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DEFINING A SOFTWARE SOLUTION REQUIREMENTS FOR DOCUMENT MANAGEMENT IN PUBLIC ENTERPRISES: A METHODOLOGY OF ORGANIZATIONS REFRAMING INTO QUALITY - SMART PUBLIC ENTERPRISES

Abstract: *Enterprise sustainability in the era of the fourth industrial revolution necessitates a novel approach involving intelligent technologies and a new role for leadership within sustainability structures, aligning with trends in emerging smart technologies and the Society 5.0 framework. This paper examines the critical role of smart parking in promoting sustainability within public parking enterprises to enhance mobility in smart cities. Key processes, including leadership and technologies essential for smart parking managed by innovative public parking enterprises, are defined. The research analyzes trends, key facts, current states of innovative technology enterprises, and methodologies for designing and establishing smart public parking enterprises. The study aims to assess the current sustainability of parking enterprises by developing a model incorporating independent variables such as leadership level, intelligent technology usage, and business process quality and risk. The dependent variable is the sustainability of smart public parking enterprises. Indicators for each variable are evaluated using techniques such as questionnaires, statistical methods, and artificial neural network approaches. This framework envisions the transformation of existing public enterprises into sustainable smart public parking enterprises.*

Keywords: *Smart Sustainability, Quality of Business Processes, Society 5.0, Support Vector Machine.*

1. Introduction

In the current research community, the application of new technologies is increasingly associated with the concept of smart cities. Smart cities represent an achievement that has emerged with the advent of Industry 4.0 and the future Society 5.0 (Gonokami & Nakanishi, 2020). This concept began as a visual design of a people-centric society grounded in the merging of cyberspace and physical space. Viewing the smart cities concept as a complex structure comprising multiple pillars, it can be observed that one of the main pillars of smart cities is smart mobility. Its development involves many stakeholders, including urban residents, public management, automotive producers and suppliers, and research organizations such as universities and research laboratories. Smart

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mobility is primarily associated with intelligent and preferably electric vehicles, smartphone and vehicle integration, vehicle connectivity, and the consumption of electrical energy, exemplified by the smart grid. The new generation of vehicles can synchronize driver capabilities with the performance of multifunctional control devices in vehicles, facilitating the development of concepts such as autonomous driving, vehicle-to-vehicle communication, and vehicle/cloud integration. To support these advancements, specialized applications are being developed to meet driver needs, including automated driving features for parking, fuel supply, sightseeing, trip planning, and food service. Numerous applications of these developed platforms offer broader possibilities for comfortable, safe, efficient, and secure mobility. Nevertheless, despite its integration within the broader framework of smart mobility, transport, and logistics, smart parking necessitates ongoing refinement and adaptation. Its significance stems from the escalating demand for parking solutions in urban areas and large cities, where vehicle density is on the rise, posing a pressing challenge. Addressing this challenge entails the development of a novel business model that amalgamates traditional practices with smart solutions, taking into account factors such as existing resources, cost-benefit analyses, and the evolving needs of smart cities and regions.

1.1. Motivations and Aims of the Study

The motivation for this study stems from the absence of business models that effectively integrate classical parking processes with the evolving needs of smart cities and regions, alongside the emerging roles of intelligent enterprises that prioritize social responsibility and sustainability within the realm of smart public and private parking enterprises. The study aims to address the following research questions: (1) Can a viable business model be applied to parking services? (2) Is it feasible to evaluate the sustainability of public enterprises in Serbia, considering its status as a developing and transitioning country? and (3) Can determinants for the efficient transition from existing to smart parking enterprises be identified?

The proposed methodology encompasses various approaches, including Business Process Management (BPM) with conceptual modeling, assessment of business process quality, risk management, and the integration of smart and intelligent enterprise principles. Additionally, it utilizes diverse techniques and tools such as statistical methods, questionnaire design, indicator monitoring, and the Support Vector Machine (SVM) approach to evaluate the effectiveness of proposed and implemented changes.

The motivation for utilizing SVM alongside statistical methods arises from their effectiveness in predicting future values of dependent variables. SVM, as a contemporary method, has garnered increased attention due to advancements in computer technology, enabling more efficient computation of complex calculations associated with time series analysis and forecasting. Moreover, the ability to compare predictions obtained from SVM models enhances its appeal, providing researchers with valuable insights and facilitating informed decision-making processes.

1.2. Contributions of the Study

The methodological contributions of this study entail the development of a model for smart parking services, encompassing decomposed processes and characteristics, as well as the establishment of a procedure for transitioning conventional "closed" parking enterprises into smart parking entities. To model the business processes within smart public or private parking enterprises, the approach of business process modeling is adopted. This methodology involves decomposing the process into five distinct sub-processes: (1) monitoring payment for parking services at conventional parking spots, (2) managing payment for parking services at designated parking spots, (3) enforcement measures for unauthorized parking violations, (4) issuance of subscription parking cards, and (5) implementation of traffic signalization for parking areas. The interconnection of these processes is elucidated through a comprehensive decomposition presented in this study. The validity of the model is assessed through a case study focusing on parking services in Serbia, considered within the context of a developing country.

Practical contributions are further elucidated through a case study involving a public enterprise located in Central Serbia, demonstrating the feasibility of transitioning it into a smart public enterprise. The research findings serve to inspire relevant stakeholders to embrace and promote smart parking initiatives across other cities within the Republic of Serbia.

