradigms, and the necessity to foster long-term organizational values serve as the foundational principles for this transformation.

The current study offers a thorough methodology and an extremely comprehensive diagnostic model that is rooted in these precisely defined areas of analysis. This dynamic structure serves to both catalyze and provide precision and clarity to the transformative process. It develops granular maturity stages and completely specifies the developmental axis' trajectories, acting as key checkpoints along the course of development.

### *A. Requirements for Smart Management*

The concept of smart management effectively combines data streams coming from linked sensors with other categories of processed data. It does this by embodying the concepts of autonomous self-organization and continual self-optimization. The smart management market's landscape is especially diverse, with a wide range of competitors and segments. Key stakeholders employ a variety of strategic strategies to assure the sustained direction of long-term growth and the improvement of their market standing. These cover a wide range of activities, such as growth initiatives, cooperative collaborations, synergistic partnerships, acquisitions of strategic assets, trailblazing new product releases, and numerous other tactical moves. It is essential to become adept at navigating the broad framework of smart management, which is eloquently explained within the scope of Fig.1, to gain a thorough understanding of the complex requirements that support the field. To assure a flexible, efficient, and customized service framework and to increase client satisfaction, several complicated systems have been painstakingly developed. The dynamics of smart management, which are evolving subtly, are keenly aware of the outside influences that promote change, particularly the trinity of consumer impact, competitive forces, and the constantly changing environment. Both management and its smart version, smart management, have their basis in the planned dissemination of information since they are based on a solid foundation of information flow.

The need for information generation is urgent, ushering visibility into the planning and control landscape within complex and scattered systems. AI and IoT remain significant technical advancement that opens up new opportunities for transparency and awareness, providing managerial undertakings with the necessary instruments for effectiveness.

Although challenging, the complex world of information processing continues to be a crucial component for advancing reasoned decision-making. For this goal, a variety of technological tools are at the ready. This toolbox includes a variety of tools that can be used to facilitate and speed up transaction processing, including cloud computing, decentralized platforms, expert systems, autonomous devices, algorithms for machine learning, and even blockchain technology.

Additionally, the emphasis on the paradigm of information's function during task completion cascades down a spectrum of complexity. Here, information functions to both enable and guide autonomous systems. However, in complex planning projects, human input is still necessary since knowledge provides the framework for good decision-making processes. The "XaaS" approach, where information plays the role of a service and is provided and consumed as a crucial component of operations, also resonates with this paradigm.

Smart management encompasses a wide range of technologies, goods, services, organizational dynamics, and intricate networks, extending its revolutionary power beyond simple operations. This all-encompassing perspective stimulates an improved lifetime trajectory, which leads to the smooth adaptation of solutions to exactly match the shifting landscape of client requirements. Notably, employees, revered as the fundamental human component, enjoy the numerous benefits brought forth by wise administration. These benefits are felt in the areas of productivity, motivation, and ergonomic effectiveness, collectively ushering in a more sophisticated way of carrying out work.

The discipline of smart management is positioned to be the pinnacle of efficacy and quality, a concerto of optimal resource use woven with the demands of speed and economy. It unfolds a story in which technology, information, and human dynamics are intelligently orchestrated to cohere in an environment of adaptive excellence.

