THE PROCESS OF BUILDING AND IMPLEMENTING A QUALITY-INNOVATION MODEL

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Abstract

This paper describes the construction and application of a relationship model between the quality and innovation variables in the context of the agricultural machinery industry in Mexico. The model allows the degree of maturity of each of the variables to be weighted, assigning a value to each component and element to analyze their relationship. Thus, the construction process is presented in four stages and its application in an agricultural machinery manufacturing company located in Mexico. It shows that quality positively but indirectly affects innovation, through the strengthening of the intermediate variable that drives innovation. Furthermore, results suggest that quality promotes incremental rather than radical innovation, by driving rational innovation, in which companies can ensure commercial viability. Finally, the limitations of the work are exposed in the work and its validation through the application in other industries and contexts is suggested.

Keywords: Quality, Innovation, Agricultural machinery.

INTRODUCTION

According to a study by Gottfredson et al. (2008), carried out in order to identify the problems faced by the 500 most important companies in the world in the last 50 years, 87% of business crises are caused by internal factors, including failures to innovate and lack of management of the organization's resources. This has led to the suggestion that innovation and quality contribute significantly to improving the performance of organizations, making them more competitive in the market (Saloner et al., 2005b; Schumpeter, 1967; Thompson et al., 2012). Although both elements contribute to the better performance of organizations, there is ample scope for discussion about the relationship between the two variables.

Quality, innovation, and their relationship

In the case of standardization in Mexico, the Quality Infrastructure Law, in its section of the National Quality and Innovation System, states that the application of standards contributes to innovation in products and services (Secretaría de Economía, 2020). Similarly, other international models such as the quality ladder model point out that quality, research, and development (R+D) and innovation are interrelated tools that allow companies to be more competitive(Grossman & Helpman, 1991; Klette & Griliches, 1997).

Although this relationship has been studied in many areas, there is still a long way to go to reach more accurate conclusions. Delving into the literature, it can be observed that this relationship has been approached in two ways. One where the quality-innovation relationship is observed as positive and the other, where innovation is negatively affected by quality. Before discussing these two perspectives, both concepts are briefly addressed, suggesting that while quality is doing things better, innovation involves doing things differently (Zeng et al., 2017).

In companies, management staff are continually trying to improve their products and services to generate wealth and profits. This gives meaning to the term perpetual innovation, which is based on Schumpeter's creative destruction, which describes the consistency and speed with which new technologies replace previous ones (Hitt et al., 2008). To be considered an innovation, an idea initially proposed must be accompanied by its commercial implementation(Schumpeter, 1967). An example of this phenomenon was the development of automobiles, which in turn reduced the demand for bicycles and made carriages obsolete.

An innovation can be "the result of a series of minor improvements that result in a significant difference, the difference between being or not, is subjective because it is relative to the context, capabilities and requirements of each company". Under this definition, many activities can be considered as innovation (OECD, 2018, p.79).Thus, the literature shows studies that classify innovations according to their impact at a given time. This explains why, while some innovations can be developed by modifications made in work practice, by exchanges and combinations of professional experience, others can be more elaborate. It is also worth mentioning that innovations are not only related to the development of new technologies, but innovation can also involve changes in the behavior and organization of companies to manage knowledge and other resources.

On the other hand, quality, according to Ishikawa, involves designing, producing, and offering a product or service that is useful, at the best price, and that always satisfies the needs of the customer (San Miguel, 2007). For his part, the creator of the Zero Defects concept, P. Crosby, defined quality as doing what was agreed at the agreed time(Munch, 2016). Whereas, for the International Organization for Standardization (ISO) it represents "the degree to which the characteristics of an object comply with the requirements of the customer, legal, regulatory or self-imposed by the organization"(ISO TC/176, 2015). In the usual terminology of the production sector, quality is linked to excellence and being at the forefront in order to obtain and maintain a competitive advantage. In the U.S., about 92% of manufacturing companies and 69% of service companies have implemented some form of quality management (Wheelen& Hunger, 2007). The rise and importance of

quality in organizations worldwide has led to the creation and implementation of multiple tools for quality management such as quality circles, *Total Quality Management* (TQM), *six sigma* and management systems based on the ISO 9000 standard.

However, we mentioned earlier that it is possible to identify in the literature different studies that have addressed the relationship between quality and innovation that present different results. A first perspective asserts that the relationship between quality and innovation is positive(Dean Jr & Bowen, 1994; Kanji, 1996; Prajogo & Sohal, 2003; Roffe, 1999; Tang, 1998; Zeng et al., 2015, 2017). However, quality does not affect different types of innovation in the same way. Authors such as Gotzamani&Tsiotras (2002) and Terziovski& Guerrero (2014) point out that, given the focus of ISO 9001, which focuses on process control, the positive relationship between quality and innovation has a greater impact on process innovation than on product innovation.

A second perspective presents a position where innovation is negatively affected by quality processes. Studies suggest that quality processes can include mechanistic routinization and standardized business processes, thus restricting creativity and innovation(Glynn, 1996; Kanter, 1983; Liao et al., 2010; Perdomo-Ortiz et al., 2009a), situations that lead organizations to concentrate inwards, becoming rigid and difficult to recognize and introduce innovations tags (Saloner et al., 2005a; Christensen, 1997).

In view of these divergent perspectives, the construction of a model that relates both variables are presented, as well as its application that allows evaluating this relationship in the context of the agricultural machinery industry.

