Revista Tecnologia e Sociedade
ISSN: 1984-3526

https://periodicos.utfpr.edu.br/rts

Providing a model for estimating the success of electronic customer relationship management systems in industry management

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ABSTRACT

This study explores the role of Electronic Customer Relationship Management (ECRM) in addressing contemporary business challenges, focusing on customer behavior, innovation management, and business process optimization. It also examines the interplay between society and technology, highlighting the mutual influence of technological advancements and societal structures. The research employs Structural Equation Modeling (SEM) to analyse data from 385 participants across two major industrial projects. This methodology comprehensively evaluates the factors impacting ECRM success, integrating technical and social dimensions. The findings demonstrate that Technological Innovation, Supply Chain Management, Business Management, Strategic Management, and Production Development significantly contribute to the success of ECRM. The study underscores the importance of considering the co-evolution of technology and society in implementing ECRM systems.

KEYWORDS: Technological Innovation, Supply Chain Management, Business Management, Strategic Management, Electronic Customer Relationship Management.

INTRODUCTION

Motivation and Problem Statement:

In the '80s and late '90s, customer-oriented software emerged, with Thomas Siebel (1993) and Bradway and Purchia (2000) pioneering modern CRM and ECRM. A revolution in customer relationship management occurred in 1999 with the advent of online infrastructure. In the 2000s, automation and marketing became integrated into CRM, which peaked in the 2010s due to social networking platforms (Richards & Jones, 2008). CRM focuses on creating higher customer value and recognizes customers as the most critical assets (Keramati & Mehrabi, 2010). Improved communication via information technology enhances service quality and customer satisfaction. The Internet facilitates closer customer relationships and ECRM implementation, enabling businesses to adapt to customer needs (Coltman et al., 2011). ECRM, an integrated marketing, sales, and electronic service strategy, identifies, acquires, and maintains customers (Payne & Frow, 2006). It uses digital tools and platforms to collect and analyse customer data, personalize experiences, and improve satisfaction. ECRM leads to increased customer loyalty, sales, and brand reputation (Magatef et al., 2023).

Effective ECRM implementation requires a strategic approach, including clear goals, communication, and continuous evaluation (Magatef et al., 2023). The digital age demands personalized and seamless customer experiences across channels, making ECRM increasingly important. The main challenge is the traditional and inappropriate company structure that does not provide flexibility and mobility according to environmental conditions (Reinartz et al., 2009). ECRM is not a solution to a problem but a strategy. It can be considered a substantial competitive advantage if implemented in an environment (company and workshop) as a partnership and cooperation.

Primary motivations for companies include:

- Increasing knowledge about customers for better relationships and loyalty.
- Listening to customer needs and suggestions for future demand prediction.
- Offering superior, customized services and products.
- Creating efficient communication channels.
- Boosting seller motivation and effectiveness.
- Improving company technologies, decision-making, and internal strategies.
- Streamlining product production and promoting new products (Reinartz et al., 2009).

Research Hypotheses:

H1. Technological Innovation has a strong effect on ECRM.

H2. Technological Innovation has a strong effect on Supply Chain Management.

H3. Supply Chain Management has a strong effect on ECRM.

H4. Technological Innovation has a strong effect on Business Management.

H5. Business Management has a strong effect on ECRM.

H6. Supply Chain Management mediates the effect of Technological Innovation on ECRM.

H7. Business Management mediates the effect of Technological Innovation on ECRM.

H8. Production development mediates the effect of Technological Innovation on ECRM.

H9. Strategic management moderates the effect of Technological Innovation on ECRM.

This study aims to provide a model for estimating ECRM success, understanding company motivations, and identifying customer needs. It assesses the impact of technological innovation on ECRM and SCM, the role of business management in ECRM adoption, and the mediating effects of SCM and business management on the relationship between technological innovation and ECRM. The study uses samples from two large industrial projects.