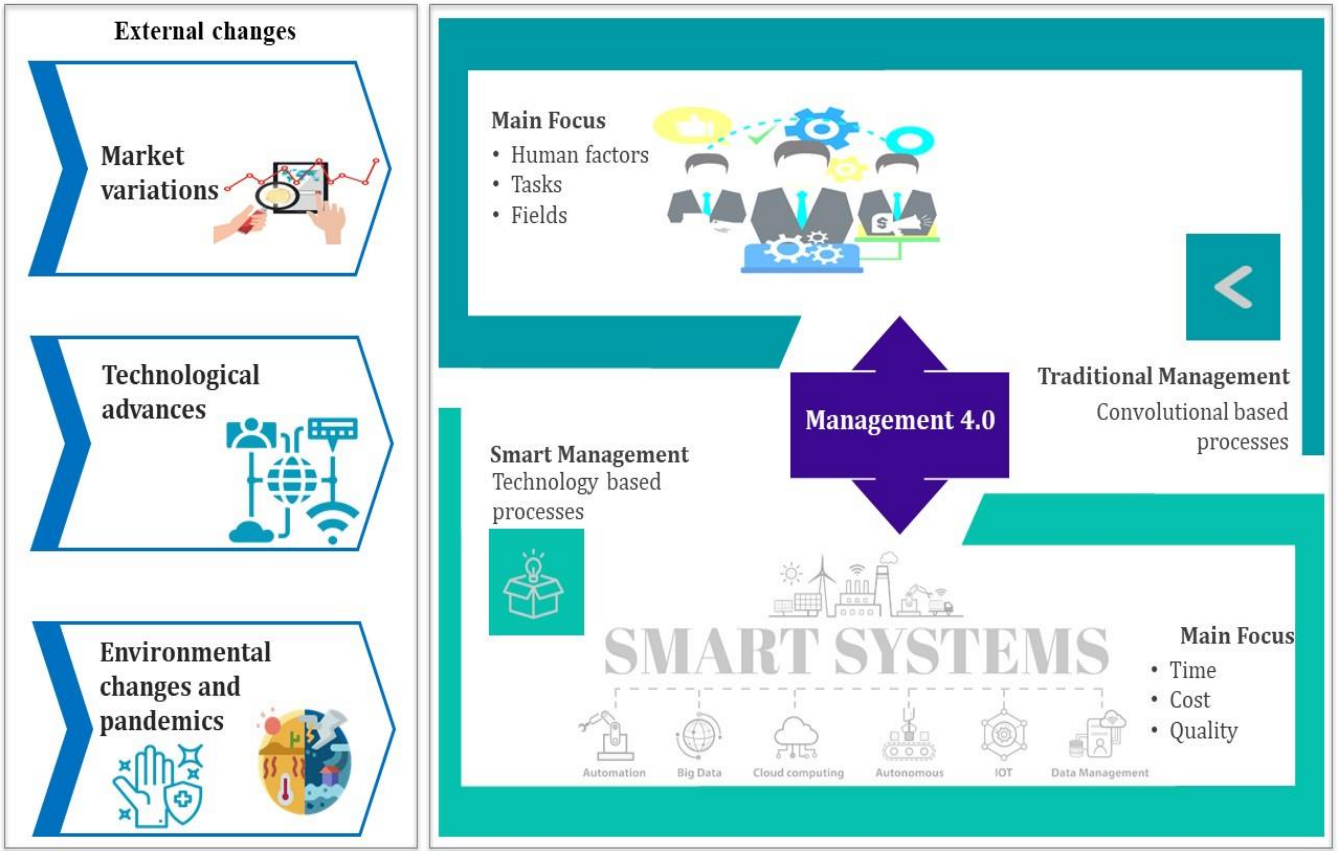


Figure. 1. A straightforward presentation of the smart management framework

### B. *Transition procedure*

The PDCA (Plan-Do-Check-Act) technique, which is wisely based on the Deming wheel [27], has been strategically adopted in the quest to ensure a smooth transition toward the field of smart management. The PDCA model is a symbol of the philosophy of constant management quality improvement. This approach reveals a methodical approach to identifying and putting into practice progressive approaches for enhancing quality within an organizational or corporate context.

The PDCA construct is a well-planned series of four iterative phases, each of which flows into the next to create a positive cycle of knowledge expansion. Its primary goal is to create a continual trajectory that continuously improves the standards for goods, services, and managerial dynamics:

• P: Plan ➔ The "Plan" step, which denotes the stage of preparing and planning, involves the definition of broad objectives, prioritization, creation of an action plan, formation of metrics for measuring success, and distribution of crucial resources.

• D: Do ➔ Plans are turned into actions at this phase, and the "Do" stage involves carrying out and realizing the painstakingly created action plan that was outlined in the previous stage.

• C: Verify The "Check" facet, which includes the critical verification phase, examines the effectiveness of carried-out operations in

comparison to the expected results. It acts as a pivot point for determining deviations through a side-by-side comparison of the "Plan" and "Do" phases.

• A: Act ➔ The "Act" part perfectly captures the proactive nature of adaptation and response. To continue the cycle of constant advancement, it drives the responsive adjustment of tactics based on the knowledge gained during the "Check" step.

Following the PDCA cycle to the letter appears as a crucial requirement for success. The approach acts as a watchdog against stagnation, particularly preventing the loss of momentum after the "Do" phase. The "Check" and "Act" stages are the foundation of ongoing improvement, and they contain the key to sustainable progress. Validating the achievement of desired results, correcting aberrations, and—most importantly—assimilating the refined knowledge to sustain a roadmap of continual improvement are all crucial pursuits in this situation.

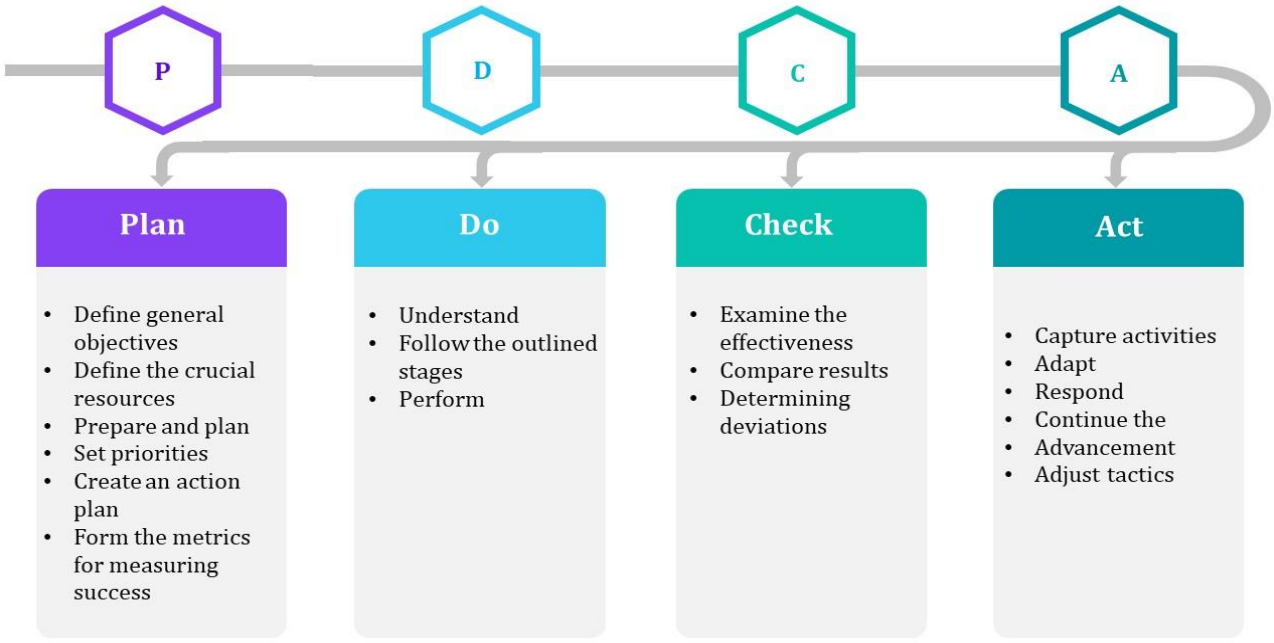


Figure. 2. Transition methodology

The following is a comprehensive outline of the complexities and ultimate goals of our transition:

- Plan: During this first stage, the compass of goals is painstakingly defined, embodying the fundamental tenets of smart management. These goals are planned out in a well-ordered hierarchy that is deliberately in line with the overall business strategy. This stage creates a crystal-clear plan that supports the transition effort and painstakingly outlines requirements, objectives, and expectations. It acts as a lighthouse to illuminate the path of the business' evolution, which is connected to the progression of the continuum of smart management.
- Do: In the following step, a diagnostic tool is introduced and put into action. This tool was carefully designed to enable a smooth transition toward smart management. This tool uses a multi-pronged strategy that includes:
  - Accurate assessment of the maturity scales, which accurately measures the depth of the business's knowledge.
  - Careful consideration throughout the process evaluation is required due to the conscious identification of the critical spheres.