Construction of the quality-innovation model

To identify the relationship between the variable's quality and innovation, a model was constructed that relates the dimensions of both variables. This model makes it possible to weigh the degree of maturity of each variable in an organization and then analyze the relationship between the quality components and the innovation results of that organization. The four stages of model construction are described below.

Stage 1. Identification of components in the quality and innovation variables

The study of the quality variable allowed us to identify that it is composed of elements that together promote learning processes, which result in useful knowledge for the improvement of performance, products and services and increase customer satisfaction. Figure 1 presents the proposed components and elements of the quality variable.

Likewise, several elements that help to characterize the innovation variable were identified. Figure 2 shows how innovation can be characterized by considering two main aspects: its type (e.g., product and services, business processes) and its degree of significance (radical innovation, incremental innovation, and improvement).

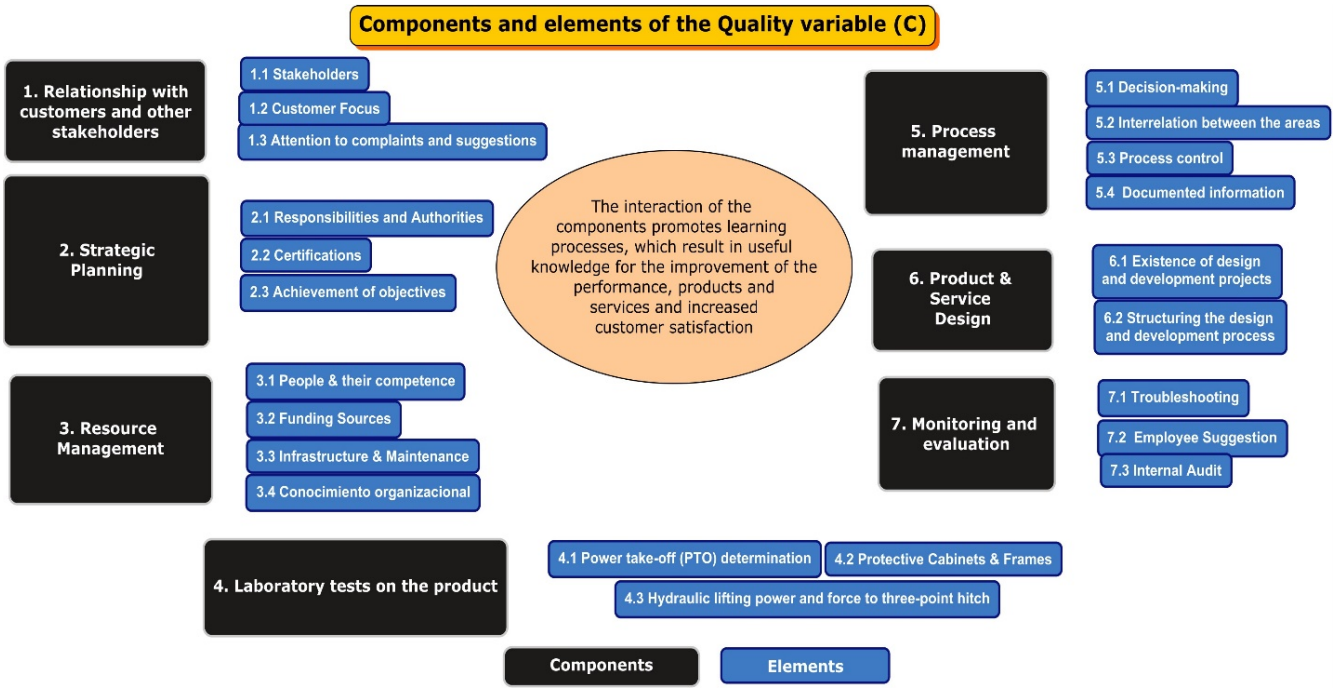

Figure 1

Components and Elements of the Quality Variable

Note. The components are presented in black and the elements that compose them are presented in blue. Own elaboration.

Stage 2. Identification of the relationship between the components of the quality variable and innovation.

After the identification of the components of the variables studied, an argument was made about the potential relationship between the components of quality and innovation results. Table 1 shows the relationship and the arguments that support this relationship (See Relationship with Innovation column).