What is more, this article contributes to the analysis of the interrelationships between technology and society since the use of ECRM will enhance the success of the companies in determining customer needs. This helps supporting managerial decisions in order provide better products and services that improve citizens' life conditions in a sustainable way. This is, the search for economic development alternatives without damaging the environment (Kahlau et al., 2019). In addition, the present helps to reveal the implications of technology in society (Simão et al., 2025) because the study comprises the use of different scientific methods applied to two companies and, therefore, demonstrates the use of technology in solving managerial issues.

Structural equation modelling (SEM) is a statistical technique for analysing structural relationships. There are different types of SEM methods, such as covariance-based (CB-SEM) and variance-based (PLS) (Usakli & Küçükergin, 2018; Cepeda-Carrion et al., 2018). While CB-SEM is widely used in social sciences and relies on assumptions like normal distribution and large sample size, PLS is a more moderate approach without such assumptions (Alamer, 2022). PLS was first introduced by Herman Wold in 1979 as an alternative to the maximum likelihood (ML) method used in CB-SEM (Ranjbar et al., 2020). PLS focuses on prediction and exploratory analysis, making it suitable for small sample sizes and non-normal data distributions (Chin et al., 2010; Hair et al., 2014). There are different approaches to SEM, including Covariance-Based Structural Equation Modelling (CB-SEM), Partial Equation Modelling (PEM), Generalized Structural Component Analysis (GSCA), and Nonlinear Universal Structural Relational Modelling (NEUSREL) (Hair, Hult, Ringle, & Sarstedt, 2016). Researchers should consider the advantages and disadvantages of each approach when choosing a method.

Despite these limitations, PLS is suitable for structural equation modelling in applied research projects (Hair & Alamer, 2022), especially in cases where participants are limited or the data distribution is skewed (Skewness). PLS-SEM can be used in various fields of science, such as accounting (Nitzl, 2016), Human Resource Management (Ringle et al., 2020), behavioural sciences (Bass et al.,

2003), strategic management (Hair, Sarstedt, Pieper, & Ringle, 2012), marketing (Henseler et al., 2009; Hair, Sarstedt, Ringle, & Mena, 2012), information management system (Hair et al., 2017; Chin et al., 2003), tourism (Do Valle & Assaker, 2016), healthcare (Avkiran, 2018), operation management (Bayonne et al., 2020), Software Engineering (Russo & Stol, 2021), Higher Education (Ghasemy et al., 2020), etc.

Backgrounds:

A large number of studies and research have investigated the effects of ECRM, which has resulted in high customer satisfaction (Al-Dmour et al., 2019; Upadhyaya, 2020), keeping customers and shareholders (Al-Dmour et al., 2019), customer allegiance (Mang'unyi et al., 2018; Shastri et al., 2020), and being profitable (Rastgar et al., 2019). Although ECRM has an excellent reputation, there have not been enough detailed studies on profitable companies with developing financial conditions (Shastri et al., 2020). ECRM systems can improve the relationship between employees, organizations, and companies because ECRM has different dimensions, such as employees, systems, advanced technology, and organizing procedures (Damabi et al., 2018). Customer Relationship Management (CRM) is integrated with technology, so technology is one of the main elements of ECRM (Almajali et al., 2022).

A company's strategy is considered a general principle that managers and organizations adapt to the rapidly changing market and environment, remain profitable in the long term, and use their limited resources to stabilize the company's economic situation. The type of strategy chosen thoroughly depends on the market analysis. Its effectiveness should increase sales and profitability, satisfy consumer demands, adapt the company's capabilities to the market situation, and achieve its goals (Poita et al., 2022). For companies that have or use information technology, integrating CRM and supply chain management (SCM) can help improve the supply chain, analyse data, and increase satisfaction (Gencer, 2020).

The theoretical foundations underpinning the study of technology and society provide critical insights into how technological change influences social dynamics. D'Hauwers et al. (2025) argue that the relationship between technology and culture is characterized by a co-evolutionary process, where technological developments are both a product of and a catalyst for societal change. This perspective is crucial for amplifying the discussion on the societal implications of technology, as it encourages a holistic approach that considers the multifaceted interactions between technological systems and social structures.

Additionally, the work of Lee et al. (2025) on the role of technology in shaping modern societal norms and values offers a valuable theoretical framework for understanding the complex interplay between technological advancements and societal evolution. By expanding the discussion in light of these theoretical bases, researchers can better elucidate how technology reflects and actively shapes societal priorities and trajectories.