- The assessment axes for each field are precisely defined, providing a thorough outline for an extensive examination.
- Thorough examination and the use of technology tools, strategically positioned to speed up the transition process.

- Verify: This phase takes on the role of validation and essentially validates the company's stance about the multifunctional transformation domains. Identifying and confirming the gaps between the desired state and the current status quo entails a comprehensive examination of each axis fundamental to the areas undergoing metamorphosis.

- Act: The final stage of this iterative cycle necessitates the creation of a concrete action plan that has been painstakingly outlined and prioritized for both the main smart management framework and each of its links. The action plan is prepared to release a cascade of practical actions, each calibrated to improve the enterprise's wisdom and coordinate an effortless transition into the world of smart management. This stage stands as a tribute to the meticulousness underpinning the transformation.

This transformational process as a whole is a model of meticulous technique that was carefully organized to accelerate the organization's transition to an intelligent management paradigm.

## IV. DIAGNOSIS OF TRANSITION APPROACH

We provide a complex diagnostic tool and conceptual framework, which successfully integrates the requirements inherent in the shift to the 4.0 paradigm with the complex stratum of maturity levels characteristic in the field of smart management. The contours of our suggested model place a comprehensive approval of data management in the center, which is clarified by careful customer-centric concerns, sophisticated lifecycle management guidelines, the human scale, and a discerning investigation of environmental dimensions. The strategic integration of technology that operates as the real foundation for guiding management practices toward an intelligent, morally sensitive, and sustainable trajectory is also highlighted by this holistic architecture.

### *A. Maturity Levels for smart management 4.0*

The core of our strategy is based on a comprehensive understanding of the crucial issues entailed in the 4.0 transition, an environment where the weave of smart management reaches the pinnacle of maturity. Together with this, our diagnostic tool displays its strength, acting as a compass that skillfully navigates through the various labyrinths that are present in both the revolutionary transition and the ever-changing development of smart management.

The organization of a complex data environment, where numerous factors interact to influence the development of management intelligence, is at the core of this paradigm. By implementing comprehensive customer-centric investigations, we gain knowledge that is in tune with the dynamics of the market, producing a strategic roadmap for effective decision-making. An arrangement that synchronizes the evolution of the product with the requirements of intelligent management is orchestrated by the strategic vision of product lifecycle management, which complements this.

As a result of the complex interactions between human labor and the management tapestry, the human component, an essential nucleus, takes center stage. This crucial aspect recognizes the critical connection between individuals and overarching organizational goals, which is in line with the philosophy of responsible and sustainable management.

Our model also recognizes the mutually beneficial connection between managerial acts and their ecological consequences, casting a critical eye on the complex web of environmental dynamics. As a result, the main focus of our approach is the thoughtful integration of cutting-edge technology, ushering in a pantheon of tools that together represent wise, moral, and sustainable management practices.

Our suggested diagnostic tool and model is a paradigm-shifting bridge that smoothly connects the diverse domains of the 4.0 revolution and smart

management maturity. Data-driven insights, holistic lifespan management, human-centered dynamics, responsibility for the environment, and technological prowess all work together to create a revolutionary ecosystem of management excellence.

A prudent approach to management requires separating management endeavors into separate subsystems: planning, manufacturing management, logistics management, or further management services. Infusing the idea of smart management in this transitional framework is a straightforward path for enhancement. Particularly, the lifespan of operational features can be greatly extended by the seamless incorporation of responsive mechanisms, in which equipment recognizes and tracks system aberrations and makes real-time modifications.