1.3. Organization of the Study

The structure of this research is organized as follows. Section 2 presents a comprehensive literature review covering key topics including sustainability, sustainability success, risk management, quality management, smart technologies, smart mobility, parking management systems, and smart leadership. Section 3 delves into the fundamental methodology employed for the development of smart public parking enterprises. Section 4 offers detailed insights into the results obtained from the analysis. Following this, Section 5 provides discussions on the findings and their implications. Lastly, the concluding remarks are presented in the final section.

2. LITERATURE REVIEW

The literature review is systematically structured into seven sub-sections to offer a thorough exploration of contemporary research within the realms dedicated to sustainability, leadership, and risk management. The final sub-section serves to delineate identified gaps in existing literature, thus highlighting areas warranting further investigation and scholarly attention.

2.1. Sustainability Review

In the 21st century, sustainable development has emerged as a crucial paradigm aimed at achieving a harmonious equilibrium between economic advancement, environmental conservation, and societal well-being. Haughton (1999) delineated key principles underpinning sustainable development, which include: (1) intergenerational equity, ensuring that future generations inherit a world of comparable or improved quality; (2) social justice across generations, promoting fairness and equity in the distribution of resources and opportunities; (3) transformative responsibility rooted in geographic equity, advocating for sustainable practices that benefit all regions and communities; (4) procedural equity, advocating for transparent and inclusive decision-making processes that treat all individuals fairly; and (5) interspecies equity, recognizing the intrinsic value of biodiversity and advocating for its preservation. This concept underscores the importance of "sustainable growth," emphasizing the need to balance economic progress with the conservation of natural resources and the protection of ecosystems (Hopwood, Mellor & O'Brien, 2005).

Drawing upon an extensive body of literature, Hopwood, Mellor, and O'Brien (2005) proposed a conceptual framework for mapping perspectives on sustainable development, delineated by two axes: (1) escalating environmental concerns, and (2) burgeoning socio-economic well-being and equality concerns. Within this framework, the authors identified three distinct zones: (1) the status quo, characterized by marginal improvements in ecological and natural resource management; (2) reformist approaches advocating for socio-environmental reform and collaboration between stakeholders; and (3) transformative paradigms focusing on holistic socioecological transformations, enhanced quality of life, and eco-socialist principles, among others. This framework offers valuable insights into the diverse viewpoints and strategies employed in the pursuit of sustainable development.

Developing countries prioritize economic sustainability within businesses by enhancing the capabilities of human resources, particularly within small and medium-sized enterprises (Hernita et al., 2021; Aladejebi, 2018). As the imperative for sustainable development continues to gain prominence, it becomes increasingly indispensable for all sectors, including businesses, educational institutions, environmental organizations, and researchers, to align their goals towards achieving sustainability.

2.2. Sustainability Success Review

Quality science profoundly impacts various facets of human life, including societal, economic, and environmental domains. A pivotal advancement in this realm is the pursuit of sustainable success, which entails the harmonization of sustainability principles with business prosperity. Numerous theoretical and practical models, such as the European Foundation of Quality Management (EFQM), have been devised to facilitate the identification and measurement of sustainable success. These models serve two fundamental purposes: firstly, to discern the key factors influencing sustainable success; and secondly, to benchmark an organization's performance against that of other entities in terms of excellence and success attainment. Additionally, standards such as ISO 9004 (Murmura & Bravi, 2017) and the EFQM Business Excellence Model (Escrig & de Menezes, 2015) have been developed by organizations like the ISO to delineate the characteristics and metrics of sustainable success. These frameworks play a crucial role in guiding organizations towards achieving sustainable excellence and fostering continual improvement.

Within ISO 9004:2009 (Amui et al., 2017), sustained success is delineated as the outcome of an organization's ability to consistently achieve and uphold its objectives over the long term. If we disregard the initial three clauses of the standard, which pertain to scope, norms, and terminology, the subsequent six clauses outline the detailed requirements of this standard. These clauses cover various aspects essential for achieving sustainable success: process management (clause 4), formulation of strategy and policy (clause 5), management of resources (clause 6), oversight of processes (clause 7), monitoring, measurement, analysis, and review (clause 8), and fostering improvement, innovation, and learning (clause 9). Annex A furnishes a self-assessment tool crucial for measuring sustainable success, while Annex B elucidates the principles of quality management, enhancing comprehension of the role of quality management in fostering sustainable success. This structured framework provides organizations with a systematic approach to continually improve their performance and ensure long-term viability.

In the context of the Industry 4.0 era, a framework known as Quality 4.0 has been formulated, drawing heavily from the EFQM model (Nenadál, 2020). This model is structured around five core components termed enablers: (1) leadership, (2) people, (3) strategy, (4) partnership and resources, and (5) processes, products, or services. Additionally, the model incorporates results in the form of (6) people results, (7) customer results, (8) society results, and (9) business results. In the context of Industry 4.0, all elements of this model hold significance; however, particular attention is directed towards leadership, individuals equipped with new knowledge, intelligence, and motivation, strategic initiatives featuring novel business models, and forging new partnerships with technologically advanced firms. These components are perceived as crucial drivers for navigating the complexities of the Industry 4.0 landscape and fostering organizational success in this transformative era.

In the study conducted by Fonseca, Amaral, and Oliveira (2021), sustainability is integrated into the EFQM model across multiple clauses. Specifically, sustainability principles are addressed in clause 4, which focuses on creating sustainable value, as well as in clause 5, which pertains to driving performance and transformation. Additionally, stakeholder perceptions related to sustainability are considered in clause 6, while strategic and operational performances aligned with sustainability goals are examined in clause 7.

The EFQM model introduced in 2020 encompasses a total of 23 criteria segments, with 600 points allocated for assessing direction and execution, and 400 points designated for evaluating results (Murthy et al., 2022). This comprehensive framework facilitates a thorough evaluation of organizational performance, with specific attention given to sustainability-related aspects across various dimensions of operation and outcome.

2.3. Risk Management Review

The literature offers a multitude of definitions for the concept of risk, reflecting the diversity of perspectives within various research domains. One interpretation views risk as an uncertain alteration in future values within a given system (Wu & Olson, 2013). Another perspective defines risk as a metric representing the potential occurrence of unfavorable events, necessitating a careful consideration of the pros and cons associated with potential outcomes (March & Shapira, 1987). These differing definitions underscore the multifaceted nature of risk and highlight the importance of understanding and managing it across different contexts.

Within the literature, risks are categorized according to various criteria, providing insights into their diverse nature and origins. Perry and Hayes (1985) proposed a classification based on the source of risk, delineating categories such as physical, environmental, design, logistical, financial, legal, political, construction, and operational risks. Sari, Pujotomo, and Wardani (2017) expanded this framework by distinguishing between disease risks, economic risks, environmental risks, financial risks, human risks, natural hazards, health risks, occupational safety risks, product suitability risks, professional suitability risks, property risks, general suitability risks, and technological risks. Batkovskiy et al. (2016) focused specifically on risks inherent in business-production systems.

Considering the origin of risks, they can be further classified as external, stemming from factors such as competition, customer unavailability, emergence of new technologies, government behavior, and shifting consumer trends. Conversely, internal risks may arise from business losses or obsolescence.

Another criterion for risk classification is the degree of predictability, which stratifies risks into predictable, partially predictable, and unpredictable categories. Furthermore, risks can be delineated based on the stage of their origin, distinguishing between risks associated with selecting a business concept (e.g., risks related to marketing strategies or new product introductions) and risks arising from changes in the business concept (e.g., operational management risks or risks stemming from poorly executed business strategies). This comprehensive classification framework offers valuable insights into the multifaceted nature of risks across different domains and stages of business operation.

In risk literature, a fundamental concept that garners significant attention is risk assessment. Despite its widespread application across various industries, the precise definition of risk assessment remains elusive (Pinto, 2014). Many scholars advocate for the quantification of risk as an integral component of risk assessment (Marhavilas, Koulouriotis & Gemeni, 2011). Historically, risk assessment relied heavily on statistical analysis; however, contemporary perspectives emphasize a proactive approach to risk assessment, urging for the integration of risk management strategies into organizational management frameworks.

Recognizing the importance of informed decision-making based on risk-related information rather than the consequences of risk, an increasing number of researchers and executives are focusing on identifying critical risk factors, particularly in resource-constrained environments (Song, Ming & Liu, 2017). The factors contributing to the occurrence of risks are diverse and multifaceted. Research in the field of risk assessment underscores the significant influence of these risk factors, underscoring the need for their careful consideration (Mabrouki, Bentaleb & Mousrij, 2014; Caputo, Giannini & Paolacci, 2015; Bounit et al., 2016). This body of knowledge serves to enhance our understanding of risk dynamics and informs strategies for effective risk management in organizational settings.

2.4. Quality Management Review

A fundamental aspect of quality science involves adopting a quality management approach, which adheres to the principles of designing, executing, measuring, controlling, and improving quality within organizational processes. This approach is often structured around the well-established PDCA (Plan, Do, Check, Act) cycle.

Shtub and Karni (2010) elucidated the fundamental concepts of enterprise process modeling, with a specific focus on business processes. These processes can be decomposed based on standards such as ISO 9001:2018 (Fonseca & Domingues, 2018) or specifications provided by organizations like the American Productivity & Quality Center (APQC) for various sectors or associations (Hinkelmann et al., 2018). These sectors may include supply chain management (ISO 26000), enterprise resource planning (Chofreh et al., 2020), product life cycle management (Liu et al., 2020), community extension (Mapiye et al., 2021), resilience management (Massaro et al., 2018), among others.

According to APQC (Hinkelmann et al., 2018), the general process classification framework comprises the following categories: (1) vision and strategy, (2) product and service development and management, (3) product and service marketing and sales, (4) product and service delivery, (5) customer service management, (6) human capital development and management, (7) information technology management, (8) financial resources management, (9) acquisition, control, and property, (10) environment, health, and safety management systems, (11) external relationships management, and (12) knowledge, improvement, and change management. This structured framework provides organizations with a comprehensive approach to managing and improving quality across various aspects of their operations.

In the era of Industry 4.0, the concept of quality management is reimagined through the lens of Quality 4.0, as proposed by Jacob (2017). Quality 4.0 extends traditional quality management principles into three key domains: technology, people, and processes.

Firstly, within the realm of technology, Quality 4.0 incorporates advanced tools such as data analytics, application development, connectivity, and scalability to enhance quality management practices. Secondly, in terms of people, Quality 4.0 emphasizes the importance of collaboration competence, effective leadership, cultural alignment, and regulatory compliance in driving quality initiatives forward. Thirdly, regarding processes, Quality 4.0 introduces innovative management systems that integrate smart technologies across all operational processes, promoting efficiency and effectiveness.

Moreover, Quality 4.0 encompasses various contemporary management initiatives, including supply chain management, customer relationship management, and enterprise resource planning, within an e-based quality management system. This system comprises autonomous and interconnected processes spanning risk compliance, improvement management, audits, monitoring, production, external processes, development, and requirement engineering. By embracing Quality 4.0 principles, organizations can adapt to the demands of the digital age and achieve higher levels of quality and efficiency in their operations.

2.5. Smart Mobility and Parking Management System

Innovative technologies represent a relatively recent phenomenon, with varying emphasis on different smart technologies across diverse sectors. Wang and Wei (2019) outline six pillars of intelligent manufacturing, encompassing material, data, productivity, sustainability, resource sharing and networking, and manufacturing technology and processes. These pillars are underpinned by intelligent technologies, such as additive manufacturing, robotics, sensors, and automation processes, which play pivotal roles in advancing technology and processes within manufacturing.

Smart mobility harnesses smart technologies to enhance mobility, safety, and cost-effectiveness. Recent advancements enable vehicles to address various business needs, including searching for information or controlling home smart devices from within the vehicle. Concepts like autonomous driving, vehicle-to-vehicle communication, and vehicle-to-cloud integration have emerged, facilitated by specialized software tailored to driver requirements. Smart mobility remains in a developmental phase, buoyed by initiatives like the Smart Transport Middleware (STM) project. STM focuses on data collection from external sources, collaboration with alternative nodes, and proactive intelligent system integration, leveraging various smart technologies within the Internet of Things (IoT) paradigm.

In the realm of smart logistic transport, integration occurs among network providers, device providers, payment providers, transport services, and application clients. An intelligent parking management system is integral to smart mobility/logistics, comprising client-server communication via IP network. Real-time data collection via parking sensors, processing through sensor-cloud interface, TCP/IP protocol deployment, and database connectivity are key components of smart parking IoT implementation. The architecture of parking booking systems involves interactions between vehicles, mobile devices, dedicated applications, and hardware components like GSM modules, LCDs, servo motors, and sensors, facilitating seamless communication and efficient parking management.

2.6. Smart Leadership Review

Smart leadership represents an evolution of traditional leadership paradigms tailored to meet the evolving needs of smart enterprises. Corbett (2021) conducted a statistical analysis to discern shifts in leadership paradigms, highlighting the necessity of adopting new models in the contemporary era.

Building organizational leadership capacity is essential for effective smart leadership (Kolzow, 2014). Furthermore, the integration of digital smart technologies plays a pivotal role in fostering leadership within smart cities and enterprises (Popov, Semyachkov & Popova, 2020). Sydänmaanlakka (2003) delves into the concept of intelligent leadership, framing it as a collaborative dialogue between leaders and followers aimed at realizing shared visions and goals within a cohesive organizational culture.

Information Communication Technologies (ICT) serve as enablers of smart working environments for leaders and followers, facilitating virtual exploration, interaction, and learning interfaces within knowledge management systems (Laudon & Laudon, 2011). The leadership role within the ICT domain is multifaceted, encompassing strategic leadership, ICT leadership, team leadership, and self-leadership. Laudon and Laudon (2011) delineate the domains of ICT leadership, which include crafting ICT visions, strategies, and plans for business continuity and change support. ICT leadership operates across governance, top management, and executive levels, entailing the assessment of informational architecture and the formulation of operational plans and budgets to gauge leadership effectiveness.

2.7. Research Gaps

The transition from traditional public enterprises to smart public enterprises remains relatively underexplored in the existing literature, with limited discussions on the methodologies and pathways involved in this transformation. Additionally, there is a notable absence of decision-making criteria and indicators that could effectively delineate the extent of transition from traditional to smart public enterprises.

This study aims to address these gaps by identifying key variables crucial for assessing the integration of smart technologies within traditional public enterprises. By identifying these variables, the study seeks to furnish stakeholders with the necessary tools to monitor the progress of public enterprises towards achieving smart status. Ultimately, the overarching objective is to facilitate the evolution of traditional public enterprises into agile and technologically advanced smart enterprises, capable of meeting the dynamic demands of the contemporary landscape.

3. METHODOLOGY

3.1. Smart Public Enterprise Model

The concept of the smart public enterprise represents a distinct category within the broader spectrum of smart enterprises, specifically tailored to address the needs and expectations of the public sector. As such, society places significant expectations on these entities to effectively tackle both operational and market challenges.

Among the foremost market challenges confronting smart public enterprises are material costs, price reduction pressures, labor costs, transport/logistic costs, environmental regulations, business regulations, global competition, labor laws, global geopolitical risks, and exposure to global markets. In response, investment priorities in new technologies prioritize objectives such as increased production capacity, enhanced responsiveness, improved collaboration with customers and suppliers, more effective communication with customers regarding quality and safety, and the integration of market intelligence.

The structural framework of a smart public enterprise model comprises several macro modules, including stakeholders with specific needs and access to smart technologies, a smart economy guided by strategic initiatives at both governmental and enterprise levels, a smart business model, smart leadership, streamlined business processes, a focus on quality of life, and the pursuit of smart sustainable success.

In delineating a specific model for smart sustainable public parking enterprises, the macro modules are tailored to suit the unique requirements of this sector. In instances where the adoption of smart technologies is limited, the model is streamlined to encompass components such as a subset of the smart economy (with a focus on risk and strategic enterprise planning), the adoption of smart technologies, smart business processes, smart leadership, and considerations for sustainable practices and resources.

The assessment of smart technologies adoption and business processes within smart parking enterprises is facilitated through metrics and criteria-based evaluations. Metrics for assessing smart technology adoption are outlined in Table 1, providing a quantitative measure of adoption levels. Similarly, the evaluation of smart business processes is conducted using a process classification framework, incorporating leadership criteria and performance assessments on a scale of 1-5.

Additionally, risk assessments are conducted based on the specific risks inherent to smart parking enterprises, ensuring a comprehensive evaluation of operational and strategic vulnerabilities.

Table 1. Metrics of smart technologies adoption.

	DESCRIPTION OF THE APPLICATION OF SMART TECHNOLOGIES
0-1	0 - No integration of smart technologies.
	0.5 - Basic implementation including data collection, processing, and billing tracking.
	0.8 - Deployment of sensors and cameras to monitor parking occupancy.
	1.0 - Utilization of RFID and WiFi network for enhanced functionality.
1-2	1.3 - Introduction of parking access software to augment existing systems.
	1.5 - Implementation of algorithms to determine available parking spaces.
	2.0 - Provision of mobile device-based parking reservations.
2-3	2.3 - Integration of Android phone data input within the parking system.
	2.5 - Adoption of web applications for streamlined parking management.
	3.0 - Integration of mobility solutions with parking services.
3-4	3.3 - Utilization of data analytics for comprehensive parking process analysis.
	3.5 - Implementation of artificial intelligence for predictive business trend analysis.
	4.0 - Deployment of decision support systems to optimize parking operations.
4-5	4.3 - Optimization of parking space allocation and capacity management.
	4.6 - Provision of additional services such as vehicle washing and repairs.
	5.0 - Comprehensive implementation of smart parking infrastructure and services, encompassing intelligent features and advanced functionalities.

The assessment of smart sustainable success is based on a recommendation from ISO 9004:2012.

3.3. Comprehensive Approach for Smart Organization Transformation (CASOT)

In effecting the transition of conventional public enterprises into smart public enterprises, a multifaceted approach encompassing various domains is imperative. The adoption of concepts such as organizational reframing as proposed by Bolman and Deal (2015), which emphasizes restructuring organizational paradigms, coupled with leading change methodologies and conceptual modeling techniques advocated by De Cesare and Frank (2017), could prove instrumental in navigating this transitionary phase. Additionally, employing methods such as qualitative data analysis, statistical techniques, SVM algorithms, and cost-benefit analysis can offer valuable insights and aid in decision-making processes throughout the transition process. These methodologies collectively serve to facilitate a comprehensive transformation, ensuring that public enterprises are equipped to embrace the challenges and opportunities presented by the smart enterprise paradigm.

Building upon the insights gleaned from the extensive literature review, this study endeavors to develop a novel methodology for effectuating the transformation of traditional organizations into smart entities. Termed as the CASOT, this framework aims to provide a structured and systematic approach to guide organizations through the intricate process of transition towards smart enterprise status. Drawing upon established theoretical foundations and practical insights, CASOT endeavors to offer a comprehensive methodology that addresses the multifaceted dimensions involved in organizational reframing. Through the integration of key concepts and methodologies from diverse domains, CASOT seeks to empower organizations with the requisite tools and strategies to successfully navigate the complexities inherent in the journey towards becoming smart entities.

The initial step of the proposed methodology involves an in-depth analysis of the organizational context. Drawing from ISO 9001:2015 guidelines, the organization's context encompasses factors pertinent to its purpose, scope of quality management system (QMS), strategic objectives, and the external and internal dynamics influencing its ability to achieve desired outcomes and meet customer needs. This entails comprehending a spectrum of elements including stakeholder expectations, core products and processes, business environment influences, resource availability, human resource competencies, and regulatory requirements. To delineate and define the organizational context, a series of stages are undertaken, encompassing PEST and SWOT analyses, identification of internal and external issues, identification of stakeholders, and definition of the QMS scope. Key inputs in this phase include strategic direction, organizational purpose, and previous QMS performance outcomes. Outputs from this phase include a well-defined organizational context, serving as a foundational input for subsequent phases.

Subsequently, the methodology transitions into the second phase, leveraging approaches such as grounded theory and quantitative data analysis. Here, a comparative analysis methodology is employed to assess qualitative and quantitative data for identifying areas of improvement and crucial variables. The outcome of this phase furnishes insights into improvement possibilities and vital variables and their interrelationships.

In the third phase, tailored specifically for public enterprises, the focus shifts towards the formulation of a "reframing model" for organizational restructuring. Inputs in this phase comprise improvement opportunities, conceptual modeling principles, and identified essential variables. The output culminates in the development of a comprehensive reframing model, encapsulating various organizational frames including sense-making, structural, human resources, political, symbolic, and leadership frames.

Moving to the fourth phase, the emphasis lies on the transition of traditional organizations into smart public enterprises (SPEs). Leveraging the reframing model and change management principles proposed by Cotter (1996), this phase delineates transition stages within SPEs and derives a strategic transition strategy.

The subsequent phase, fifth in the sequence, entails the analysis of mathematical development scenarios using simulation techniques based on dynamic modeling. Inputs in this stage include the transition strategy, smart mobility requirements, and stakeholder demands, culminating in the derivation of mathematical transition scenarios for SPEs.

Finally, the sixth phase undertakes the validation of the CASOT methodology through a comprehensive case study involving a public parking enterprise. Utilizing diverse methodologies such as statistical analysis, SVM, cost-benefit analysis, and questionnaire development, this phase seeks to validate the efficacy of transitioning traditional public enterprises into SPEs, thereby affirming the stated hypotheses.

4. CASE STUDY

This section presents the results of applying the CASOT to transition a public parking service enterprise into a Smart Public Enterprise (SPE). The first phase of CASOT involves defining the context of the public parking enterprise located in Kragujevac, Central Serbia. The determination of the organizational context and quality assessment is based on the decomposition of business processes according to the ISO 9001:2015 standard.

By employing the decomposition method, it is possible to accurately describe the activities within each process and verify all process outcomes, ensuring that no process within the organization operates in isolation. Typically, one process triggers another, and the result of this process decomposition is a detailed data flow diagram. This diagram effectively maps out the interdependencies and flow of data between processes, providing a comprehensive overview of the organization's operations and facilitating the identification of areas for improvement and integration of smart technologies.

Process decomposition offers a systematic approach to clearly defining processes by identifying inputs that can be transformed into outputs for the user or subsequent processes. This method also facilitates the identification and measurement of process outcomes, elucidates the relationships between processes, activities, and organizational functions, and assesses the impacts on stakeholders, management, and customer satisfaction.

In the second phase of the CASOT application, grounded theory was employed to identify key variables and formulate hypotheses as follows:

H_1: Smart leadership has a potential impact on smart quality.

H_2: Smart leadership positively influences the reduction of risks.

H_3: Smart leadership affects smart sustainability.

H_4: Smart leadership, quality, and risk collectively impact smart sustainability.

These hypotheses suggest that smart leadership is a derivative of quality, reflecting the evolving role of leadership in the context of Industry 4.0. The relationships between the sustainability of the implementation process (S), the quality of the implementation process (Q), the derived smart leadership (L), and the risk associated with the implementation process (R) were analyzed using data from the observed public parking enterprise over a period of 100 months, from September 2010 to December 2018.

This analysis underscores the significant role of smart leadership in enhancing quality, reducing risks, and promoting sustainability within smart public enterprises. By examining these interdependencies, the research aims to provide a comprehensive understanding of the transformative processes necessary for transitioning traditional public enterprises into smart public enterprises.

The values for sustainability were determined by consensus over the observed period by a team comprising the director, executive director, and head of the service. These estimated values were recorded as real numbers with two decimal places. The statistical analyses were conducted using SPSS IBM software.

The Risk (R) variables are categorized as follows: R_1: Very small (0-1); R_2: Small (1-2); R_3: Moderate (2-3); R_4: High (3-4); and R_5: Very high (4-5).

Similarly, the Smart Sustainability (S) variables are classified as: S1: Very small (0-1); S2: Small (1-2); S3: Moderate (2-3); S4: High (3-4); and S5: Very high (4-5).

The results of the correlation analysis between these variables are presented in Tables 3 and 4. This analysis aims to identify and quantify the relationships between risk levels and the degree of smart sustainability within the public parking enterprise, providing insights into the effectiveness of smart leadership in mitigating risks and enhancing sustainability.

Based on the results of the correlation analysis, it can be concluded that Sustainability (S) exhibits a strong positive correlation with both Leadership (L) and

Quality (Q), as evidenced by correlation coefficient values of 0.769 and 0.904, respectively. Conversely, Risk (R) shows a negative correlation with Sustainability (S), with a correlation coefficient value of -0.884. These findings suggest that enhancements in leadership and quality are significantly associated with improvements in sustainability, whereas higher risk levels are inversely related to sustainability within the public parking enterprise.

Table 2 Descriptive Statistics

	Mean	Std. Deviation	N
L	2,1663	,29314	100
Q	2,5254	,35182	100
R	3,1912	,28684	100
S	1,6217	,31620	100

Table 3 Correlations between Leadership (L), Quality (Q), Risk (R) and Sustainability (S)

	L	Q	R	S
L	1	,710	-,627	,769
Q		1	-,885	,904
R			1	-,884
S				1

Tables 4, 5, 6, and 7 provide model summaries and linear regression coefficients pertaining to Quality (Q) and Risk (R) as dependent variables, with Leadership (L) serving as the independent variable. These results confirm hypotheses H1 and H2.

These statistical analysis results indicate significant parameters in the linear regression model for predicting risk (R). The standardized coefficients for Leadership (L) and Quality (Q) are 0.003 and -0.887, respectively. This means that both factors are significantly associated with the risk variable.

When considering the p-value (Sig.), it is noticeable that both factors (L and Q) are statistically significant, as the p-value is less than the conventional significance level of 0.05. This suggests that there is a statistically significant relationship between Leadership (L) and Quality (Q) with Risk (R).

Regarding the statistical indicators of collinearity statistics, Tolerance and Variance Inflation Factor (VIF) for both variables are quite high (0.495 and 2.019), indicating some level of multicollinearity between predictors. This may suggest the need for further investigation to assess whether there is any significant multicollinearity that could affect the reliability of the model.

Upon reviewing tables 8 and 9, it becomes evident that positive linear regression coefficients exist between Leadership (L) and Quality (Q) as independent variables, and Smart Sustainability (S) as the dependent variable. Conversely, a negative linear regression coefficient is observed between Risk (R) as an independent variable and Smart Sustainability (S) as the dependent variable.

Table 4. Model Summary

					Change Statistics				
..	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	,907[a]	,823	,819	,14949	,823	225,657	2	97	,000
a. Predictors: (Constant), L, R									

Table 5. Coefficients a

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4,695	,324		14,490	,000		
	R	-,888	,067	-,724	-13,212	,000	,607	1,648
	L	,307	,066	,256	4,673	,000	,607	1,648
a. Dependent Variable: Q								

Table 6. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,885[a]	,783	,779	,13490	,783	175,292	2	97	,000
a. Predictors: (Constant), Q, L									

Table 7. Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5,011	,108		46,527	,000		
	L	,003	,066	,003	,049	,961	,495	2,019
	Q	-,723	,055	-,887	-13,212	,000	,495	2,019
a. Dependent Variable: R								

Tables 8 and 9 also represent model summaries and linear regression coefficients for smart sustainability (S) as dependent variable.

Table 8. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,939[a]	,883	,879	,11000	,883	240,662	3	96	,000
a. Predictors: (Constant), R, L, Q									

Table 9. Regression Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,532	,424		3,612	,000		
	L	,278	,054	,257	5,181	,000	,495	2,019
	Q	,339	,075	,377	4,537	,000	,177	5,653
	R	-,429	,083	-,389	-5,176	,000	,217	4,614
a. Dependent Variable: S								

All linear regression coefficients exhibit relatively high values, suggesting that potential enhancements in predictors L, Q, and R could positively influence S within the examined public parking enterprise. Particularly noteworthy is the relatively substantial impact of L (B=0.278). Consequently, this variable's influence is further scrutinized in this study as a potential avenue for significant improvements in smart sustainability.

An additional step in the CASOT methodology involves the usage of Support Vector Machine (SVM) analysis. The SVM analysis was performed based on the approach described by Huang et al. (2020) and implemented using the sklearn.svm module within Python V3.9. The first step was to create an SVM model with three input variables (Q, L, and R) and one output variable (S).

Table 10 presents the SVM model performance evaluation values, comparing real and predicted sustainability values after the SVM training. The obtained overall regression coefficient value (R=0.8978911497378496) indicates a relatively high correlation between the real sustainability values and the SVM outputs, thereby validating the initial mathematical model. Based on these results, it was concluded that sustainability predictions could be effectively performed using the SVM model.

Table 10. SVM model performance evaluation

Parameter	Value
Mean Absolute Error (MAE):	0.10755367142389473
Mean Squared Error (MSE):	0.018224485178038867
Root Mean Squared Error (RMSE):	0.1349980932385301
R-squared (R^2):	R 0.8978911497378496

Finally, a comparison of the SVM and regression analysis prediction models was conducted over a period of 100 months (Figure 1). The comparison reveals that the values determined by the SVM model (S_SVM) and the regression analysis (S_REG) do not significantly deviate from the real sustainability values. This indicates that both models provide accurate predictions, with the linear regression model potentially offering enhanced predictive capabilities.

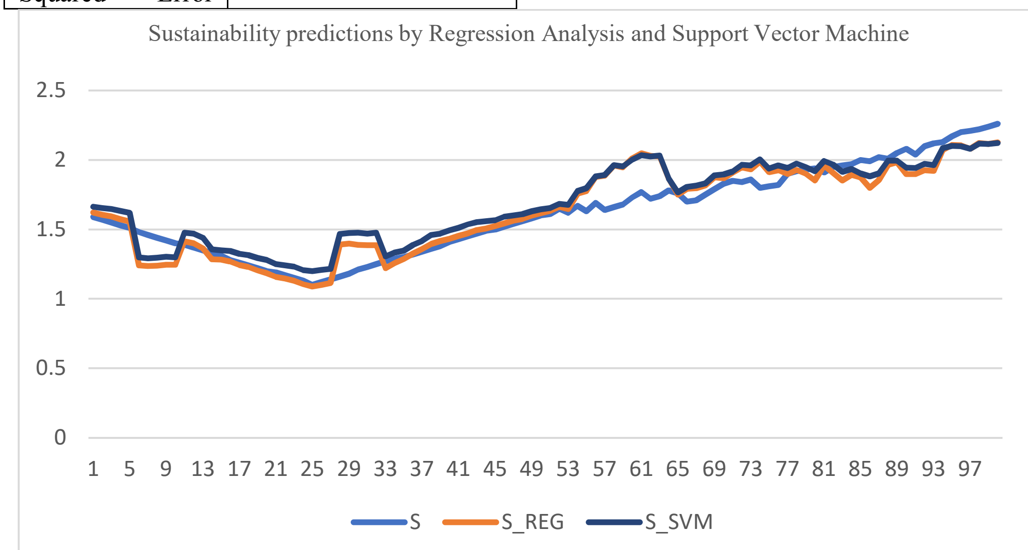

Figure 1. Sustainability predictions by SVM and regression analysis

The analysis of the research results indicates that the initial hypotheses have been validated. Consequently, it is feasible to concentrate on the prediction of Smart Sustainability (S) as the dependent variable for Smart Public Enterprises. In this specific use case, the variable of interest is Smart Leadership (L), whose values are varied. This variation is examined in combination with the projected improvements in Quality (Q) values and the reduction in Risk (R) values over time.

5. DISCUSSIONS AND IMPLICATIONS

Data on smart leadership, smart sustainability, smart quality, and risk were grouped around their mean values. Utilizing the statistical software SPSS-Statistics 21, mean values and standard deviations for these variables were calculated. Based on the analysis of the correlation coefficients between smart leadership, smart sustainability, smart quality, and risk, the following observations can be outlined:

1. Very high correlation coefficients were achieved between smart leadership and smart sustainability (0.769), smart leadership and smart quality (0.710), and smart leadership and risk (-0.627), as expected (Table 3).
2. There is also a high negative correlation between risk and quality (-0.885), which necessitates an extension of the existing model to determine the relationship between smart quality and risk (Table 3).
3. There is a high correlation between smart sustainability and smart quality (0.904); as smart quality increases, smart sustainability also increases (Table 3).
4. Very high correlation coefficients between smart sustainability and risk were achieved (-0.884), indicating that increasing risk reduces smart sustainability (Table 3).
5. Based on the results (Table 4), the decision coefficient (0.823) indicates that the proposed model can explain more than 82% of the variance, which is highly positive.
6. Preliminary results are confirmed by statistical analysis (Model Summary), which demonstrates the overall high level of significance of the proposed model.
7. Based on the results (Table 7), the value of the coefficients can be determined. It is observed that smart leadership has a minor influence (B = 0.003), with a standard error of 0.066, while smart quality has a greater influence, expressed by coefficient B (-0.723), with a standard error of 0.055. The relatively low standard error indicates a high level of prediction accuracy for the dependent variable (risk).
8. It was also determined that the variance inflation factor (VIF) is 2.02 for both smart quality and smart leadership, indicating that the independence of sub-variables has been achieved within the smart quality and smart leadership models.

This study primarily focuses on the redesign of quality management, leadership, and risk management through the application of smart technologies and knowledge management. Additionally, significant enhancements in smart sustainability are anticipated in the near future. These improvements are expected to be driven by advancements in smart technologies, innovative business models, and an increased level of horizontal and vertical integration with business, social, and environmental contexts.

The practical implications of this study are substantial in several key areas: (1) the CASOT methodology can be effectively employed by other public enterprises to facilitate their transition to smart enterprises, (2) the general methodology can be adapted and applied by industrial enterprises for similar transformations, and (3) the findings from the provided real-life case study offer a foundational basis for improving key factors and variables related to smart sustainability. Furthermore, for each public enterprise, there exists the potential to quantify the effects of introducing smart technologies using statistical methods, and to conduct feasibility studies to prioritize processes and technologies.

6. CONCLUSIONS

This study introduces the CASOT methodology to analyze the impact of smart leadership on sustainability, encompassing aspects of smart technologies, smart business processes, and risk management. The successful implementation of the CASOT methodology necessitates a high level of knowledge and skills among team members, coupled with strong motivation, passion, and awareness of their impact on smart sustainability.

The advantages of the proposed methodology are manifold. Firstly, it presents a general approach that integrates internal and external variables pertinent to the business context in the era of Industry 4.0. Secondly, the CASOT methodology can be adapted for various enterprises in other public and business sectors with appropriate modifications to the model, variables, and performance goals. Thirdly, this novel methodology synergizes different approaches, theories, and methods, and facilitates continuous team building and management. Most significantly, it emphasizes smart leadership as a pivotal driver for the cost-effective enhancement of quality and sustainability while mitigating business risk.

Practical findings from this study indicate that a higher level of smart leadership positively impacts smart quality and smart sustainability, while reducing business risks. Additionally, SVM results can be used to forecast the effects of improvements in smart leadership on smart sustainability. Major implications of this study include (a) increased transparency of business processes, (b) preparation of enterprises for effective transformation into smart enterprises, (c) the incorporation of new variables into the CASOT methodology for specific cases and business models, and (d) improved horizontal and vertical integration of internal processes with the social and natural environment in alignment with the Industry 4.0 concept.

However, the proposed methodology has certain limitations. These include a relatively small sample size, the effects of smart technologies calculated over the past two years, and a case study focused on a specific public parking enterprise with a well-established information system for quality and risk management over the last twelve years. Additionally, the base model is limited to three variables (smart leadership, smart quality, and risk) and their impact on smart sustainability, which may only have indicative relevance for other public and business enterprises due to differences in their business contexts and models.

Future research will involve the application of new methods for current business applications and expanding the list of variables to achieve different goals for public and business enterprises. Furthermore, future studies will aim to encompass aspects of project management and leadership, improvement and sustainable success, as well as the integration of knowledge, wisdom, and spirituality to manage greater complexity and achieve the millennium development goals.

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