Exploring the link between society and technology also reveals the critical role of digital platforms in facilitating social engagement and connectivity. Recent research highlights that access to technology applications such as email, the internet, and social media has become a cornerstone for promoting social interactions and fostering community ties. This digital connectivity enhances

communication and provides a means for individuals to engage with broader societal issues, thereby influencing public opinion and collective action. Smith and Ely (2025) demonstrated how digital tools can strengthen societal connectivity and enhance overall community engagement, particularly in diverse social contexts. This underscores the potential of technology to bridge social gaps and create more inclusive communities, further emphasizing the need to consider the societal impacts of technological advancements in policy and practice.

A change in the organization's CRM strategy and the concentration of employees communicating with customers in various marketing and support areas cause long-term relationships between the customer and the organization (Cierna & Sujova, 2022). Moreover, digital e-commerce is based on innovative behaviours, customer demands, and society's awareness in the digital era (Hermawati et al., 2020). Consequently, to maintain the company's profitability, the target market of the customers is considered the company's goal (Gelhard & Von Delft, 2016). Creating a competitive advantage through ECRM helps marketing to identify customer and market needs and develop effective capabilities for employees and managers (Gil-Gomez et al., 2020). According to a survey of small and medium companies, the existence of ECRM is necessary for a long-term relationship (Pohludka & Stverkova, 2019). One of the marketing goals is to convince customers to buy products or services. With the development of information and communication through new technologies and organizing ECRM, the relationships between companies and customers are changing and converging while maintaining customer satisfaction (Lokesh et al., 2022).

To sum up, electronic customer relationship management (ECRM) has become crucial for businesses in managing customer relationships in the digital age. Implementing ECRM can help organizations improve customer satisfaction, understand market requirements, and make informed decisions. By analysing customer behaviour and preferences, ECRM enables businesses to personalize their offerings and enhance the overall customer experience. Moreover, ECRM can facilitate strategic and supply chain management by providing valuable insights into customer needs and preferences (Ledro et al., 2022).

METHODOLOGY

The behaviour of society and customers has become a determining factor for behaviour and social reality, which directly affects qualitative research. Tests on hypotheses considered in problems and development are used in quantitative research, which is the opposite of qualitative research. In qualitative research, the focus is on the essence of the research itself and not on the number of its features. This case study deals with the issue of companies and organizations having the best products and services accepted by customers and individuals, and according to the customers' needs, they should provide the best. Management under the title of customer experience management can, by transferring these experiences to organizations, create competitive and advantageous solutions that ultimately improve the performance of companies and lead organizations to new knowledge.

The factors involved in collecting information include the purpose of the research, the nature of the data required, the availability of resources, and the time constraints. The methods and stages of information collection in industrial

projects are also examined. These stages typically include planning, data collection, processing, analysis, and reporting. The validation of real information in the activities process is crucial to ensure the accuracy and reliability of the data. This involves cross-checking the data with various sources and verifying it with those directly involved in the projects.

Finally, ideas are provided to obtain the required information for Engineering, procurement, and Construction (EPC) and industrial projects. These ideas are illustrated with examples from case studies in internal groupings of projects. This helps understand the practical application of the data collection and analysis methods in real-world scenarios.

Analysis of the research model:

The analysis of models using the method of structural equations with the partial least squares (SE-PLS) approach consists of two main stages: checking the model fit and testing the research hypotheses. The model fitting stage includes three parts: measurement models, structural model fitting, and overall model fitting (Schuberth et al., 2023; Hair et al., 2012).

The fit of the measurement model:

In general, a measurement model is related to a part of the overall model that includes a variable along with questions related to it, and three criteria of convergent validity, divergent validity, and reliability are used to fit measurement models (Hair et al., 2017; Ringle et al., 2023).