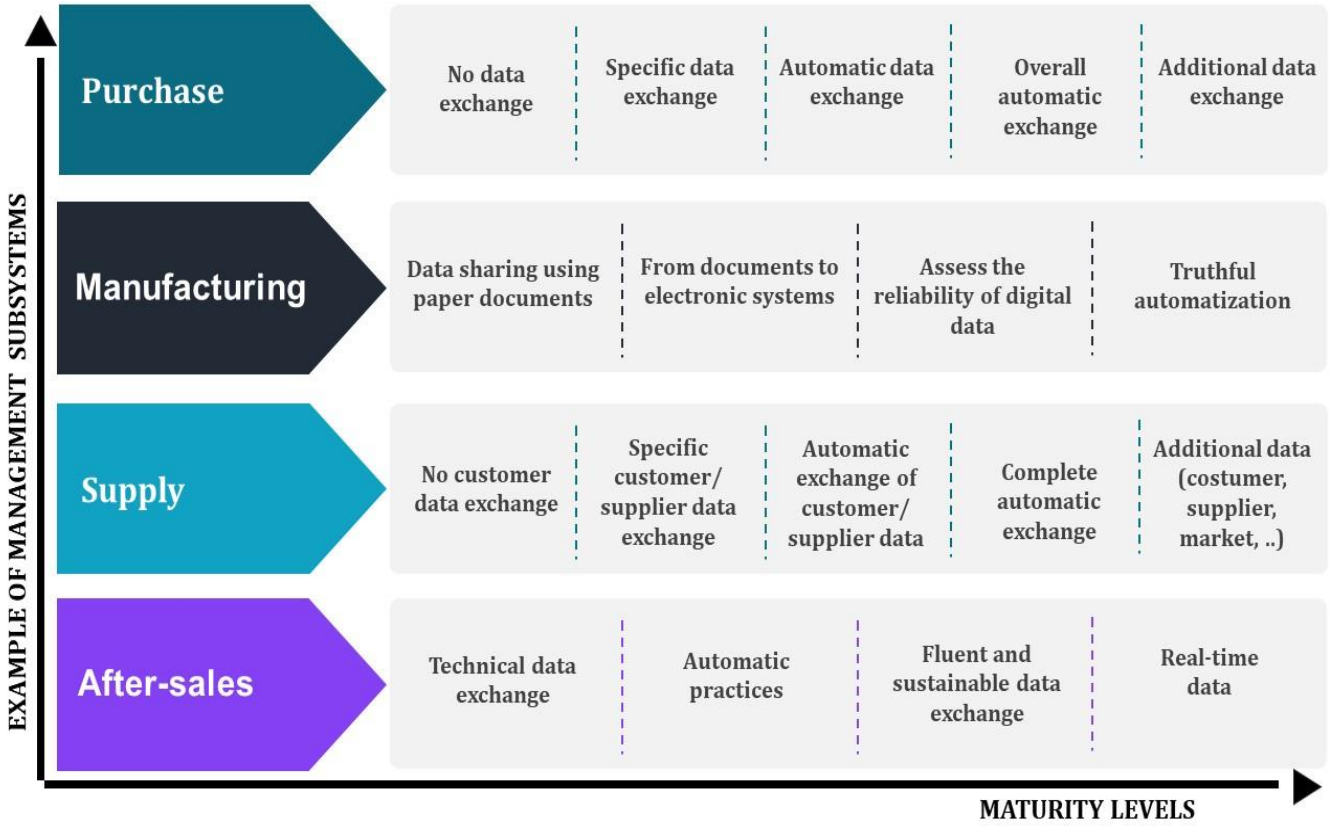


Figure. 3. Example of Maturity levels for Management 4.0

In this context, the presented adjusted maturity levels stand out as a powerful witness, representing a wide range of characteristics inherent in the field of smart management. This paradigm shift foresees the possibility of shaping a future management landscape with increased efficacy and resilience. Figure 3 highlights a demarcation of the many levels of maturity, precisely measured for each sub-system covered inside the smart management framework, providing an illuminating panorama. In essence, the recommended maturity stages act as a guidepost, directing the metamorphosis toward an impending vista of innovative management organization.

The strategic division of traditional leadership into four distinct subsystems is important not only as a means for discerning the complex interaction of maturity levels in these processes but also as an essential underlying for the establishment of an intelligent and flexible smart management maturity model. A painstaking orchestration of the following critical factors, each organically affecting the roadmap of the envisaged transformation, underpins the design of such a model:

• Reactivity: A key characteristic is the capacity to quickly navigate through unanticipated disturbances by shortening the time gaps between operational tasks. The quick development of information technology, including data interchange, connectivity, and other advances, is the driving force behind this project. This responsiveness serves as the cornerstone for eliminating disruptions and minimizing negative effects.

• Agility: Across the whole management continuum, continuous adjustment of expenses and performance criteria is a fundamental component of the envisioned approach. This paradigm creates an agile organization that is ready to swiftly pivot according to the constantly changing external landscape, making it perfectly matched to the needs of the time.

• Collaboration serves as a key fulcrum in creating improved cooperation across stakeholders in the management matrix. A harmonious symphony of coordinated efforts is created by this collaborative synergy, which transcends individual silos to increase overall customer satisfaction.

• Integration: The integration prism, which focuses on the smooth synchronization of provider and distributor management paradigms, has fundamental importance. This orchestrated convergence enhances the orchestration of holistic management, allowing operations to run smoothly and maintaining the continuity of activities.

• Transparency: A key characteristic built into the paradigm is the achievement of total transparency across management processes. Throughout the accurate information cascades, ensuring an unimpeded vision that crystallizes into well-informed judgments and actions.

• Intelligence: The development of intelligence as a discriminating tool for quick and pertinent decision-making is a fundamental aspect pervading the model. Through the skillful incorporation of chips and sensors in intelligent objects, real-time insights spread across all levels of the company and its cooperative partners, harmonizing diverse information shards.

• Sustainability: Three cardinal pillars—edifices, transportation, and waste management—underpin the sustainability paradigm, which weaves a robust and environmentally friendly framework around the management structure. These elements combine to give the management continuum an enduring spirit of ecological management, optimizing resource utilization, reducing energy waste, and promoting group well-being.

The clarification of these characteristics reveals a carefully designed roadmap for the advancement of smart management. This holistic construct serves as both a strategic entryway to a future adorned with agile, clever, and sustainable management methods as well as a witness to the evolution of management.

### *B. Diagnosis model*

We present an all-encompassing global model (shown in Fig.4) in a determined attempt to promote a smooth transition toward smart management. This all-encompassing paradigm acts as a nexus, bringing together the full range of previously clarified maturity levels. Its main goal is to make it possible to carefully choose the areas that require improvement and to strategically plan out the necessary tactics. This dynamic model serves as a useful roadmap, orchestrating a course where management activities mesh amicably with the needs of the major stakeholders and the uncovered requirements of the end user.

Our proposal, which is based on the incorporation of maturity models drawn from the canon of academic discourse, reveals a complexly stratified quintet of maturity tiers, calibrated to support the diagnostic architecture in the "OD" (Organizational Development) stage of our thorough methodology:

• Ignoring: This emerging echelon gives a caring embrace to novices setting out on the transforming voyage, where the developing investigation of priorities promotes the renunciation of incidental matters.

• Defining: The first step in the transition journey is the creation of a clear blueprint that outlines solutions, resources, and technology conduits that have been painstakingly designed to trigger a sophisticated transformation. The information processing approaches are where this evolution starts to take off.

