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# THE IMPACT OF STAKEHOLDER BEHAVIOR ON THE OPTIMIZATION OF DIGITALIZATION IN THE MOROCCAN AGRICULTURAL SUPPLY CHAIN: A PLS-BASED VERIFICATION

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**Abstract:** Digital transformation is increasingly recognized as a strategic lever to enhance the logistical performance of agricultural supply chains, particularly in emerging economies. This study investigates the effect of actors' behavior on the optimization of digitalization, by analyzing the relationship between human usage patterns, data storage and processing capacity, and agricultural logistics performance. A conceptual model grounded in the diffusion of innovation theory and the dynamic capabilities theory was tested using the PLS-SEM method on a sample of 308 stakeholders from the Moroccan agricultural sector. The empirical results reveal that actors' behavior significantly influences digital capacity, which in turn affects several key performance dimensions, including cost reduction, quality improvement, operational efficiency, market competitiveness, and the reduction of intermediary roles. These outcomes highlight the importance of human factors in driving technological adoption and suggest that successful digital transformation requires not only infrastructure and tools but also active engagement, digital literacy, and collaborative practices among supply chain participants. The study underscores the need for policies and capacity-building initiatives that empower local actors and facilitate the integration of digital solutions adapted to the realities of agricultural logistics in low- and middle-income countries. The proposed model offers practical insights applicable to other low-digital-maturity logistics contexts and contributes to the growing literature on digital innovation in agri-food systems.

**Key words:** digitalization, agricultural logistics, stakeholder behavior, logistics performance.

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## Introduction

In recent years, digital transformation has emerged as a key driver of innovation in supply chains, offering new opportunities to improve logistics performance, responsiveness, and data transparency. While progress has been remarkable in industrial sectors, the agricultural sector, particularly in developing countries, still lags behind in terms of digital integration. Agricultural supply chains are often fragmented, lack technological infrastructure, and have limited data interoperability, which weakens coordination and decision-making (Gopal et al., 2024; Klerkx et al., 2019).

In Morocco, this digital divide is especially evident. Although national strategies such as Generation Green 2020–2030 aim to modernize agricultural systems, the integration of digital tools remains limited in wholesale markets, cooperatives, and distribution networks. Key technologies related to traceability, information management, and data sharing are unevenly adopted across actors, depending on their resources, knowledge, and willingness to innovate (Banque Mondiale, 2021; Haut-Commissariat au Plan [HCP], 2023, n.d.). This technological gap leads to persistent inefficiencies, overdependence on intermediaries, and difficulty meeting international standards.

Prior research has highlighted that successful digitalization requires more than infrastructure. It also depends on the human dimension, specifically, how stakeholders adopt, use, and integrate digital tools into their practices (Bag et al., 2020; Ben-Daya et al., 2019). However, there is still limited empirical research on the specific mechanisms through which stakeholder behavior influences the effectiveness of digital transformation, as well as its direct impact on overall logistics performance. Within this context, the present study addresses the following research question: How does stakeholder behavior influence the optimization of digitalization in Moroccan agricultural supply chains, and to what extent does this digitalization affect overall supply chain performance?

This study aims to address this research gap by analyzing the role of stakeholder behavior in shaping digital capacity, operationalized here as the ability to store and process information, and by assessing how this capacity affects key dimensions of agricultural logistics performance, such as cost reduction, quality improvement, efficiency, and market competitiveness. The analysis focuses on the Moroccan agricultural supply chain and uses the partial least squares structural equation modeling (PLS-SEM) method on data collected from 308 supply chain actors.

## Material and Methods

This study adopts a quantitative explanatory research design to examine the influence of stakeholder behavior on digital capacity and its subsequent effect on the performance of agricultural supply chains. The proposed model is grounded in two theoretical foundations. The first is the diffusion of innovation theory, which suggests that an individual's or organization's readiness to adopt innovation depends on perceived usefulness, social influence, and ease of implementation. This theory highlights how the behavior of stakeholders – such as their openness to change, willingness to use digital tools, and training engagement – affects the pace and depth of technological adoption within supply chains (Rogers, 1983). The second is the dynamic capabilities theory, which emphasizes that organizations must continuously reconfigure internal and external competences to adapt to rapidly changing environments. In this context, the capacity to store and process data is seen as a dynamic capability that enables agricultural supply chains to respond flexibly and efficiently to market and operational demands (Teece, 2007). This theoretical grounding supports the hypothesis that behavioral readiness among stakeholders enhances the organization's digital capabilities, particularly in terms of data storage and processing, which in turn influence various dimensions of logistics performance. Within this framework, data storage and processing capacity is considered a central operational pillar of digitalization, as it reflects the actual implementation of digital systems in core supply chain processes. In this context, it represents the embodiment of digitalization itself ( Orjuela-Castro et al., 2023; Dubey et al., 2019).