The second criterion for evaluation is generally internal consistency and reliability. The value of this index should be above 0.7 (Hair et al.,2022). Due to the limitations of Cronbach's alpha in the community, another internal consistency reliability measure, Composite Reliability (CR), is permissible. This type of reliability considers different external loads of representative variables. The appropriate value for this index is 0.7 (Hulland, 1999; Hair et al., 2020). To check the convergent validity at the factor level, the Average Variance Extracted (AVE) Index is used, which, as mentioned in the third chapter, the minimum suitable value for this coefficient is 0.5 from the point of view of Fornell-Larker (1981). According to the point of view of Magner et al. (1996), the value is 0.4 (Hair et al., 2017).

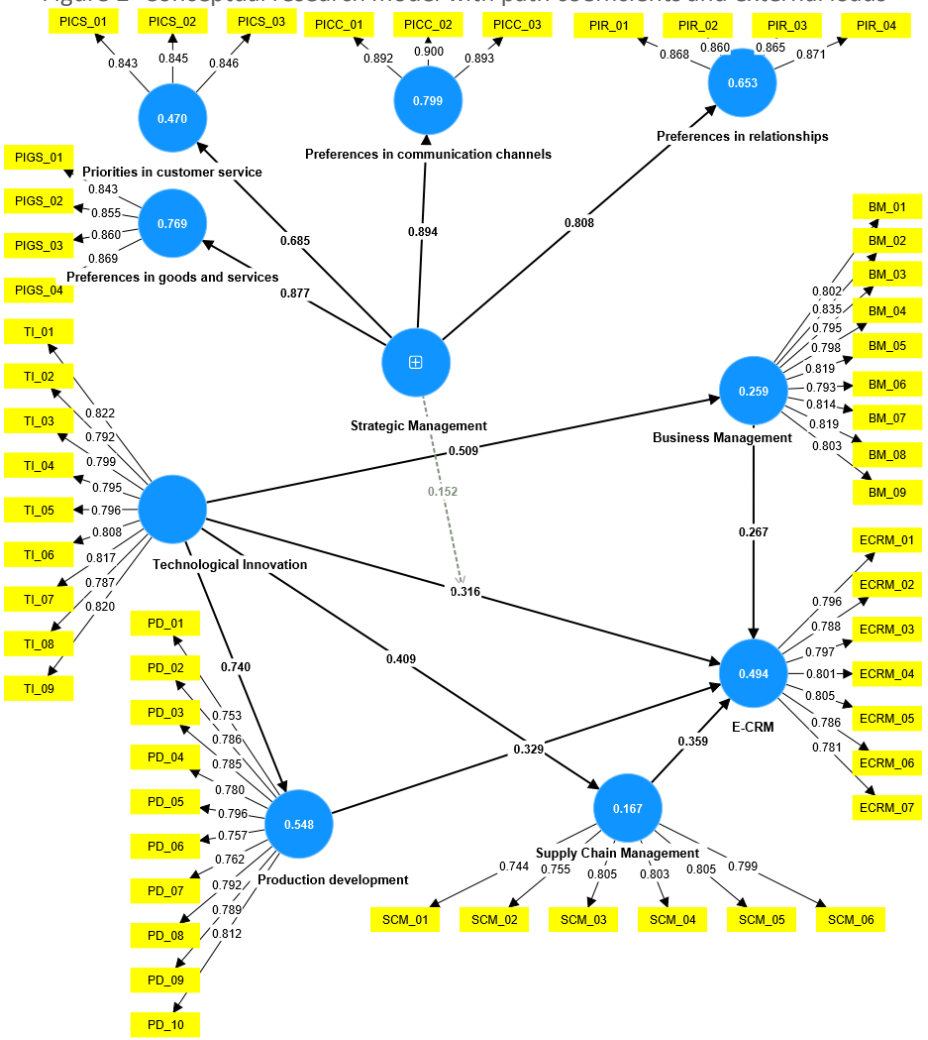
Table 1- An overview of the quality criteria of the model

Latent Variable	ð	CR	AVE
Business Management	0.934	0.934	0.654
ECRM	0.902	0.902	0.630
Preferences in communication channels	0.876	0.876	0.801
Preferences in goods and services	0.879	0.880	0.734
Preferences in relationships	0.889	0.889	0.750
Priorities in customer service	0.800	0.800	0.714
Production development	0.929	0.930	0.611
Strategic Management	0.877	0.908	0.615
Supply Chain Management	0.924	0.927	0.510
Technological Innovation	0.932	0.932	0.647
AVE= Average variance extracted; CR= Composite reliability; ð=Cronbach's alpha			