• Adopting: At this point, technological techniques relevant to information processing are being put into practice. This includes the purposeful incorporation of cutting-edge tools like Blockchain, AI, cloud computing, and the Internet of Things (IoT). The diverse collection of cutting-edge materials has been adapted to the needs of the company's industry.

• Managing: This stage handles the dynamic management of flows, solutions, and procedures, coherently integrated to permit a harmonious integration of all aspects inside the management system. It is located at the center of strategic orchestration. A synergetic operational environment is ensured by seamless interfacing.

• Integrating: The integrated realm, at the top of our maturity spectrum, acts as a testing ground for the effectiveness and consistency of implemented and linked solutions. It is evidence of the organization's steadfast dedication to ongoing innovation and a testament to its ongoing quest for improvement.

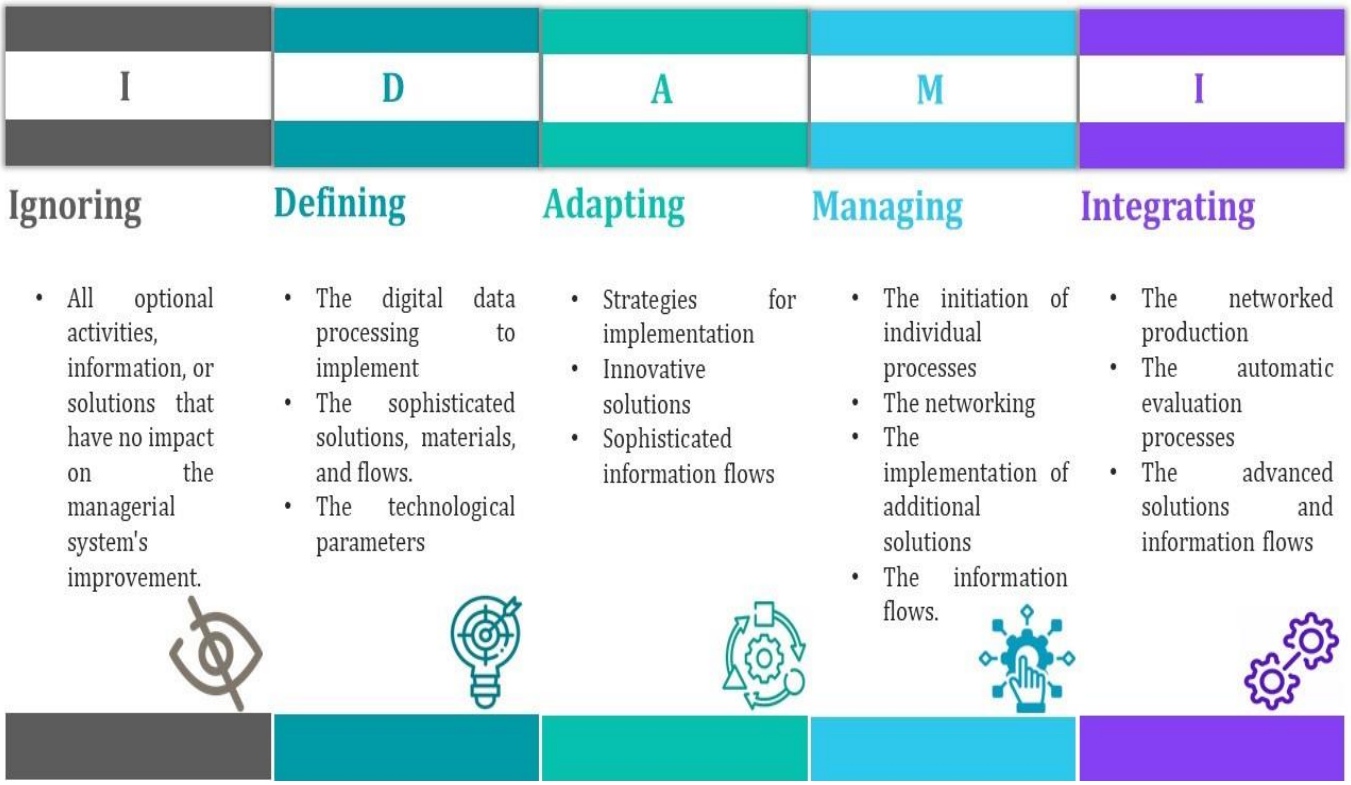


Figure. 4. A maturity model for smart management

Maturity models are widely used in a variety of industrial sectors and act as unstoppable catalysts for efforts to improve processes continuously. Our painstakingly designed process management paradigm upholds the lofty goal of improving organizational performance and is a beacon of revolutionary efficacy. This complex model, which is highlighted by its thorough maturity level calibration, emerges as a roadmap, guiding enterprises over the challenging terrain of changing from traditional management concepts to the dynamic weave of smart management. Herein lies the promise of increased effectiveness, efficiency, and the age-old spirit of invention.

### C. *Strategic decision assistance*

As a tool for strategic management, diagnosis plays a crucial part in examining an organization holistically and revealing aspects of its performance. Its scope goes beyond simple self-reflection and includes an objective, practical analysis that acts as a compass for understanding the web of

organizational dynamics. This rigorous analysis, which is grounded in impartiality, provides a wide-ranging canvas filled with minute details. The foundation for defining objectives and areas deserving wise intervention is this dossier of insights. This orchestration is represented by a trio of crucial goals that are supported by an organizational diagnostic approach:

Company Maturity Assessment: The accurate assessment of the company's maturity, which shines a bright light on the breadth of its evolutionary journey, serves as a vital benchmark for the diagnostic trip. This expansive view offers an unbiased assessment of the organizational structure, highlighting the areas where maturity has reached its pinnacle and those that call for careful nurture.

The second aspect navigates the complexities of individual industries and fields, whose specific altitudes of maturity cut into relief. This detailed viewpoint breaks down the organization's overall continuum and reveals the various maturational gradients that come together to form a unified whole.