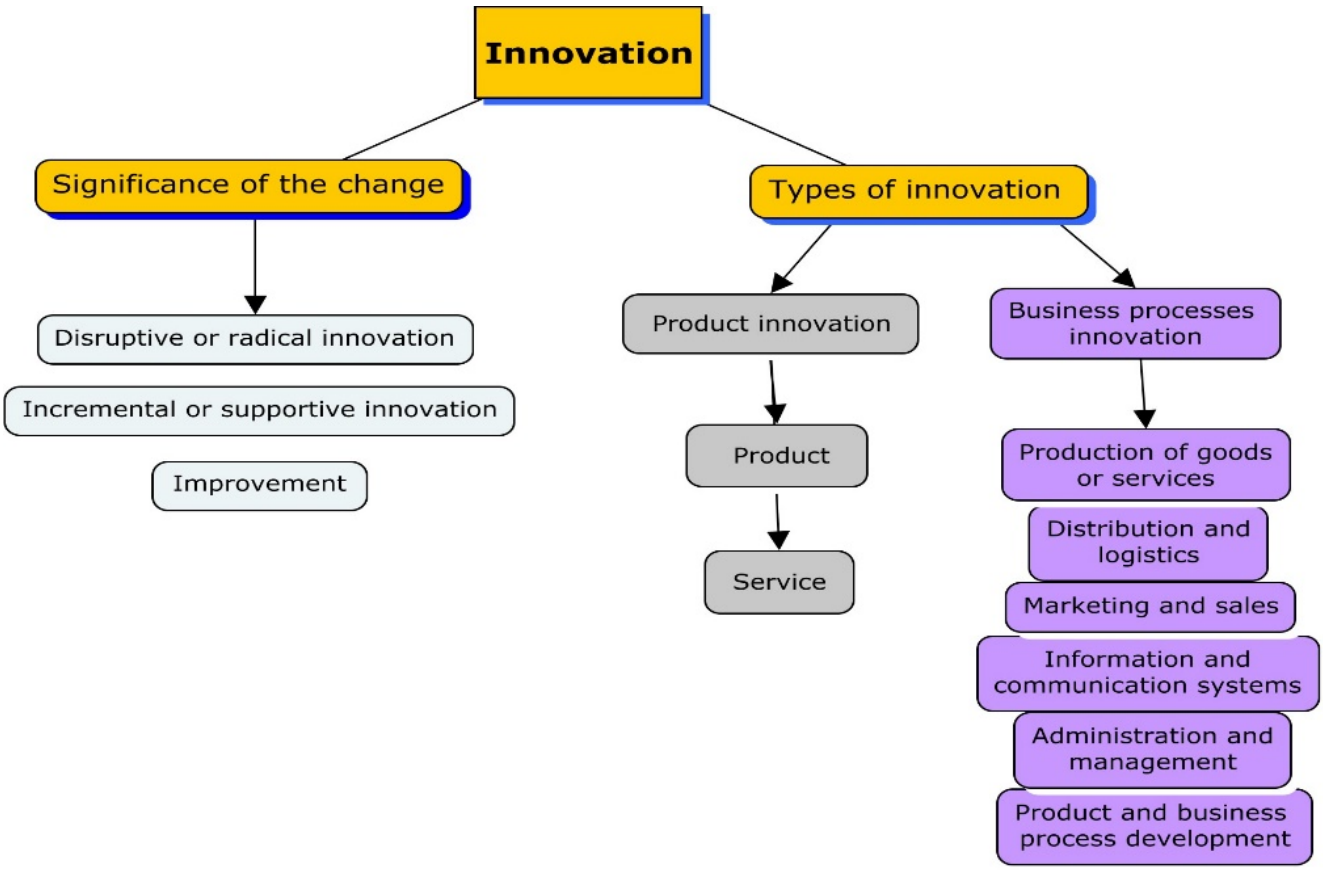

Figure 2

Elements of the innovation variable (results).

Note. Authors' own elaboration based on the Oslo Manual (OECD, 2018).

Table 1.
Components and elements of the quality variable and its relationship with innovation.

QualityComponent	ComponentDescription	ComponentElements	ItemDescription	Relationshipwithinnovat
Relationship with customers and other stakeholders	Understanding the needs and expectations of stakeholders through communication and consultation activities with customers, suppliers, regulatory entities, partners, etc	Stakeholders	Knowledge of the needs of different stakeholders (customers, suppliers, government, etc.)	Communication and consultation with the different stakeholders allo the organization to know what they expect from the products/services, what ar their problems that need t be solved. Analyze the context and factors involv
		Customer Focus	Commitment to understanding and regularly meeting customer requirements.	Position of senior management regarding th need to know the expectations and needs of client and how much it is their interest to provide everything necessary for th to be pursued.
		Attention to complaints and suggestions	Existence of methods for dealing with complaints and suggestions from customers and other stakeholders.	Thanks to the analysis of complaints, it is possible t identify information abou the company's deficiencies but also information that not been previously identified, such as future trends or current needs no covered in the market.
Strategic Plannin g	Direction set by the steering group, as well as its commitment to provide the resources and make the necessary changes to achieve the goals and implement changes to pursue the opportunities of the context.	Responsibilities and Authorities	Definition of structure and definition of organizational roles.	Not applicable.

			Existence of policies, objectives, and other strategic guidelines.	If the policy and objective clearly show a posture of seeking significant improvement and innovat in its processes, products, services to improve performance and custome satisfaction. The guide lin are likely to drive innovati behavior.
		Certifications	Number of certifications held by the company.	The number of certificatio reflects the constant commitment to continuo improvement, reorganization, reengineering, and innovation (ISO TC/176 2015).
			Types of certifications held by the company (voluntary/ mandatory).	If a company's certificatio are voluntary, it implies th it is an extra that they seek comply with, and if they a also seen as challenges wit the organization, they will look for a way to comply, sometimes with innovativ solutions.
			Importance that the company gives to certifications.	
		Achievement of objectives	The degree to which the organization sets goals and shares information about productivity and quality.	Compliance analysis can l the organization to chang goals or challenge itself an lead to an attitude of defiance that drives the organization to make cha to processes, products, or services.
Resource Management	It includes managing the resources the organization needs to operate and improving performance. As well as the continuous creation and safeguarding of knowledge to nourish decision-making and projects.	People & their competence	Number of people employed in the company	The larger the organizatio the greater the capacity to generate and implement innovative ideas (Mazzuca 2014).
			Employee turn over rate (%)	Job stability leads to peopl being able to commit to lo term projects.