Source: Author's own

The conceptual model of the current research, along with external loads and path coefficients (Figure 2):

Figure 2- Conceptual research model with path coefficients and external loads



Source: Author's own

Structural model fit:

The presence of transverse loads that exceed the external loads of the representative indicates the problem of differential validity. This measure of differential validity is weak (Hair et al., 2022). Fornell-Larker criterion is the second and more conservative approach to measure discriminant validity.

Table 2- Fornell-Larker criterion

Raw	Latent Variable	1	2	3	4	5	6	7	8	9	10
1	Business Management	0.809									
2	ECRM	0.421	0.794								
3	Preferences in communication channels	0.506	0.507	0.895							
4	Preferences in goods and services	0.333	0.519	0.743	0.857						

5	Preferences in relationships	0.573	0.419	0.670	0.550	0.867					
6	Priorities in customer service	0.364	0.685	0.490	0.524	0.373	0.845				
7	Production development	0.576	0.414	0.470	0.489	0.416	0.473	0.784			
8	Strategic Management	0.540	0.653	0.594	0.677	0.508	0.685	0.512	0.714		
9	Supply Chain Management	0.568	0.320	0.353	0.432	0.481	0.593	0.611	0.418	0.786	
10	Technological Innovation	0.509	0.358	0.419	0.364	0.448	0.314	0.710	0.473	0.409	0.804

Source: Author's own

The results of Table 2 indicate that the square root of AVE for the reflective structures mentioned in the above table is all higher than the correlation of this structure with other latent variables in the path model. Therefore, the discriminant validity has been demonstrated. The problem that the Fornell-Larcker criterion aims to solve is establishing discriminant validity in research models by ensuring that each construct shares more variance with its corresponding variables than with other constructs, thereby confirming that the constructs are distinct and unrelated.

The heterotrait-monotrait ratio of correlation (HTMT) matrix method is used to investigate the differential validity of measurement models. For differential validity analysis, questions of constructs should be more significant compared to the factor loadings of other constructs (Henseler et al., 2015; Ringle et al., 2023; Hair et al., 2022). The results of the measurement model analysis indicate that the HTMT index for the values of all structures is greater than the factor loads of other structures. This means that the HTMT value of each variable should be less than 0.85 or 0.90 (Henseler et al., 2015; Franke & Sarstedt, 2019; Hair et al., 2019).

Table 3- The results of the differential validity test of the HTMT index

Raw	Latent variable	1	2	3	4	5	6	7	8	9	10
1	Business Management										
2	ECRM	0.457									
3	Preferences in communication channels	0.559	0.570								
4	Preferences in goods and services	0.367	0.583	0.846							
5	Preferences in relationships	0.629	0.467	0.759	0.622						
6	Priorities in customer service	0.421	0.638	0.586	0.625	0.443					
7	Production development	0.618	0.433	0.520	0.540	0.457	0.316				
8	Strategic Management	0.585	0.724	0.769	0.641	0.798	0.812	0.549			
9	Supply Chain Management	0.625	0.356	0.401	0.486	0.316	0.344	0.673	0.458		
10	Technological Innovation	0.545	0.323	0.464	0.402	0.493	0.363	0.795	0.511	0.442	

Source: Author's own

Overall model fit:

After examining the fit of measurement and structural models, the fit of the overall research model will now be discussed. Henseler and Sarstedt (2013) have recently challenged the usefulness of this index conceptually and empirically. In

general, when we use the fourth version of SmartPLS (SmartPLS V.4), we have two model fit indices, one of which is the Standardized Root Mean Square Residual (SRMR), whose value should be less than 0.08 (Schuberth et al., 2023; Cho et al., 2020). If the value of this index is less than 0.08, an acceptable fit is concluded. In the present study, this value is equal to 0.0796.