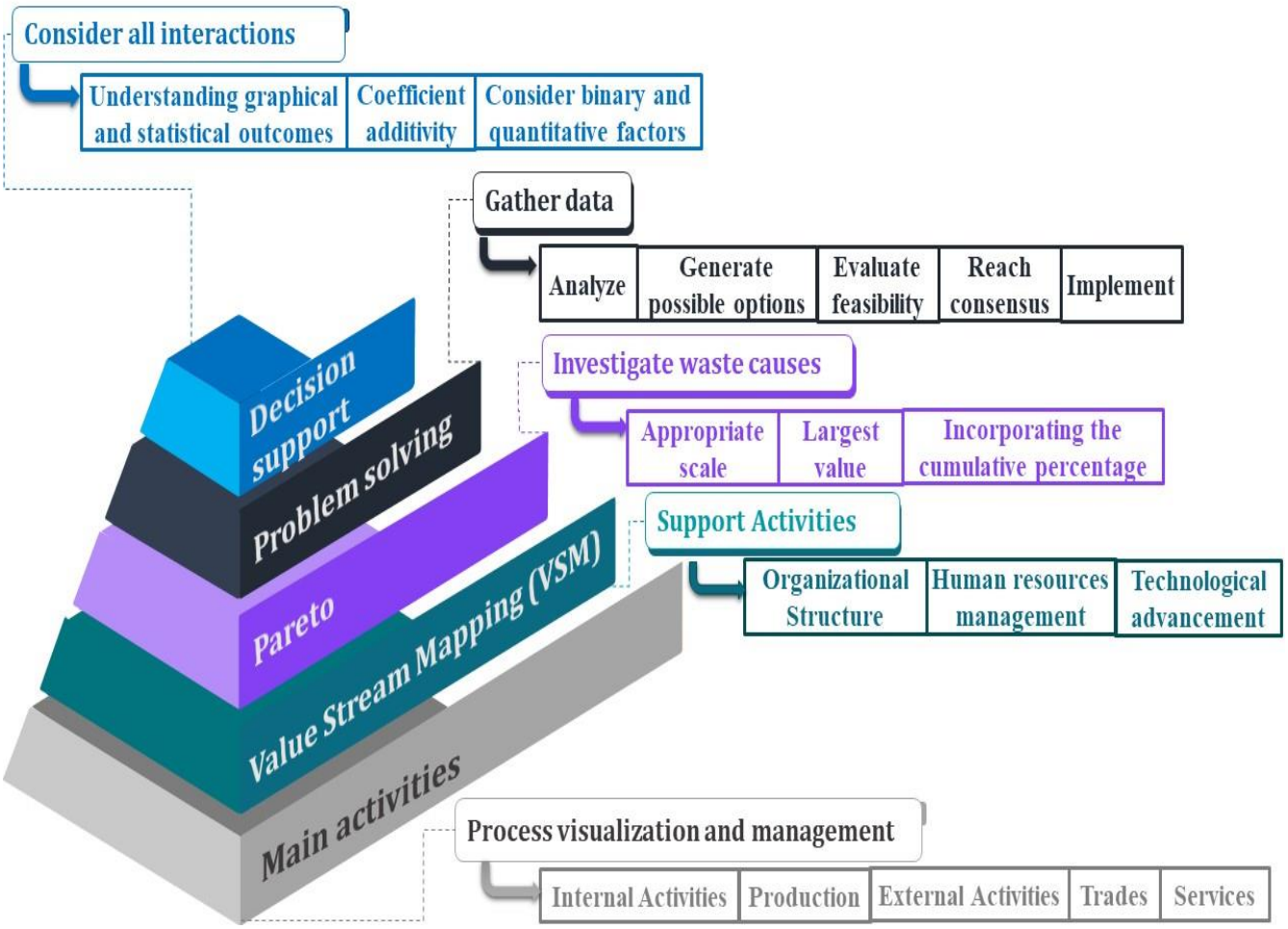

Figure. 5. The suggested strategic decision support

Creating the Action Plan Agenda: The creation of an action plan agenda, which serves as a guidepost for future corrections, is an essential component in this epistemic structure. This prophetic plan of action describes a prophetic path of action, containing the necessary interventions required for guiding the firm toward improved performance. It functions as a guide for transformative activities.

Our methodology develops its acumen in the furnace of methodology evaluation through the lens

of decision support plans, creating an intersection involving visualization, maturity examination, and wise problem-solving. This triangular alliance employs decision tree approaches' dynamic synergy and harnesses their computational strength to identify the best course of action. It grants the ability to handle unforeseen circumstances, unfold the picture of how processes interact, and bravely navigate the complexities of decision-making. Through this sophisticated dance, the strategy not only makes it easier to identify the current maturity levels within each axis but also sheds light on the path toward desired outcomes.

The orchestration of a thorough diagnostic strategy, which combines the fields of evaluation, prognosis, and strategic orchestration, beckons as a crucial fulcrum of management progress. Its unstoppable goal, to reveal the organizational ensemble's quirks and prepare the canvas for transformative embellishment, emerges amid the complexity matrix.

Motivated by the notion that thorough analysis is the source of improved management effectiveness, our attempt unfolds as a complex triad, linking the requirements of wise decision-making, as described in the framework shown in Fig. 5. Value Stream Mapping (VSM), Pareto Examination, and Decision Trees are the three steps that make up this strategic architecture.

Value Stream Mapping (VSM), the first pillar of this trifecta, [28] crystallizes the entire process experience into a coherent narrative that is understandable even to people who are buried within the complex maze of the process itself. It unfolds a panoramic canvas using an understandable graphical representation, capturing the current situation and creating a realistic tableau. VSM, which is based on cooperation, promotes a participatory discourse in which stakeholders share their perspectives and suggest changes, helping to create the framework for a workable plan. The concept of lean management is ingrained in VSM, which reaches its pinnacle in process improvement. A taxonomy that divides process activities into three cardinal categories—value-adding, non-value-adding (yet required), and waste—underpins VSM's transformative effectiveness. The maturity model's category delineation, which serves as its pivot, crystallizes process priorities and acts as a compass for the move to the realms of smart management.