			Number of employees needed (% of current)	Having the necessary num of employees can allow th company to assign groups the development of innovative ideas and proje
			Degree of the company's commitment that employees receive ongoing training and skills development in the workplace.	Having people with skills multiple areas gives the organization the capabilit to develop processes, products and services that allow it to obtain competi advantages.
		Funding Sources	Access to finance *(sources)*	Government support and private investors - The company may allocate exclusive resources to research and development projects.
		Infrastructure& Maintenance	Physical Infrastructure – Installed Capacity	If the company has an adequate infrastructure, it allows it to tackle new projects.
			Degree of maintenance and diagnosis of the equipment in order to plan for repair or replacement.	Not applicable.
Process management	Planning, operation, and constant adaptation of the processes that are necessary for the provision of goods or services.	Decision-making	The degree to which the employee can make decisions.	Empowered employees ar committed to the growth the organization.
		Interrelation between the areas	The degree to which the areas of the company work in an interrelated way.	If there is continuous collaboration between the areas of the company, it w allow you to take advantag of all the company's capabilities to achieve spe projects.

		Internal process control	The degree to which processes are monitored to avoid variations.	Detecting variances can dr the implementation of fix through improvements or innovations.
		Documented information	Creation, updating and control of documented information.	Organizations with contro of their information have easier time planning, structuring, tracking, and preserving evidence of results.
Product & Service Design	Structured creative activities to meet customer needs and expectations and provide a competitive advantage in the marketplace.	Existence of design and development projects	Existence of product design projects.	From the design and R+D activities, the company wi obtain significant changes products and services.
			Existence of service design projects.	
		Structuring the design and development process	Existence of structured processes for design and validation.	The structured stages of creative and research activities allow for control to ensure that significant changes are feasible and sustainable in continuous production.
Monitoring and evaluation	Posture of the organization to achieve continuous improvement in processes, products, and services.	Trouble shooting	Employees organize themselves to get opinions and ideas before planning and solving problems.	Empowered employees engage in solving operatio problems to pursue the growth of the organizatio
		Employee Suggestion	The degree to which managers take and apply product and process improvement suggestions from employees.	The companies that listen the most to their employe have the vision of the problems and needs from various perspectives and levels, which generates use knowledge for the constan improvement of productio processes and service provision. Such as the modification of procedure incorporation of poka-yok Kaizen, etc.

		Internal Audit	Degree of commitment in internal reviews of quality processes	Audit events allow the company to self-assess and identify process performa risk and opportunity management, complaints, and customer satisfaction.
Laboratory tests on the product	Carried out by a third party to determine compliance with technical specifications, safety, and actual performance of the product.	Power to PTO	Degree of conformity in the test	Testing provides compani with third-party informat that is relevant to identify compliance with technica and safety specifications i the context of actual prod performance.
		Protective Cabinets & Frames	Degree of conformity in the test	
		Hydraulic lifting power and force to three-point hitch	Degree of conformity in the test	

Note. Own elaboration.

3. Identification of the intermediate variable between quality and innovation.

During the previous stages of the construction of the relationship model and the data that were collected in a first stage, it was identified that quality does not directly provide results in innovation. This led us to delve deeper and analyze the link that mediates this relationship. As a result of this research, it was identified that the interaction and presence of the components of the quality variable led to the appearance of a variable that was called the intermediate vairbale to promote innovation. This variable affects the company's decisions to adopt new technologies, its access to new knowledge and its ability to assimilate it; aspects that together allow the organization to remain at the same level as its competitors or gain a certain advantage. This variable is divided into two components: a) input and b) process, proposing that the resulting outputs are, in effect, the results in innovation. Thus, Figure 3 shows that the components of the intermediate variable of driving innovation enable the relationship between the quality components and the results in innovation, while Table 2 presents the description of the components and elements that make it up.

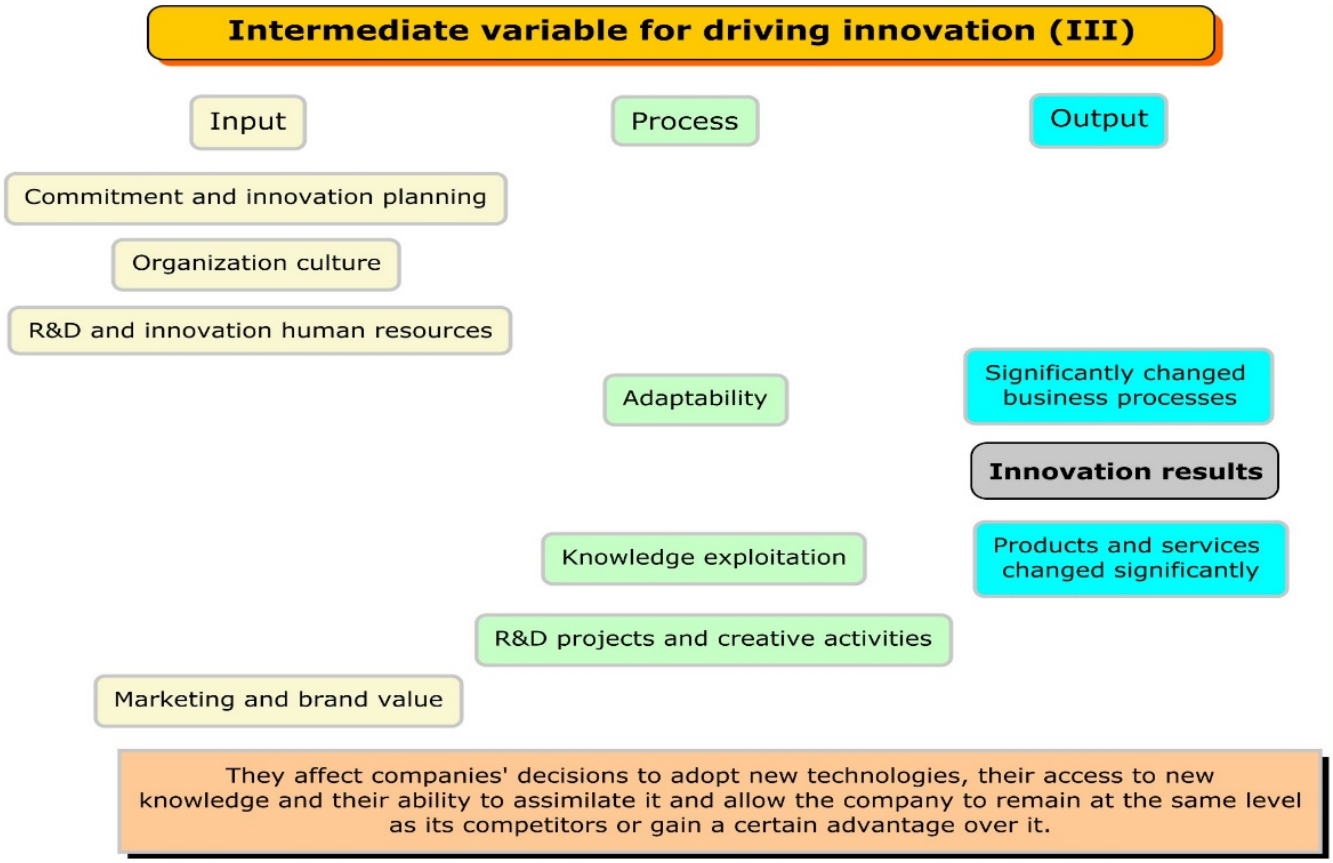

Figure 3

Components of the intermediate variable that drives innovation.

Note. Own elaboration

Table 2

Components of the intermediate variable that drives innovation and its components

Components of the variable	Description	ComponentElements	Description
Innovation Engagement & Planning	Prioritize innovation activities, as well as establish the scope and impact of innovation.	Innovation Planning	Existence of a technological innovation strategy in the company/ organization.
		Management'scommitment to innovation	Existence of a budget for the promotion and development of innovative ideas that can be incorporated into processes, products, or services.
		Government Support	Participation in support programs offered by government institutions.
R+D projects and creative activities	Application of experimentation and creativity, to generate resilience and benefits.	External R+D	Degree of use and contracting of scientific and technological services in R+D.
		Engineering, design, and other creative pursuits	Regular existence of experimentation or design and development projects.
Culture of theorganization	The coexistence of creative behaviors and risk aversion in their execution.	Staff initiative in new projects	The degree to which people take the initiative on new projects.
		Risk aversion	Degree of risk aversion in decision-making.

R+D and innovation human resources	Development of competencies that support the creation and execution of new ideas.	Employees with research backgrounds	Number of employees with a master's or doctorate degree engaged in design and development activities or experimentation.
			Existence of training programmes to promote innovation
		Proficiency in the English language	Percentage of employees who are proficient in the English language (*Yes, English is not the official language).*
Exploitation of knowledge	Effective insights go beyond the obvious and incorporate strategic foresight about future needs and conditions	Protection of knowledge	The degree and way knowledge related to product, service, or process developments is protected.
		StrategiesforKnowledgeGeneration	Existence of stimuli in the company for the generation of new ideas.
		Acquisition of externalknowledge	Acquisition of knowledge or technological developments through the purchase of patent licenses from other organizations.
Adaptability	Systematically anticipating, understanding the need for change, and responding to it is necessary for innovation	TechnologicalLearning	Use of systems to monitor technological trends in the sector.
			Degree of use and contracting of scientific and technological services.

		Organizational Flexibility	Accept risks and push for process changes that in turn can be transformed into opportunities to innovate.
Marketing & Brand Equity	The demand for products and services depends on their characteristics and their social image.	Relational Capital	Extent to which the company has a relationship with universities, research centres or knowledge networks (Academic research for R+D purposes).
			The degree to which the company has participation in confederations, chambers, or associations.
		Marketing	Use of new advertising strategies in recent years.

Note. Own elaboration.

Stage 4. Operationalization of the model

Based on the above, it is suggested that the quality variable, through its components, has a relationship with the intermediate variable that drives innovation, which in turn generates results in innovation. Once the three variables of the model have been determined, Table 3 presents the structure of the designed measuring instrument, whose reagents allow the evaluation of the components and elements of the three variables in question. Each item was given a quantitative weighting to identify the degree of maturity of each variable. Regarding the measurement of each component of the three variables, Tables 4, 5 and 6 show the way in which it was evaluated. It is worth mentioning that this same questionnaire has been applied to other companies, the results of which are declared in other works that were in the process of evaluation at the time of submission of this work.

Table 3.
Structure of the questionnaire applied to the companies studied.

Section 1Elements of Quality	**Section 2 Intermediate elements that drive innovation**	**Section 3Innovation Results**
Subsections		
1. Resource Management	1. Management Planning&Engagement	1. New or significantly improved products and processes
2. Decision-making	2. Projects, Behavior, and Integration	2. Collaboration in development.
3. Interrelationbetweenthe areas	3. Staff initiative in new projects.	3. Degree of novelty
4. Process control	4. R+D Human Resources	4. Purpose of Innovation
5. PreventiveMaintenance	5. OrganizationalKnowledge	5. Internal company sources for improvement and innovation
6. Achievement of objectives	6. TechnologicalLearning	6. Factorsthathinderinnovation
7. Troubleshooting	7. Relational Capital	
8. Employee Training	8. Scientific and technologicalservices	
9. Certifications		

Note. Ownelaboration.

Table 4
Weighted elements in the quality variable

QualityComponent	Value	ComponentElements	Description	Measurement/ Reagent in Questionnaire
Relationship with customers and other stakeholders	N/A	Stakeholders	Knowledge of the needs of different stakeholders (customers, suppliers, government, etc.).	ISO 9001 Requirement
	N/A	CustomerFocus	Commitment to understanding and regularly meeting customer requirements.	ISO 9001 Requirement
	N/A	Attention to complaints and suggestions	Existence of methods for dealing with complaints and suggestions from customers and other stakeholders.	EC OCIMA Requirement
Strategicplanning	N/A	Responsibilities and Authorities	Defined existence of organizational structure and roles.	ISO 9001 Requirement
	N/A		Existence of policies, objectives, and other strategic guidelines.	ISO 9001 Requirement
	5	Certifications	Number of certifications held by the company.	1.10.0
	N/A		Types of certifications held by the company (voluntary/ mandatory).	1.10.1
	4		Importance that the company gives to certifications.	1.10.2

	5	Achievement of objectives	The degree to which the organization sets goals and shares information about productivity and quality is available to all employees.	1.6
Resource Management	N/A	People&YourCompetition	Number of people employed in the company.	1.1.1
	5		Staff turnoverrate (%).	1.1.2
	3		Number of employees needed (% of the current one).	1.1.3
	5		Degree of the company's commitment that employees receive ongoing training and skills development in the workplace.	1.9
	3	Funding Sources	Access to finance*(sources).*	1.1.4
	5	Infrastructure & Maintenance	Physical infrastructure – installed capacity.	1.1.5
	5		Degree of maintenance and diagnosis of the equipment to plan for repair or replacement.	1.5
Process management	4	Decision-making	The degree to which the employee can make decisions.	1.2
	5	Interrelationbetweentheareas	The degree to which the areas of the company work in an interrelated way.	1.3

	5	Process control	The degree to which processes are monitored to avoid variations.	1.4
	N/A	Documented information	The extent to which the information required for the activities is documented.	ISO 9001 Requirement
Product & Service Design	N/A	Existence of design and development projects	Existence of product design projects.	2.2.1
	N/A		Existence of service design projects.	2.2.1
	N/A	Structuring the design and development process	Existence of structured processes for design and validation.	ISO 9001 Requirement
Monitoring and evaluation	5	Trouble shooting	The degree to which employees organize themselves in order to get opinions and ideas before making a decision and solving problems.	1.7
	5	Employee Suggestion	The degree to which managers take and apply product and process improvement suggestions from employees.	1.8
	N/A	Internal Audit	Degree of commitment in internal reviews of the organization's processes.	ISO 9001 Requirement
Laboratory Tests	N/A	Power Take-Off Power Determination	Degree of conformity in the test.	EC OCIMA Requirement Interview

N/A	Testing Protective Cabinets and Frames	Degree of conformity in the test.	EC OCIMA Requirement Interview
N/A	Determination of hydrauliclift	Degree of conformity in the test.	EC OCIMA Requirement Interview
Total: 64 points			

Note. The elements with N/A in the value column, despite not providing value, allowed us to understand the context and robustness of the company's quality management. Own elaboration.

It should be noted that in the case of the laboratory testing component, the product, which provides relevant information for manufacturers in terms of compliance with technical and safety specifications, was evaluated through documentary review and interviews with the source of information.

Table 5.
Weighted elements in the intermediate variable of driving innovation.

Innovation Promotion Component	Value	Component Elements	Description	Measurement/ In Questionnaire
Innovation Engagement & Planning	5	Innovation Planning	Existence of a technological innovation strategy in the company/organization.	2.1.1
	5	Management's commitment to innovation	Existence of a budget for the promotion and development of innovative ideas that can be incorporated into processes, products, or services.	2.1.2
	2	Government Support	Participation in support programs offered by government institutions.	2.6.2
R+D projects and creative activities	5	External R+D	Degree of use and contracting of scientific and technological services in R+D.	2.7.1
	4	Engineering, design, and other creative pursuits	Regular existence of experimentation or design and development projects.	2.2.1
Culture of the organization	5	Staff initiative in new projects	The degree to which people take the initiative on new projects.	2.2
	5	Risk aversion	Degree of risk aversion in decision-making.	2.2.2
R+D and innovation human resources	5	Employees with research backgrounds	Number of employees with a master's or doctorate degree engaged in design and development activities or experimentation.	2.4.1
	N/A		Existence of training programs to promote innovation.	Observation
	N/A	Proficiency in the English language	Percentage of employees who are proficient in the English language (*Yes, English is not the official language).*	2.4.2

Exploitation of knowledge	5	Protection of knowledge	The degree and manner in which knowledge related to product, service, or process developments is protected.	2.5.1
	4	Strategies for Knowledge Generation	Existence of stimuli in the company for the generation of new ideas.	2.5.2
	2	Acquisition of external knowledge	Acquisition of knowledge or technological developments through the purchase of patent licenses from other organizations.	2.5.3
Adaptability	5	Technological Learning	Use of systems to monitor technological trends in the sector.	2.6.1
	N/A	Organizational Flexibility	Degree of flexibility in understanding and responding to the need for change.	3.1.1
Marketing & Brand Equity	N/A	Relational Capital	Extent to which the company has a relationship with universities, research centers or knowledge networks (Academic research for R+D purposes).	3.1.3
	3		The degree to which the company has participation in confederations, chambers, or associations.	2.6.2
	N/A	Marketing	Use of new advertising strategies in recent years.	Observation
Total: 55 points				

Note. Own elaboration.

Table 6
Weighted Elements of the Innovation Variable

Component	Description	Component Elements	Description	Measurement / In questionnaire
Type of innovation	Significant improvements in products, services, or business processes.	New or significantly improved products and processes	Number of new or significantly improved products (goods or services) or processes (including methods) introduced to the market.	3.1.1
		Type of innovation (characterization)	More significant change incorporated into the company's innovations/ improvements.	3.15
		Purpose of Innovation	Importance of the purpose of the company's innovations/ improvements.	3.1.6
Degree of innovation	Degree of novelty (improvement, incremental innovation, radical innovation)	Degree of novelty or improvement of products and services	Classification of new or improved products and/or services.	3.1.2
		Degree of novelty or improvement of processes	Classification of new or improved processes.	3.1.2
		Degree of novelty	Degree of novelty of innovations.	3.1.4
Additional results				
Source of innovation	Sources and collaborators in innovations	Collaboration in development.	Actors in the development of significant improvements.	3.1.3
		Internal Sources for Improvement and Innovation	Internal company sources for improvement and innovation and its importance.	3.2.1
Barriers to innovation	Obstacles faced in the innovation process	Factors that hinder innovation	Factors that hinder innovation activities in the company and their impact.	3.3.1

Application of the model and results

The results of the application of the relationship model are presented in Table 7 and Figure 4, applied to an agricultural machinery manufacturing company located in Mexico, considered a large company due to its number of employees that exceeds half a million.

Table 7

Unit of Analysis Findings

Variable/Element	Findings of the analyzed company
Location	Mexico
Employees	521
Maturity of the quality variable	80%
Certifications	5 (ISO 9001, ISO14001, ISO45001, ISO 50001, ISO17025)
How Certifications Are Viewed	Important, they help to challenge themselves
Maturity of the intermediate variable that drives innovation	76%
People take the lead on new projects	Yes, proposing is rewarded
Do you think that there is a profit to be gained from the failure and error of projects?	It is not a good idea to experiment without having all the factors under control.
R+D staff	100 people
Employees in R+D who are fluent in English.	80%
Program to stimulate the generation of new ideas (internal)	Yes
Participation in confederations, chambers or associations	2
Programmes to support research and development or innovation (external)	1
Technology Monitoring System	Benchmarking
Contracted scientific and technological services	1. Consulting and Technical Assistance Services 2. Market research 3. Feasibility studies
Degree of novelty	Nationally, but not globally 50% Incremental product innovation 30% Significant improvement in product 20% improvement in product
Significantly improved products in the last 3 years	6 products, 25% of total
Purchase or licensing of patents from other organizations in the last 3 years	No
Source of Significant Change	The company with other locations worldwide
Internal Sources for Improvement and Innovation	1. Research, experimentation and technological development area. 2. Product Design Department 3. Production Department
Purpose of Innovations	1. Improve the quality of the product or service. 2. Expand product range. 3. Maintain market share. 4. Expand participation or create new markets
Limiting Innovations Expressing	1. Lack of adequate funding sources 2. Lack of public support 3. Obstacles arising from existing legislation (rules, regulations, standards)

Note. Own elaboration

Derived from the application of the model to study the relationship between quality and innovation, mediated by the intermediate variable of impulse to innovation, it was found that the robustness of the components of the variable quality related to the design, development, and manufacture of the product, contribute to the strengthening of the intermediate variable of impulse to innovation.

Likewise, it is observed that the quality variable has a maturity percentage of 80%, which shows its strength and contribution to the constant delivery of compliant products and high customer satisfaction. This strength of the quality variable is largely due to the global vision, the follow-up of warranty claims and the lessons they generate, as well as the continuous efforts to maintain five certifications in management systems (quality, environmental, occupational health, energy, and laboratory tests). Likewise, the solidity of the quality variable is largely due to the large databases that allow the company to manage the knowledge generated within it, as well as to the implementation of Kaizen and other analysis tools. In the same vein, efforts to maintain collaborative relations abroad with subsidiaries, importers, suppliers, government, etc., are very useful in strengthening the quality variable.

On the other hand, the model also made it possible to identify positive results with respect to the intermediate variable of driving innovation, obtaining a 76% maturity rate. This percentage is due, on the one hand, to the culture of experimentation and risk aversion, which leads the company to experiment once it has the greatest of the controlled parameters, once these have already been evaluated in other contexts. On the other hand, the exploitation of knowledge contributes to the strengthening of the intermediate variable thanks to the efforts made with respect to industrial secrets and patent registrations, which has allowed the company not to seek the purchase of developments patented by other organizations.

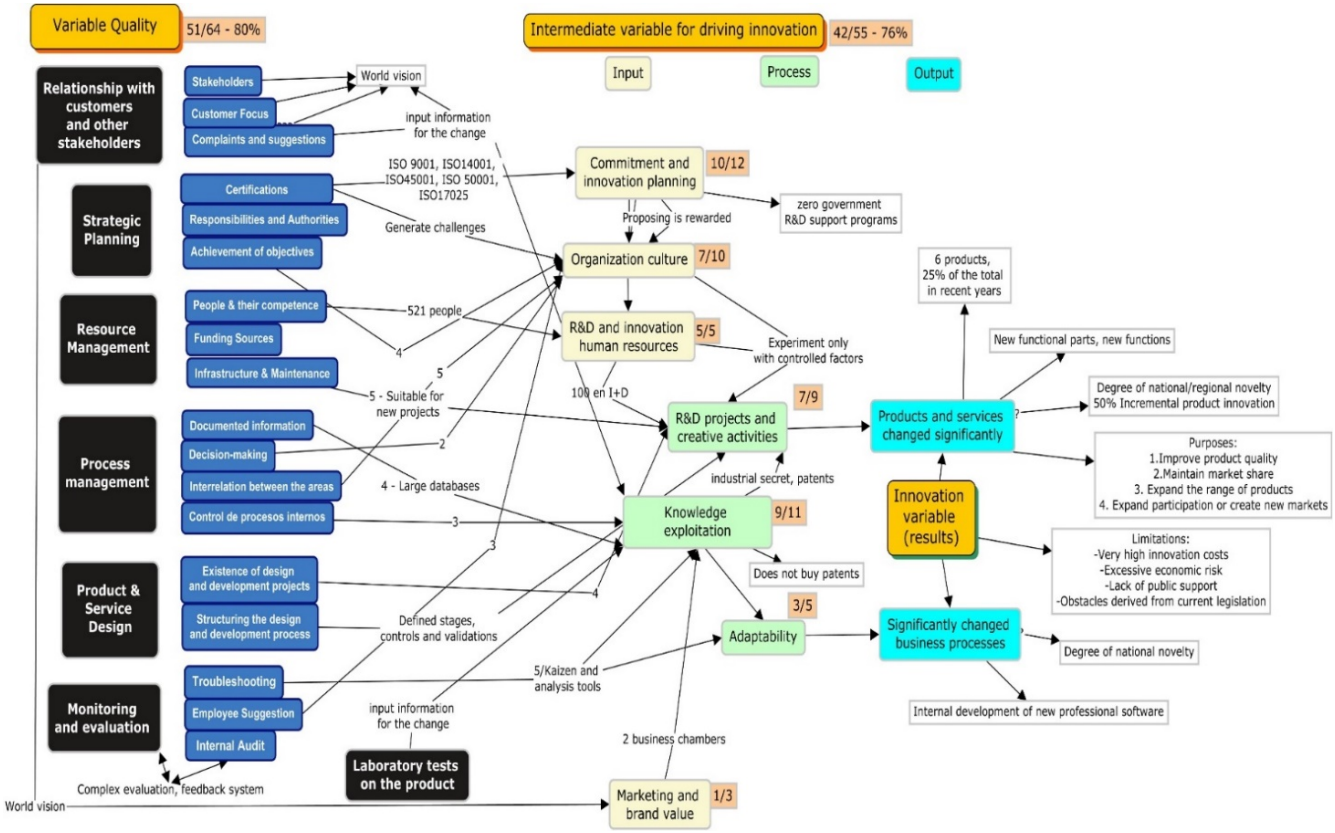

Figure 4

Models of unit of analysis relationships.

Note. The graph shows the score obtained in the elements of the variables in the unit of analysis - Manufacturer located in Mexico. Own elaboration.

The strength of the intermediate variable of driving innovation has allowed the company to integrate six new products into the market that include new functional developments, considered to have a degree of incremental international regional innovation. This has allowed the substitution of its product portfolio, the improvement of product quality, an increase in market share, the increase in developments of precision agriculture services and new markets in the industry.

Finally, in relation to the limitations presented by the company, it pointed out the difficulties they face in terms of current regulations, as well as the lack of public support for innovation and R+D in the Mexican STI ecosystem. Taken together, these situations make it difficult for the company to deal with the excessive risk of potential losses associated with the high costs involved in innovation. As a whole, the proposed model and its application allow us to observe that the elements of quality such as attention to complaints and guarantees, laboratory tests, process control and documented information contribute to the exploitation of knowledge component of the intermediate variable of impulse to innovation and that, in turn, this knowledge can be used to strengthen the components of adaptability of business processes and generation of innovative projects.

In addition, the quality components of process management, quality information, and product and service design contribute to the generation of development into more robust products and processes, while the monitoring and evaluation component allows for innovation in the way problems are solved and customer expectations are exceeded.

CONCLUSIONS

The study of the relationship model shows that the components of the quality variable have a direct relationship with the intermediate variable that drives innovation, and that this, in turn, strengthens the foundations for the development of innovative products, processes and services. This is since the components of the intermediate variable of impulse to innovation allow structuring and strengthening the activities and stages of development, through the generation of new knowledge that can be incorporated into innovative developments.

Given that the company indicated that it has limited budgets and deadlines for each project, the proposed model shows that quality promotes incremental innovation to a greater extent than radical innovation. This is because quality drives rational innovation, as it considers the viability of innovative projects.

Regarding the limitations of the study, one of the most relevant is the difficulty of access to information. This is because on some occasions the company hesitated whether to provide information, since, even though such information did not put the company or its projects at risk, there is no culture of providing information openly. This problem was especially present when issues related to the variables of impulse to innovation and their results in innovation were addressed. This situation, on the other hand, reflects the level of business distrust in the context in which it is located.

Finally, it is also worth mentioning that the results of this research are derived from the study of a company in the agricultural machinery industry, so it is suggested to validate the proposed model in other agricultural machinery companies, as well as in companies in other industries.

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