Table 4- Model fit values

Model of Fit	Criteria	Value	Conclusion
SRMR	< 0.08	0.0796	Indicating acceptable model fit
NFI	> 0.9	0.898	Indicating acceptable model fit
RMS Theta	< 0.12	0.061	Indicating acceptable model fit

Source: Author's own

Table 5 presents the outcomes of testing and rejecting research hypotheses. It is important to note that a hypothesis can be considered proven if the t-value or t-statistic exceeds 1.96. Consequently, at a 95% confidence level, it can be asserted that the hypothesis is valid. Based on the findings presented in the table, all hypotheses from numbers 1 to 9 are confirmed at the 95% confidence level.

Examining research hypotheses:

Table 5- PLS standardized path coefficients

Hypotheses	Path coefficient (β)	STDEV	T-statistics	p-Values	Support
H1: Technological Innovation -> ECRM	0.316	0.054	3.292	0.049	YES
H2: Technological Innovation -> Supply Chain Management	0.409	0.048	8.554	0.000	YES
H3: Supply Chain Management -> ECRM	0.359	0.044	2.322	0.046	YES
H4: Technological Innovation -> Business Management	0.509	0.034	15.022	0.000	YES
H5: Business Management -> ECRM	0.267	0.05	5.301	0.000	YES
H6: Technological Innovation -> Supply Chain Management -> ECRM	0.224	0.018	2.309	0.001	YES
H7: Technological Innovation -> Business Management -> ECRM	0.136	0.027	4.967	0.000	YES
H8: Technological Innovation -> Production development -> ECRM	0.244	0.045	5.393	0.000	YES
H9: Strategic Management x Technological Innovation -> ECRM	0.152	0.041	3.704	0.000	YES
*p<0.10(90%), **p<0.05(95%), ***p<0.001(99%)					

Source: Hair Jr. et al. (2021)

RESULTS AND DISCUSSION

Practical suggestions:

Based on the research findings and theoretical background, the following recommendations are proposed for industrial EPC projects:

- Utilize updated machines and modern technologies to streamline installation, implementation, testing, and start-up work, minimizing delays and unforeseen costs. Developing specialized software in design, R&D, testing, and commissioning departments can also improve progress and accuracy.
- Implement data management and working group meetings to create systems integration and provide accurate feedback from technology in the R&D department with Re-Engineering. Utilize innovative and digital supply chains to develop a coordinated connection between production, transportation, and production sectors, maximizing efficiency and profitability.
- Collect customer information transparently to understand their needs and demands, improving relationship management and creating an intelligent network to integrate information.
- Optimize product development and production by providing distribution channels, workflow designs, and training for production personnel. A skilled product production manager can lead the production team, ensuring compliance with production and quality laws and improving product quality, customer satisfaction, sales, and profitability.
- Adopt creative and innovative technologies in business management to affect the company and project process positively. Create a coordinated and intelligent network to recognize market shortcomings and communicate between clients, reducing costs and promoting the company nationally and globally.
- Implement intelligent and efficient supply chain management as an intermediary between production and customer management. Utilize high-production technology machines and an ECRM system to collect feedback and improve efficiency in the market.
- Implement operational, structural, and analytical management to create stronger relationships in the market and among projects, resulting in more efficient business management, lower costs, and improved market knowledge.
- Utilize an advanced and precise product development and production system to minimize errors, reduce problems, and prevent their occurrence. Intelligently manage product development and establish a connection between production technology and customer demands to increase production capacity and stability.
- Determine necessary strategies for company and project goals by creating a network of critical relationships, analyzing communication channels, identifying customer groups, and making decisions in communication. Understand market and customer needs to satisfy demands and lead the

market. Identify suppliers, services, and standards, and provide necessary resources and support. Prioritize customer needs and create a bright and robust ECRM network, sales and distribution network, and markets for customer needs.

By following these recommendations, industrial EPC projects can improve efficiency, reduce costs, and increase profitability, leading to successful project outcomes.

Recommendations:

The statistical sample of this study comprised 385 respondents, determined through the Sample Power software. Despite the willingness of the respondents to complete the questionnaire, time constraints posed a challenge. Many respondents had busy work schedules and other commitments, which often resulted in delays in data collection. To overcome these issues, future studies might consider expanding the statistical sample, although this could increase the cost and duration of the research.