Pareto Analysis [29], the second pillar, appears as a dependable beacon, guiding the path to ideal problem-solving. It orchestrates a symphony of targeted actions by carefully sorting through the causes to isolate the key factors from the web of effects. The Pareto diagram's history is one of a painstakingly planned project including a variety of stratagems:

- Organizing the variety of causes of waste: The first step entails painstakingly determining and categorizing a wide range of aspects that lead to trash formation. These variables may include a wide range of topics, including resource management, consumption patterns, production processes, and disposal techniques.
- The pertinent information is structured and separated into discrete arrays according to the indicated categories after the waste-causing causes have been found. This organized setup makes it easier to methodically identify and treat the many different causes of waste.
- revealing a well-considered hierarchy of categories in declining order: The components are first categorized, and then they are grouped hierarchically in descending order of importance or influence. This hierarchy provides a fundamental structure for allocating resources and efforts to solve the most significant waste-contributing elements.
- Discover cumulative data values: A detailed picture of the overall impact of waste-causing variables is obtained by adding up the data values in each category array. This process aids in comprehending the overall impact of different elements within each category.
- Estimating the % allocation for each category: The amount of waste that can be specifically assigned to each category is calculated as a percentage of the total garbage. The relative importance of each

aspect in the waste creation process is revealed quantitatively by this.

- Composing the cumulative ratio: The individual percentages are gradually added up to produce the overall percentage of waste that is ascribed to each category. The distribution of cumulative waste across several elements is fully viewed from this cumulative perspective.
- Choosing "Histogram" as the visual archetype, with the dominant facet on the left as the culmination: The graphical archetypal is a histogram, which has bars that indicate several categories and their corresponding frequencies or percentages. The most important waste-contributing factor's prominence is highlighted by placing it on the opposite side of the histogram.
- Drawing the cumulative % curve in peaceful coexistence: By showing the cumulative impact of waste components as the data points rise along the graph, a cumulative percentage curve that is overlaid on the histogram improves its graphical depiction. A dynamic picture of the waste rank and cumulative impact is provided by the interaction of the histogram and continuous curve.

Choosing a wise scale for graphical representation: To achieve accuracy and clarity, the scale for the visual representation must be chosen carefully. The best scale for clearly communicating the waste-contributing components can be determined by carefully examining the range and distribution of data values.

A careful routine follows in line with the Pareto theory, which states that only 20% of cases result in an astounding 80% of the waste. This requires giving the main contributing factors priority, which results in rapid and significant improvement. The use of the Pareto model appears as a tactical move to reduce anomalies and ensure the transition's flawless navigational trajectory. Such a tactical allocation helps to coordinate the orchestration of operations, creating an equilibrium that portends increased effectiveness.

Through the lens of Decision Trees [30, 31], a powerful decision support tool with a graphical veneer, the final arc of this triadic symphony is revealed. It manifests as an arboreal structure that encompasses the entire range of possibilities as it converges at the junction of options. Decision Trees appear as a potent talisman in the context of the shift to smart management, especially in circumstances ruled by convoluted complexity, where thorough options analysis predicates wise decisions. With the help of this transformative tool, a tapestry of possible possibilities is revealed, with each terminal node serving as a signpost for a likely outcome. It erupts as a dynamic hub for careful analysis, providing a hospitable environment for exploring numerical scenarios, encouraging reflective thought, and cultivating an incubator for knowledge sharing [32].

Our carefully constructed strategy follows a roadmap that begins with the comprehensive depiction of value streams using VSM, moves on to the detailed causal analysis using Pareto Analysis, and concludes with the persuasive exploration of options using Decision Trees. A blueprint for traversing an evolving shift from conventional to smart management, amidst a variety of dynamic organizational issues, is generated by this attempt, which unites into a cogent symphony resonating with strategic meaning.

## V. DISCUSSION

Our study's main goal was to operationalize and evaluate the applicability of a maturity model specifically designed for the complexities of smart management in the context of Moroccan businesses [33,34]. This project, which spans theoretical, managerial, and technical areas, basically takes a multifaceted relevance. By offering a deftly calibrated maturity model and simplifying the assessment of Industry 4.0 integration into management processes, this trailblazing work represents one of the first steps in digging into the complexities of shifting toward smart management [32].

This study offers insights into the revolutionary foundations of the 4th Industrial Revolution since they converge with managerial paradigms,

resonating as a seminal venture from a theoretical perspective. It outlines a conceptual path that navigates the intersection of cutting-edge technologies, including data-driven digitization, predictive analytics, and improved information security. As a result, it creates a theoretical pillar and establishes itself as a pioneering contribution to the investigation of the developmental path of smart management.

From a managerial standpoint, the study unfolds as an essential navigational compass, providing management entities with a strong instrument for evaluating their readiness for this disruptive period, especially those who are deeply ingrained in the areas of Industry 4.0. The maturity model equips businesses to conduct an introspective study, revealing hidden strengths and vulnerabilities. It serves as a discriminating meter. It becomes a tangible organizational asset that enables stakeholders to assess their existing situation, pinpoint key areas in need of improvement, and chart a course for increased operational effectiveness.

The investigation's technological conclusion is a thorough exposition that painstakingly distinguishes the different levels of maturity inside the smart management transition approach. To create an intelligent, flexible, and future-proof managerial landscape, cutting-edge technologies, including blockchain technology, machine learning, IoT, and data analysis, harmoniously integrate with this strategic plan. The study creates a solid plan through this thorough architectural demarcation, coordinating the incorporation of smart management's technical toolkit to enhance efficiency, data security, cost savings, and temporal efficacy.

Empirical findings support the project's enormous effects, which cut across industries. With the introduction of artificial intelligence (AI), a disruptive trajectory has been paved, with leading businesses experiencing significant profit increases of more than 5%. Only 10% of current systems use AI, so there is a sizable untapped market waiting for the strategic fusion of intelligent technology. This integration can be seen not only in process automation, where automated imitation of human behavior is common, but also within cognitive analysis, processing, and prediction powered by AI. The result is stronger mistake mitigation, time gains, and responsive maneuverability, which ultimately leads to improved management skills.

The complex interplay of timing and tool deployments emerges as a key factor in determining success and long-term competitive advantage in the tapestry of strategic initiatives. The ability to plot a long-term investment plan stands out as a key difficulty in the complex mosaic of emerging technologies. Resource allocation that is led by foresight, the deployment of tools in the right order, and frictionless user adoption serve as the pillars that determine whether investments result in the maximum returns, both numerically and qualitatively.

This document shines as an example of transformative potential within the Moroccan industrial environment, unfolding an arc of creative dynamism that connects with the country's goals for technological progress and economic prosperity. The study navigates the complex pathways of this industrial transformation, pushing it beyond theoretical considerations and into the domain of practicable tactics with an acute focus on Industry 4.0's horizons.

The meticulously developed methodology is a key component of this project; it is a multidimensional instrument that goes beyond traditional frameworks to create a unique design for the upcoming transition to smart management. This plan is analogous to an adaptable compass, calibrated to navigate the complex landscape of organizational subtleties while pointing in the direction of a more promising future. A strategic synergy that maximizes the fields of agility, effectiveness, profitability, and sustainability is made possible by each enterprise's ability to construct its roadmap, carefully honed to line perfectly with customer imperatives.

As this methodology takes hold, it transforms into a catalyst for change, melding effortlessly with the complex web of Industry 4.0's environment rather than just following the outlines of organizational complexity. This orchestration smoothly connects processes, innovations, and

human initiatives, moving through every stage from suppliers to end-customers like a roadmap leader synchronizing numerous instruments. The result is a seamless synthesis of technological orchestration and strategic refining, which realizes smart management in its most advanced form.

This coordinated orchestration, infused with Industry 4.0 principles, represents a paradigm change that encourages a comprehensive reevaluation of business operations, customer relationships, and economic sustainability. This convergence transforms smart management from an operational design to a corporate mindset that permeates all facets of a company, providing an evolving structure that pushes businesses past the boundaries of traditional business models.

The potential of Industry 4.0 unfolds into an intricate pattern of creativity and expansion at the center of this transformative journey. Each enterprise's journey is guided by a unique roadmap that has been created using a complex approach, with each milestone demonstrating the organization's strategic strength and adaptability. The journey of smart management transforms into a pursuit of excellence, driven by the inherent alignment with customer needs and the larger currents of technological evolution, with agility as its defining characteristic, efficiency as its foundation, revenue as its reward, and sustainability as its directing manager.

At the core of this revolutionary journey, the promise of Industry 4.0 emerges as a complex pattern of invention and expansion. Every firm has a distinct roadmap that has been developed utilizing a complicated methodology to lead its path, with each milestone highlighting the organization's strategy strengths and adaptability. Smart management's journey evolves into a pursuit of excellence, with agility as its defining trait, efficiency as its cornerstone, income as its motivation, and sustainability as its guiding manager. This pursuit is motivated by the related alignment with market needs and the broader currents of technological evolution.

The study lays a fundamental foundation, ushering in a period of significant change for the management discipline. This study advances businesses toward a time when smart management transcends a theoretical notion to take the form of a concrete, adaptable, and futuristic operational reality. It does this by fusing theoretical depth, managerial skill, and technology innovation. The study creates a design that resonates as an architectural magnum work, reinvigorating the fabric of modern management paradigms, through painstaking analysis, strategic structuring, and technology synergy.

## VI. CONCLUSION AND PERSPECTIVES

We have released a precisely designed and extensive maturity model that captures the essence of smart management within the confines of this study. We started by exploring the complex interactions between smart management and the revolutionary world of Industry 4.0. We then began a thorough investigation of maturity models, laying the groundwork for effortless integration of Industry 4.0 solutions into the world of management processes.

The combination of these maturity models with previous research has produced a fresh and effective methodology that examines the complex environment faced by management-centric organizations as they move toward adopting Industry 4.0 principles. Our methodology has emerged as a guiding light, exposing the problems, possibilities, and imperatives that drive the transformation toward smart management by penetrating the very core of the transition to the 4.0 paradigm.

Our efforts are prepared to explore each issue in unprecedented depth as our study's scope extends beyond the bounds of this article. This will result in a rich tapestry of insights drawn from empirical research conducted within Moroccan organizations. With this project, we hope to go beyond theoretical boundaries and ingrain useful answers into the very fabric of corporate operations. We anticipate providing a roadmap that not only handles the business-technology connection but also demonstrates the strategic stepping stones required to achieve and sustain willingness for the transformative journey of smart management by placing our methodology within the larger context of

real-world challenges encountered by Moroccan enterprises.

A convergence involving machine learning as well as maturity levels, which will amplify the dynamic outlines of our maturity model, is on the immediate horizon of our investigation. The ongoing development of smart management is ready to take on new directions as a result of this integration of machine learning technologies, taking it beyond the bounds of conventional paradigms and toward a future characterized by driven by intelligence agility, precision, and flexibility.

The trip taken in this paper is merely the prelude to a story of managerial transformation and technical development that is still in progress. Our developed model is no longer just a theoretical idea; it is now a practical tool that enables businesses to go beyond limitations and adopt the cutting edge of smart management. As we continue to improve our approach, delve deeper into empirical studies, and incorporate a multidisciplinary framework of innovation, we believe in an atmosphere in which smart management effectively coordinates with the cadence of the 4th industrial revolution, leaving a lasting impact on the course of business management for generations to come. Industry 4.0 discovers its peak within this coordination.

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