The study tests six hypotheses:

H1: Stakeholder behavior has a positive effect on data storage and processing capacity.

H2.1: Data storage and processing capacity positively influences cost reduction.

H2.2: Data storage and processing capacity positively influences quality improvement.

H2.3: Data storage and processing capacity positively influences the reduction of intermediary roles.

H2.4: Data storage and processing capacity positively influences transactional efficiency and flexibility.

H2.5: Data storage and processing capacity positively influences market competitiveness.

To empirically validate these relationships, data were collected through a structured questionnaire administered to actors in the fruit and vegetable supply chain operating in three Moroccan wholesale markets: Casablanca, Agadir, and Oujda. These locations were selected for their logistical significance and diversity

in practices. The data collection process took place between April and June 2024 and targeted a wide range of stakeholders including wholesalers, intermediaries, retailers, and distributors. After screening, 308 valid responses were retained. The questionnaire was built using items adapted from validated scales in prior literature and measured responses on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The construct "stakeholder behavior" captures openness to innovation, digital skills, readiness for change, use of digital tools, and collaborative practices (Rogers, 1983; Venkatesh et al., 2012). The construct "data storage and processing capacity" measures the organization's ability to collect, store, structure, and utilize information using digital platforms, data analytics, and system integration. "Logistics performance" is conceptualized as a multidimensional construct encompassing five areas: cost reduction, quality improvement, reduction in intermediary roles, transactional efficiency and flexibility, and market competitiveness (Papadopoulos et al., 2017; Zhang et al., 2002).

The data were analyzed using SmartPLS 4 software. The analysis followed a two-step procedure: first, the evaluation of the measurement model through reliability (Cronbach's alpha, composite reliability), convergent validity (average variance extracted), and discriminant validity (Fornell-Larcker criterion and HTMT ratios); second, the evaluation of the structural model based on path coefficients, $R^2$ values, $f^2$ effect sizes, and predictive relevance using $Q^2$ statistics. Hypotheses were tested using the bootstrapping method with 5,000 resamples and a significance level of 5%, which ensures robustness in the presence of non-normal data distributions and complex intervariable relationships.

## Results and Discussion

To evaluate the impact of stakeholder behavior on agricultural logistics performance through digitalization, a structural model was estimated using the PLS-SEM method. This model includes, on the one hand, behavior (STK_BEH) as a predictive factor, and on the other hand, data storage and processing capacity (DSP_CAP) as the central lever of digitalization. The latter then acts upon five key dimensions of logistics performance: cost reduction, quality improvement, reduction of intermediary roles, transactional efficiency and flexibility, and market competitiveness. This model allows for the evaluation of how stakeholder behavior influences the optimization of digitalization, and how such optimization is reflected in the performance of the agricultural supply chain. Figure 1 illustrates the structure of the model.

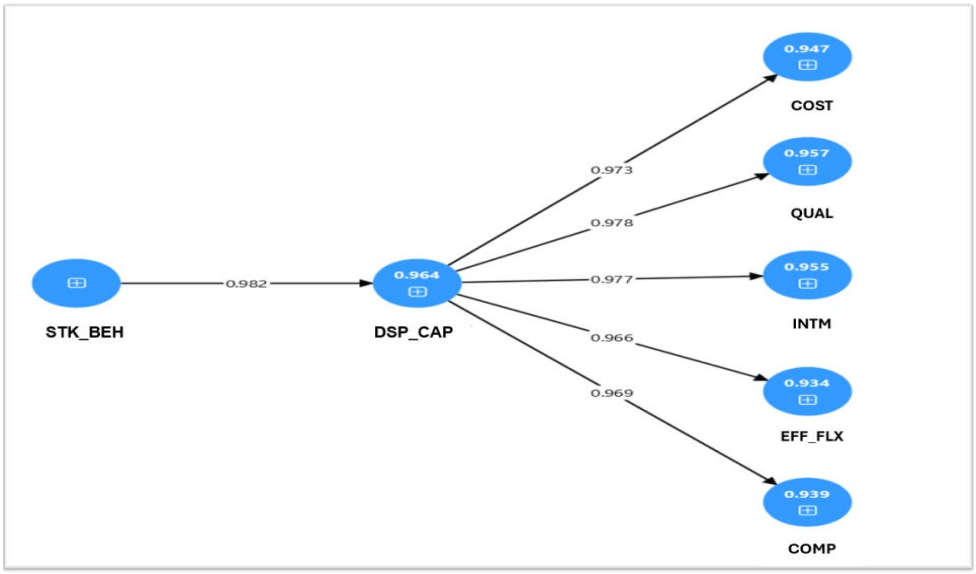


Figure 1. Structural model showing the influence of stakeholder behavior on logistics performance through data storage and processing capacity.

Test of direct effects

The analysis of direct effects was conducted using bootstrapping (5,000 subsamples, BCa confidence interval, $p < 0.05$). Table 1 presents the standardized coefficients (β), t-statistics, and associated p-values:

Table 1. Results of direct effects (PLS-SEM).

| Relationship | Coefficient β | t-value | p-value | Interpretation |
|---|---|---|---|---|
| BEHAVIOR → DSP_CAP | 0.982 | 229.985 | 0.000 | Highly significant |
| DSP_CAP → COST | 0.973 | 237.773 | 0.000 | Highly significant |
| DSP_CAP → QUALITY | 0.978 | 212.833 | 0.000 | Highly significant |
| DSP_CAP → INTERMEDIARIES | 0.977 | 193.115 | 0.000 | Highly significant |
| DSP_CAP → EFFICIENCY_FLEXIBILITY | 0.966 | 165.079 | 0.000 | Highly significant |
| DSP_CAP → COMPETITIVENESS | 0.969 | 154.231 | 0.000 | Highly significant |

These results confirm that stakeholder behavior had a strongly significant effect ($\beta = 0.982$; $p < 0.001$) on data storage and processing capacity, emphasizing the importance of human practices (technology use, engagement, training) in the success of digital initiatives. Hypotheses H2.1 to H2.5 have been also supported:

- H2.1: Cost reduction ($\beta = 0.973$; $p < 0.001$);
- H2.2: Quality improvement ($\beta = 0.978$; $p < 0.001$);
- H2.3: Reduction of intermediaries ($\beta = 0.977$; $p < 0.001$);
- H2.4: Improved efficiency and flexibility ($\beta = 0.966$; $p < 0.001$);
- H2.5: Enhanced market competitiveness ($\beta = 0.969$; $p < 0.001$).

These results confirm that data storage and processing capacity – used here as a proxy for the optimization of digitalization – served as a transversal operational lever that significantly influenced all major dimensions of logistics performance. In line with previous research, this capacity enables real-time information flows, enhances decision-making agility, and improves coordination between supply chain actors (Fumasoli, 2022; Kamble et al., 2020). It thus represents the functional embodiment of digital transformation within agricultural logistics, particularly in contexts where fragmented processes and limited interoperability are prevalent (Papadopoulos et al., 2017).

Coefficients of determination

The analysis of determination coefficients evaluates the proportion of variance in each dependent variable explained by its predictors. Table 2 presents the $R^2$ and adjusted $R^2$ values obtained in the final model:

Table 2. Coefficients of determination for each dependent variable.

| Endogenous variable | $R^2$ | Adjusted $R^2$ | Interpretation |
|---|---|---|---|
| DSP_CAP | 0.964 | 0.964 | Stakeholder behavior explains 96.4% of the variance in data storage capacity |
| COST | 0.947 | 0.947 | Data storage capacity explains 94.7% of cost reduction |
| QUALITY | 0.957 | 0.957 | Data storage capacity explains 95.7% of quality improvement |
| INTERMEDIARIES | 0.955 | 0.955 | It explains 95.5% of the reduction in intermediary roles |
| EFFICIENCY_FLEX | 0.934 | 0.934 | It explains 93.4% of transactional efficiency and flexibility |
| COMPETITIVENESS | 0.939 | 0.939 | It explains 93.9% of market competitiveness |

The results demonstrate a very high level of explained variance across all performance dimensions, confirming the strong predictive quality of the structural model (Sarstedt et al., 2014; Shmueli et al., 2016). In particular, stakeholder behavior emerged as a key determinant of effective digitalization, significantly enhancing the organization's capacity to store and process data. This finding aligns with the view that behavioral readiness and user engagement are essential enablers

of digital transformation in low-maturity contexts (Gunasekaran et al., 2017; Venkatesh et al., 2012). Furthermore, data storage and processing capacity – used here as an operational proxy for digitalization – functioned as a transversal lever that drove improvements in logistics performance, confirming previous empirical evidence from agro-food and supply chain studies (Dubey et al., 2019; Ning and Yao, 2023).

Effect size (F2)

The local effect size (F2) measures the individual contribution of each predictor variable to the explained variance of a dependent variable. Table 3 presents the effect sizes obtained.

Table 3. Local effect sizes for key relationships in the structural model.

| Relationship | $f^2$ | Interpretation |
|---|---|---|
| BEHAVIOR → DSP_CAP | 26.985 | Exceptionally strong effect of behavior on digital capacity |
| DSP_CAP → COST | 17.798 | Medium to strong effect on cost reduction |
| DSP_CAP → QUALITY | 22.096 | Medium to strong effect on quality improvement |
| DSP_CAP → INTERMEDIARIES | 21.380 | Medium to strong effect on reduction of intermediary roles |
| DSP_CAP → EFFICIENCY_FLEX | 14.087 | Medium effect on efficiency and flexibility |
| DSP_CAP → COMPETITIVENESS | 15.322 | Medium to strong effect on market competitiveness |

These results confirm that data storage and processing capacity is a structural lever for performance, significantly activated by stakeholder behavior. The exceptionally high effect size observed supports the growing body of literature suggesting that successful digital transformation in supply chains depends less on the mere presence of technologies and more on how organizational actors engage with them. Recent research emphasizes that digital optimization is primarily driven by user engagement, digital culture, and collaborative practices embedded in daily operations (Kern, 2021; Queiroz et al., 2019; Wamba and Queiroz, 2020). In agricultural contexts, these dynamics are critical due to the heterogeneous digital readiness of actors and the fragmented nature of data ecosystems.

Total effects

The analysis of total effects provides a summary of all significant direct relationships within the structural model. Table 4 presents the total effects and their significance level.

Table 4. Total effects and significance of structural paths.

| Relationship | Total effect (β) | Significance |
|---|---|---|
| BEHAVIOR → DSP_CAP | 0.982 | Highly significant |
| DSP_CAP → COST | 0.973 | Highly significant |
| DSP_CAP → QUALITY | 0.978 | Highly significant |
| DSP_CAP → INTERMEDIARIES | 0.977 | Highly significant |
| DSP_CAP → EFFICIENCY_FLEX | 0.966 | Highly significant |
| DSP_CAP → COMPETITIVENESS | 0.969 | Highly significant |

These findings provide robust empirical support for the view that stakeholder behavior constitutes a critical driver of digital optimization within agricultural supply chains. The results demonstrate that digital capacity, understood as the ability to store, structure, and mobilize data, was not merely a technological resource but a transversal lever that significantly and consistently enhanced all key dimensions of logistics performance. This dynamic aligns with recent research emphasizing that human-centered factors such as openness to change, digital competencies, and inter-organizational collaboration are decisive in the effective deployment of digital innovations, as shown by Raj et al. (2020), Kamble et al. (2020), and Gölzer and Fritzsche (2017). The structural model confirms a strong and coherent interaction between the three core constructs of this study: stakeholder behavior, digital capacity, and performance. The highly significant influence of behavior on digitalization outcomes reinforces the idea that technological transformation in contexts such as Morocco's agricultural sector is inextricably linked to user engagement, capacity-building efforts, and organizational readiness for change.

These findings are fully consistent with the theoretical perspectives mobilized in this research. The diffusion of innovation theory (Rogers, 1983) finds clear empirical support here: it is users' attitudes, practices, and ability to adopt digital tools that determined their actual effectiveness. Our results also support the dynamic capabilities theory (Teece, 2007). Data storage and processing capacity clearly strengthened supply chain performance by reducing costs, improving quality, making transactions more efficient, and increasing competitiveness.

The relationship between stakeholder behavior, data storage and processing capacity, and logistics performance can be interpreted as a sequential activation dynamic central to digital transformation. In this framework, behavioral engagement initiated digital capacity, which subsequently generated tangible value across logistics processes. This progressive chain is particularly relevant in the Moroccan agricultural context, where levels of digital adoption vary across actors. Our findings show that when stakeholders engaged with digital tools, their behavior significantly enhanced data storage and processing capacity, which

subsequently improved logistics performance. The results therefore confirm that the proposed mechanism operates effectively in a context where digital transformation is still evolving.

The strength of the obtained coefficients confirms not only statistical significance but also an underlying organizational reality. The ability to exploit data effectively is no longer a purely technical function; it acts as a transversal engine for coordination, responsiveness, and process optimization in fragmented agricultural ecosystems (Gunasekaran et al., 2017; Kamble et al., 2020; El Moutaouakil et al., 2022). However, this capacity is not autonomous: it is critically dependent on the willingness of stakeholders to collaborate, develop digital competencies, and adopt shared platforms, as highlighted by recent studies on socio-technical integration in emerging markets (Mangla et al., 2018).

Ultimately, this research contributes to the literature by confirming that digitalization in agricultural supply chains is not merely a question of deploying technologies, but a broader organizational and human transformation. In emerging economies especially, the success of such transformation relies on the activation of behavioral levers, the reinforcement of digital infrastructures, and the integration of analytics into decision-making processes. These findings reinforce previous observations on the interdependence of technological readiness and organizational maturity in enabling logistics performance (Wang et al., 2024).

## Conclusion

This study has answered the central question posed in the introduction: stakeholder behavior is indeed a fundamental lever in optimizing digitalization within Moroccan agricultural supply chains. The results obtained through PLS-SEM analysis confirm that without human involvement, a shared digital culture, and willingness to adopt and integrate tools, digitalization cannot achieve its intended outcomes.

Data storage and processing capacity, considered here as the operational expression of digitalization, acted as a transversal lever across all dimensions of logistics performance: cost, quality, flow efficiency, and competitiveness. However, this capacity cannot emerge or evolve without the people who activate, understand, and improve it.

As Morocco seeks to modernize its agricultural value chains and integrate more fully into global value systems, it becomes urgent to act at the root of the problem: to train, raise awareness, support, and involve all field-level stakeholders. Public policy must go beyond infrastructure and platforms to include concrete actions focused on skill-building, trust development, and collaborative practice.

This research proposes a model that is reproducible in other sectors and countries with low digital maturity. Its message is clear: no digital transformation

will succeed without human transformation. Morocco has the resources, the ambition, and now the empirical evidence to move forward. What remains is the courage to invest in people as the foundation of progress.

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# UTICAJ PONAŠANJA ZAINTERESOVANIH STRANA NA OPTIMIZACIJU DIGITALIZACIJE U MAROKANSKOM POLJOPRIVREDNOM LANCU SNABDEVANJA: VERIFIKACIJA ZASNOVANA NA METODU DELIMIČNIH NAJMANJIH KVADRATA

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R e z i m e

Digitalna transformacija se sve više prepoznaje kao strateški instrument za unapređenje logističkih performansi poljoprivrednih lanaca snabdevanja, naročito u zemljama u razvoju. Ovo istraživanje ispituje uticaj ponašanja aktera na optimizaciju digitalizacije, analizirajući odnos između obrazaca korišćenja od strane ljudi, kapaciteta za skladištenje i obradu podataka i učinak poljoprivredne logistike. Konceptualni model zasnovan na teoriji difuzije inovacija i teoriji dinamičkih sposobnosti testiran je primenom modeliranja strukturnih jednačina metodom parcijalnih najmanjih kvadrata (engl. *PLS-SEM*) na uzorku od 308 aktera iz marokanskog poljoprivrednog sektora. Empirijski rezultati pokazuju da ponašanje aktera ima značajan uticaj na digitalne kapacitete, koji potom utiču na više ključnih dimenzija učinka, uključujući smanjenje troškova, unapređenje kvaliteta, operativnu efikasnost, konkurentnost na tržištu i smanjenje posredničkih uloga. Ovi nalazi ukazuju na značaj ljudskih faktora u podsticanju usvajanja tehnologija i sugerišu da uspešna digitalna transformacija zahteva ne samo infrastrukturu i alate, već i aktivno angažovanje, digitalnu pismenost i postojanje saradnje među učesnicima u lancima snabdevanja. Istraživanje naglašava potrebu za politikama i inicijativama za jačanje kapaciteta koje osnažuju lokalne aktere i olakšavaju integraciju digitalnih rešenja prilagođenih realnim uslovima poljoprivredne logistike u zemljama sa niskim i srednjim prihodima. Predloženi model nudi praktične uvide primenljive i u drugim logističkim kontekstima sa niskim nivoom digitalne zrelosti i doprinosi sve obimnijoj literaturi o digitalnim inovacijama u poljoprivredno-prehrambenim sistemima.

**Ključne reči:** digitalizacija, poljoprivredna logistika, ponašanje zainteresovanih strana, logističke performanse.

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