Given the advancements in the PLS-SEM method in recent years, a step-by-step approach for improvement and standardization is proposed:

- Creating a general model and formulating hypotheses and theories: Previous research and samples can be reviewed to investigate prior works and formulate necessary assumptions and hypotheses, leading to an initial model.
- Creation of Datasheet and Specification for Tools and Methods of Measurements: One such measurement tool is PLS-SEM, which can be used with SmartPLS software to measure the researched items. The more current the technique used, the more accurate the calculations will be.
- Collecting, categorizing, and grouping all data and information obtained: The statistical community's extent and diversity are crucial. Various methods can be used to collect data and information, and the demography, typology, statistical sample framework, and the extent and consensus of the data can be investigated.
- Model analysis and data extraction for initial evaluation: Validity, Reliability, External and internal models, Reflective and formative models, Variance-based, etc., can be used as examples for this step. Information output and comprehensive report: The final report should include detailed calculations, results obtained, generalizability, and future suggestions. The findings and steps to access them should be presented understandably.

FINAL CONSIDERATIONS

The rapid advancement of technology and information not only presents a plethora of research opportunities for the future but also underscores the evolving relationship between society and technology. As technological innovations continue to reshape industrial landscapes, they simultaneously influence societal structures and dynamics. This interplay between technology and society is crucial for understanding the broader impacts of industrial projects and technological implementations (Lee et al., 2025).

The successful execution of various projects worldwide, facilitated by innovative technologies, remains central to any industrial endeavor. These technologies significantly reduce time and cost, thereby enhancing efficiency and productivity. A crucial aspect of these projects involves managing relationships with various stakeholders, such as employers, clients, owners, consultants, contractors, and manufacturers, often referred to as customers. Meeting their demands is a critical focus in every project, reflecting the societal expectations and values that shape technological adoption and adaptation.

Industrial projects across diverse sectors—including the oil and gas industry, petrochemical industry, refineries, urban and suburban subways, inter-urban and country railways, construction industry, raw material manufacturing industries, and pharmaceutical and chemical industries—offer rich contexts for future research. Expanding the scope of research to larger projects, investigating more complex case studies, or exploring projects in different and more specific locations can provide valuable insights into the societal implications of technological advancements (D'Hauwers et al., 2025).

Identifying other factors involved in unique project samples, producing special equipment or samples, creating exceptional products and processes, and increasing the sample size with diverse data collection methods can significantly contribute to future research. The Partial Least Squares Structural Equation Modeling (PLS-SEM) method, a promising and valuable approach, can guide researchers toward developing sustainable solutions. This method has made significant strides in recent years and has proven beneficial at the organizational and company levels. It can be considered a practical method in customer communication, as it effectively transforms experimental viewpoints, perceptions, and opinions into measurable data.

Moreover, emphasizing research in artificial intelligence (AI) can be a promising direction. In this context, research on AI-CRM (Artificial Intelligence Customer Relationship Management) and AI-ECRM (Artificial Intelligence Electronic Customer Relationship Management) can make significant strides. These advancements will not only enhance needs assessment and strengthen relationships but also provide deeper insights into the societal impacts of AI Technologies (Yi et al., 2023).

In conclusion, the integration of technological innovations in industrial projects must be viewed through the lens of their societal implications. By considering the co-evolution of technology and society, future research can contribute to developing more sustainable and socially responsible technological solutions.

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Recebido: **29/04/2025**
Aprovado: **30/06/2025**
DOI: 10.3895/rts.v21n64.20191

Como citar:

HASSANI, Alireza; PALACIO, Juan Carlos Castro; MONSORIU, Juan Antonio. et.al. Providing a model for estimating the success of electronic customer relationship management systems in industry management.

Rev. Tecnol. Soc., Curitiba, v. 21, n. 64, p.58 - 74, abr./jun., 2025. Disponível em:

https://periodicos.utfpr.edu.br/rts/article/view/20191

Acesso em: XXX.

Correspondência: