Instruments to Identify Relevant Quality Management Practices to Productivity

Reference to this paper should be made as follows: Ruales Guzmán, B.V., Castellanos Domínguez, O.F. and Brun, A. (xxxx) 'Instruments to identify relevant quality management practices to productivity', Int. J. Productivity and Quality Management, Vol. X, No. Y, pp.xxx–xxx. DOI: 10.1504/IJPQM.2019.10030817

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Abstract

The objective of this research was to develop data collection instruments that allow the identification of relevant quality management practices (QMp) to productivity indicators related to the economic, environmental and social sustainability of the dairy industry. The identification of the variables was carried out, on the one hand, through an exhaustive literature review and, on the other hand, through the suggestions of the academy and industry experts. Subsequently, in the construction and validation of the instruments, the most cited models in the literature about Quality Management (QM) were considered and the content validation by top managers was included. The findings revealed that the most reported QMp in the literature are 32 and that productivity indicators of the dairy industry suggested by the experts were 7 in total. Content validation evinced that vocabulary and structure of the instruments is adequate and understandable. The originality and the value of developed instruments in this study consist in that, unlike the previous ones, they will allow identifying the relevant QMp to specific productivity indicators for the dairy industry context. Additionally, they are easily adaptable to different agro-industries and they will generate inputs for the continuous improvement of companies and the strengthening of their competitive advantages. This makes them a valuable and useful tool for data triangulation, for future empirical research, for practitioners, managers and political decision-makers.

Keywords: Data collection instrument, Quality management, Productivity, Agro-industrial sector, Dairy industry, Questionnaire, Interview, Checklist

1. Introduction

The relationship between QM and performance is a topic of great relevance for researchers and practitioners due to its implications for the field of study and for sustainability and competitiveness of companies. To obtain useful and reliable

results in the research on the relationship of these variables, it is necessary to have appropriate and rigorously developed instruments for each context, since as Kumar (2011) stated, this is the first practical step to carry out any study. However some researchers do not consider it an inescapable step.

Several data collection instruments have been developed within the QM field and some of them are described below, which reflect the trend of most studies. One of the most reported instruments in the literature is the questionnaire proposed by Saraph, Benson and Schroeder (1989). It was developed to measure the critical factors of QM and tested in a sample of manufacturing and service companies in the United States. The questionnaire of Flynn, Schroeder and Sakakibara (1994) identified and grounded the key dimensions of QM in United States plants in the transport, electronics and machinery components industries. There is also the questionnaire proposed by Ahire, Golhar and Waller (1996), which was designed to measure QM constructs that affect the quality of the product and empirically tested in plants of the manufacturing industry of automotive components of the United States. The questionnaire of Rao, Solis and Raghunathan (1999) conceptualised and developed valid measurements for key dimensions of QM in the international context, in addition to considering the internal and external quality results at the plant level in manufacturing and service companies of the United States, India, China, Mexico and Taiwan. The one of Samson and Terziovski (1999) determined the relationships between the practices of Total Quality Management (TQM), individually and collectively, and the performance of the firm in manufacturing companies in Australia and New Zealand. The Van Der Spiegel, Luning, Ziggers and Jongen (2005) questionnaire was developed to measure the effectiveness of food quality systems and validated in the Dutch bakery sector. The one of Psomas, Kafetzopoulos and Fotopoulos (2013) was developed to measure the effectiveness of the QM ISO 9001 system, based on the objectives of the standard, and empirically validated in the Greek food sector. The structured questionnaire by Psomas and Jaca (2016) explored the impact of TQM factors on performance dimensions of Spanish service companies. The in-depth structured interview and questionnaire proposed by Jimoh, Oyewobi, Isa and Waziri (2019) examined the relationship and influence of TQM practices on different measures of performance in Nigerian construction companies. Finally but not least important, the one developed by Shafiq, Lasrado and Hafeez (2019) studied the effect of TQM practices on organisational performance in the Pakistan textile sector, a developing country in South Asia.

The data collection instruments proposed throughout the literature have been the input for other studies, have made a significant contribution to the consolidation of the theory of the QM and have also been a guide to continuous improvement for practitioners and political decision makers. However, as evidenced in the previous studies described and as the findings by Ruales Guzmán, Brun and Castellanos Domínguez (2019) demonstrated, most of them have been designed and tested in developed countries, have mainly addressed general performance approaches and few have considered specific productivity indicators related to the economic, environmental and social sustainability of the industries. Additionally, a minority of studies has used more than one data collection resource, where the questionnaire is the most commonly used, and has scarcely studied key industrial sectors for developing countries such as the agro-industry.

Considering the gap in the literature and the opportunity for research in the field of QM identified in the previous paragraph, the objective of this research was to develop data collection instruments that allow to identify relevant QMp to specific productivity indicators related to the economic, environmental and social sustainability of the agro-industrial sector, considering the particularities of developing countries. In order to promote the triangulation of data, strengthen the results of

research and minimise the limitations of using a single resource (Eisenhardt, 1989; Voss, Tsikriktsis and Frohlich, 2002; Yin, 2014; Tsironis and Psychogios, 2016; Ruales Guzmán et al., 2019), in this article, the dairy industry was taken as a study sector and three types of data collection instruments were developed: an interview with open questions; a questionnaire with closed questions and with descriptive evaluation through a Likert scale; and, a checklist for non-participant observation.

To fulfil the proposed objective, outstanding studies in the development of data collection instruments in the field of QM were taken as a model, such as those by Saraph et al., (1989), Flynn et al. (1994), Ahire et al., (1996), Joseph, Rajendran and Kamalanabhan (1999), Rao et al. (1999), Samson and Terziovski (1999), Robinson and Malhotra (2005), Van Der Spiegel et al. (2005), Das, Paul, Swierczek and Laosirihongthong (2006), Singh and Smith (2006), Qui and Tannock (2010), Holschbach and Hofmann (2011), Psomas et al. (2013) and Shafiq et al. (2019). The steps suggested by the previous referents for the development of data collection instruments were taken into account and include the identification of the variables, development of instruments, validation and the proposal of the adjusted instruments.

The main findings of this research were: the QMp identified in the 119 papers were 32, which were grouped into 8 constructs named Top management support, Customer focus, Human resources management, Supplier management, Continuous improvement, Process management, Product design, Process control. The number of productivity indicators for the dairy industry suggested by the academy and industry experts were 7: 1 related to economic sustainability, 2 related to economic and social sustainability, and 4 related to economic and environmental sustainability of the companies. Content validation showed that the instruments have an adequate and comprehensible structure and vocabulary.

This paper is original, novel and contributes to the consolidation of the theory of QM, since, unlike earlier studies, it provides data collection instruments, which first will allow to identify relevant individual QMp and their respective constructs to each productivity indicator in the dairy industry and second, will promote the triangulation of the data to ensure greater reliability of the results. These instruments may be easily replicated or adapted to other agro-industrial sectors because of their rigor and because the entire elaboration process is transparently shown throughout the document. The solid results obtained with these instruments will guide managers and practitioners in decision making aimed at continuous improvement of companies, and for policy makers they will be an input to formulate projects that strengthen the relevant QMp of productivity indicators. in each sector studied.

Considering the previous approach, the research questions (RQ) that will be answered in this study are:
RQ1- What are the most cited QMp in the literature?
RQ2 -What are the most common plant-level productivity indicators in the dairy industry?
RQ3 -How to involve these two variables in data collection instruments?

The remainder of the document was organised as follows. First, the literature review was performed, then, the research methodology was described. The following section covered the findings and their discussion, and the last section outlined the conclusions, implications, limitations and suggestions for future research.

2. Literature review

In the last decades, the use of QM has grown in the food sector due to the increase and change of customer expectations, government and sector regulations, and the expansion of competition in the global market (Dora, Kumar, Van Goubergen, Molnar and Gellynck, 2013). The benefits of QM in the agro-industry are linked to the improvement of food safety and quality throughout the food chain, the increase in customer satisfaction and organisational effectiveness (Psomas et al., 2013; Kafetzopoulos and Gotzamani, 2014). In addition, it generates advantages in the external business environment, such as the improvement of the company's position in the market, the increase in the value of export sales, benefits for the customer and the supplier, as well as internal gains such as quality improvement and benefits for employees (Fotopoulos, Psomas and Vouzas, 2010; Wilcock and Boys, 2017).

Despite the obvious benefits of QM to the agro-industry, Ruales Guzmán et al. (2019) found that studies in this sector are still scarce, since as Kakouris and Sfakianaki (2018) state, most of the research on QM has focused on the manufacturing and service sector. This can be attributed to the high complexity of the supply chain in the agro-industrial sector and its special characteristics, such as a short shelf life, heterogeneous raw materials, seasonality and varied harvest conditions (Dora et al., 2013; Van Der Spiegel, Luning, Ziggers and Jongen, 2005b).

Although the number of studies on the link between QM and performance or productivity in the agro-industry is still scarce, some works have included food in the manufacturing sector. For example, Kanapathy, Bin, Zailani and Aghapour (2017) developed a questionnaire to examine the relationships among quality, innovation, and organisational culture under a moderation model of manufacturers in Malaysia, including in the sample, 13 food and beverage manufacturers (12.26%). The authors suggested for future research to conduct longitudinal studies to present more conclusive proofs of causation, and to study subsectors to be more contextually specific and provide in-depth understanding. Valmohammadi and Kalantari (2017) examined how motivation of ISO 9000 certified organisations impacts the depth of ISO 9000 implementation and in turn how this impacts the organisational performance of Iranian manufacturing organisations in the Kermanshah province. They used a questionnaire that included questions to measure internal motivation, external motivation, depth of ISO implementation, organisational performance, and questions designed to gather respondents' demographic information and profile of the sample organisations. The sample was composed of 191 companies and 35 of them belonged to the food and medical sector. In order to gain deeper understanding of the cause-and-effect relationship among the variables, for future research the authors suggested collecting the data longitudinally.

Likewise, Anil and K.P. (2019) developed a survey instrument to study the direct and indirect effects of TQM practices on quality performance, customer satisfaction level, operating performance, employee performance, innovation performance, society results and financial performance in the Indian manufacturing context, including 10 Food companies (3.85%). The questionnaire used Likert scale and covered general information about the organisations, 4 TQM practices with 16 items, and 35 items evaluating multiple performance indicators. And finally, the study by Sahoo (2019) provided sector-specific empirical evidence on the comparative evaluation of total productive maintenance (TPM) and total quality management (TQM) approaches, implemented exclusively and collectively to improve manufacturing business performance. The questionnaire comprised a set of general questions related to the company's profile and few close-ended questions to identify the company's manufacturing focus, operational philosophy and years of experience in the implementation of manufacturing

practices. It also included questions focused on whether the participating organisation experienced some degree of improvement in performance parameters after the implementation, using a Likert Scale. The sample covered manufacturing companies from food and beverages, textiles and electrical and electronics sectors in the Indian context. For future research the authors suggested in-depth case studies to further validate the findings of the study empirically. The studies previously described are an approach to the analysis of the agro-industry; however, they do not offer results and specific direction for this sector.

Regarding the works that used data collection instruments in the food sector, the following stand out. Dora et al. (2013) analysed the managers' perceptions of the status of QM practices and identified benefits from the implementation and practice of QM principles and barriers to the QM implementation among food SMEs in Belgium, Germany and Hungary. The structured questionnaire covered the company's basic information such as company name, number of employees, turnover, respondent's position, company's business strategy, customer loyalty, and cost concerns. The second section was about the company's acquaintances with the quality management system. The third section was used to extract information on the perceived benefits and barriers of implementing FQM. This instrument used a Likert scale. Kafetzopoulos, Gotzamani and Psomas (2013) explored the impact of the effective implementation of both ISO 9001 and ISO 22000 systems on the competitive performance of certified food manufacturing companies in the Greek business environment. The questionnaire used a Likert scale and included questions on the demographic profile of the company and three theoretical dimensions, namely the "ISO 9001 effective implementation", "ISO 22000 effective implementation" and "competitive performance". The authors suggest to collect empirical data from different food industry sub-sectors, in order to detect whether the findings of this study vary within specific food sub-sectors.

Djekic et al. (2014) analysed the implemented quality management systems in the production / service sector, operating only with food of animal origin in Serbia. The research covered the analysis of the rationale for the implementation of quality management systems, the quality tools used in interviewed food companies and the achieved effects and outputs. The structured questionnaire included general information about the companies, as well as questions related to the reasons for implementing quality management systems, their effects, benefits, outputs and quality tools used in selected companies across a Likert scale. Kafetzopoulos and Gotzamani (2014) proposed a model for measuring the effectiveness of quality (ISO 9001) and food safety (HACCP) systems, identified the critical factors for effective implementation and examined the degree to which the combined implementation of ISO 9001 and HACCP influences the overall performance of the certified firms. For the data collection, they used a structured questionnaire with Likert scale in the Greek food industry. The questionnaire consisted of general information about the companies' profile, critical factors of effective implementation, ISO 9001 quality system objectives, HACCP food safety system objectives and Business Performance. As suggestions for future research, they mention that studies should be conducted with on-site collection of primary data from multiple respondents and, since the limited number of companies per subsector in the sample made it impossible to test the validity of the model in certain food subsectors, future studies must test the proposed model for its validity in specific subsectors of the food industry.

Similarly, Psomas, Vouzas and Kafetzopoulos (2014) examined the binary character of total quality management in food companies and determined the impact of the two aspects of TQM - "soft" and "hard" - on the quality management benefits in Greek food companies. The questionnaire use a Likert scale and contains questions regarding the food companies' profiles,

statements regarding the adoption of the philosophical TQM elements by a food company, statements regarding the level to which a food company implements the proposed quality tools/techniques, and statements regarding the level to which a food company derives quality management benefits with regard to customers, employees, society, quality and business performance. Talib, Ali and Idris (2014) identified and validated a measurement model for assessing quality management practices among small and medium-sized enterprises, of the food processing industry in Malaysia. They developed a questionnaire that also used a Likert scale. Danyen and Callychurn (2015) identified factors needed for a successful implementation of a total quality management program in Mauritian food manufacturing companies and evaluated their impact on operational performance, quality performance and business performance. The questionnaire included the demographic profile of companies, ten constructs for the identified TQM factors and three constructs for the performance measures. Each statement was measured with the help of a subjective Likert scale.

The study by Akanmu, Bahaudin and Jamaludin (2017) developed a structured questionnaire using a Likert scale to propose an inclusive research model comprising the factors proposed in the model to improve organisational performance in the Malaysian food and beverage companies. The authors suggest that a longitudinal research could be extended to explain the complex relationship between TQM and organisational performance over a longer period of time. Wilcock and Boys (2017) explored the impact of ISO 9001 on food manufacturing companies in Guyana and semi-structured in-depth interviews were used for data collection. Kakouris and Sfakianaki (2018) explored the association between ISO 9000 certification and business performance for small-to-medium enterprises in the food and beverage industry. The data collection instrument was semi-structured in interviews to research in depth how companies perceive ISO 9001 and also used non-participant observation, document analysis, and secondary sources. Finally, Sunil Kumar, Shrivastava and Rajasree (2018) investigated the effect of critical success factors or predictors on the performance measurement factors of citrus industry in Nagpur India. A questionnaire was designed for collecting quantitative data from stake holders with a Likert scale.

From the previous studies, only those of Kanapathy et al. (2017), Valmohammadi and Kalantari (2017) and Kafetzopoulos and Gotzamani (2014) show the data collection instrument in the paper, therefore, only these can be taken as models for future research. In summary, the instruments used in the food sector before this work, focused on the general context, including several subsectors, except the one developed by Sunil Kumar et al. (2018) for the citrus industry. Of the 15 papers described in this section, 13 used a questionnaire with Likert scale, 2 used semi-structured in-depth interviews and only the research of Kakouris and Sfakianaki (2018) used more than one data collection resource. In addition, none of the works addressed specific productivity indicators, and as Ruales Guzmán et al. (2019) affirm, the strengthening of the productivity of the agro-industry of developing countries is a necessity for the sustainability of the regions. To conclude, the authors of the analysed articles suggested for future research to study specific industries in the food sector and also carry out in-depth studies, for which, more than one resource for data collection will be necessary.

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Considering the suggestions of the previous studies and to overcome the limitations, in this study 3 data collection instruments were developed to identify the relevant QMp for the productivity indicators of the dairy sector

3. Research Methodology

To address the objective of this research, outstanding studies were taken as reference in the development of data collection instruments in the field of QM, such as those of Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Joseph et al. (1999), Rao et al. (1999), Samson and Terziovski (1999), Robinson and Malhotra (2005), Van Der Spiegel et al. (2005), Das et al. (2006), Singh and Smith (2006), Qui and Tannock (2010), Holschbach and Hofmann (2011), Psomas et al. (2013) and Shafiq et al. (2019). The suggested steps by the previous referents for the development of data collection instruments are described below.

3.1 Identification of variables

The variables considered in this study were the QMp and productivity indicators of the dairy industry at the plant level.

3.1.1 Identification of QMp.

The identification of these variables was carried out through an exhaustive literature review considering as reference the studies of Carnwell and Daly (2001), Tranfield, Denyer and Smart (2003), Cronin, Ryan and Coughlan, (2008), Seuring and Müller (2008), Nightingale (2009), Randolph (2009), Tavares, Scavarda and Scavarda (2016), Aquilani, Silvestri, Ruggieri and Gatti (2017) and Ruales Guzmán et al. (2019). The literature review aimed to address the RQ1, identifying the QMp reported in the articles and related to productivity, performance, efficiency, technical progress or profitability. The inclusion/exclusion criteria used for the sample selection of the articles were described in Table 1.

Table 1. Inclusion/Exclusion criteria

Criteria		**Description**
Inclusion	Subject area	All subject areas
	Document type	All kinds of papers (empirical, theoretical and reviews)
	Source Type	Journals
	Period of time	All papers until December 2018
Exclusion		Publications not related to the objective of the literature review
		Articles that did not clearly identify the QMp

Subsequently, the search in the databases Scopus and Web of Science was carried out using a search equation created with the combination of keywords (Table 2) and Boolean operators, with the filter "article title, abstract, keywords" and considering the inclusion criteria of Table 1. In addition, a filter was used (article title, abstract, keywords) with the words "plant level", "firm", "industry", "manufacture" and "manufacturing". The main keywords were "Quality Management practices" and "Productivity", and the related keywords were taken from the systematic literature review of Ruales Guzmán et al. (2019), since their findings showed that there are several synonyms or related terms for the QMp (Table 2).

Abstracts of all papers were reviewed considering the first exclusion criterion. In the final selection, the entire articles were reviewed and the second exclusion criterion was applied in order to identify the QMp reported by the authors. The Snowball search method was used to identify extra papers that would serve to extend the final sample.

Table 2. Main keywords and related keywords

Main keywords	Related keywords
Quality management practices	TQM factors
	QM criteria
	TQM elements
	QM dimensions
	TQM measures
	TQM variables
	Critical success factors of TQM
Productivity	Performance
	Efficiency
	Technical progress
	Profitability

Once the article analysis unit was selected, the QMp were identified and classified. For the classification of the QMp, it was necessary to identify constructs proposed in previous studies, such as those of Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Rao et al. (1999), Samson and Terziovski (1999), Ebrahimi and Sadeghi (2013) and Ruales Guzmán et al. (2019).

Once the constructs were identified, the classification of the QMp was made, as in the study by Ebrahimi and Sadeghi (2013), where QMp of similar nature were grouped into a single practice.

3.1.2 Identification of productivity indicators.

Productivity has been recognised as the most important driver of long-term economic growth (Harris and Moffat, 2015) and as one of the vital factors affecting the competitiveness of a manufacturing company (Tangen, 2005). However, few studies have assessed the relationship between QM and Productivity (Ruales Guzmán et al., 2019), which can be attributed to the fact that it has been often confused with performance.

The indicators were identified with the help of academic and industry experts based on the definition of productivity, expressed as the relationship between outputs and inputs (Solow, 1957; Chew, 1988; Tangen, 2005; Shahin, 2008; Syverson, 2011).

The dairy industry generates added value to raw milk through its transformation into products such as cheese, yogurt, butter, ice cream, among others. Additionally, it is one of the most outstanding industries in the Colombian and Italian agro-industrial sector, for its economic contribution, employment generation and food security. According to Knips (2005), the dairy sector plays an important economic role in the agricultural sector in most industrialized countries and also in many developing countries. For this reason, in this study we have selected it as a case for the development of instruments. Academy and industry experts participated in the identification of the variables and in the validation of the instruments, while top managers of the dairy industry participated only in the validation of the instruments. The participants were contacted in Colombia through the Universidad Nacional de Colombia and ASOLECHE, and in Italy through the Politecnico di Milano and ASOLATTE. Master's students participated in the development of the instruments in Spanish and Italian language.

3.2 Development of instruments

The most widely used data collection resource in the field of QM is the questionnaire (Sousa and Voss, 2002; Ruales Guzmán et al., 2019). The popularity of the questionnaire among researchers is due to the fact that it allows quick and easy data collection, it is less expensive, it allows to cover a large sample and facilitates data processing, while its limitations are mainly linked to the risk of losing objectivity and impartiality of the results, due to the little or scarce personal contact of the researcher and the respondent and because the answers cannot be supplemented with additional information. Authors such as Scandura and Williams (2000) state that including a variety of data collection methods in a study can result in a more robust and generalizable set of findings, which at the same time would minimise the limitations of using a single resource. In order to promote the triangulation of data, to strengthen the research results and to minimise the limitations of the use of a single resource, a questionnaire, an interview and a checklist for observation were developed in this section to address the RQ3.

3.3 Validation of instruments

It was done through content validity with a panel of academic and industry experts and also with a pre-test carried out by top managers of the dairy industry that covered the evaluation of grammar, writing, ease of understanding, ambiguity and technical vocabulary. According to Kumar (2011), the purpose of the pre-test of a research instrument is to identify whether there are problems in understanding the way in which a question was formulated, the adequacy of the meaning that it communicates and if the different respondents interpret a question in a different way from what the researcher wants to convey.

3.4 Proposed instruments

The instruments were modified and adjusted according to the findings that emerged in the validation and with the suggestions and comments received.

4. Findings and discussion

The objective of this paper was to develop data collection instruments to identify the relevant QMp to productivity indicators of the dairy industry and it was fulfilled applying the steps suggested by referring authors: identification of variables, instrument development, instrument validation and proposed instruments.

4.1 Identification of variables

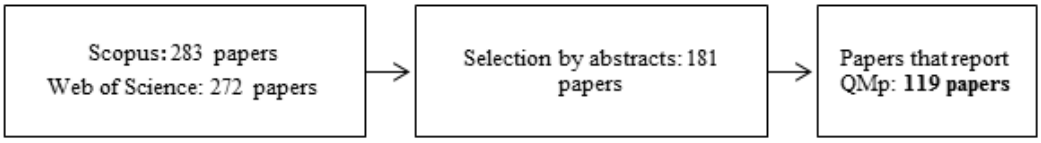
The variables considered in this study were the QMp and productivity indicators of the dairy industry at the plant level.

4.1.1 Identification of QMp.

The identification of these variables was carried out through an exhaustive literature review considering the references presented in the methodology. The objective of the literature review was to address the RQ1, identifying the QMp reported in the articles and related to productivity, performance, efficiency, technical progress or profitability.

The search in the databases retrieved 283 articles in Scopus and 272 in Web of Science applying all the methodological conditions set out in the previous section. These documents were subsequently selected as shown in Figure 1. In the first selection, abstracts of all papers were reviewed considering the first exclusion criterion, which resulted in a sample of 181 documents. In the final selection, the articles were reviewed in their entirety and the second exclusion criterion was applied in order to identify the QMp reported by the authors. The final sample was 119 articles. The snowball search method was used to identify extra papers that served to expand the final sample, but not many additional items were found.

Figure 1. Selection of articles



Once the analysis unit of 119 articles was selected, the QMp were identified and classified. For the classification of the QMp, first it was necessary to identify constructs proposed in previous studies (Table 3), such as those proposed by Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Rao et al. (1999), Samson and Terziovski (1999), Ebrahimi and Sadeghi (2013) and Ruales Guzmán et al. (2019).

The constructs found are very similar in all papers despite being developed in different periods of time. However, Table 3 shows that only some studies clearly included the QMp within each construct. In this work, the 8 constructs proposed by Ruales Guzmán et al. (2019) were taken as a model for the classification of the QMp found in the literature review, because it is the most recent study, it covers the constructs of the previous works for being a systematic literature review and also because it clearly shows the QMp for each construct.

Once the constructs were identified, the classification of the QMp was made as in the study by Ebrahimi and Sadeghi (2013), where QMp of similar nature were grouped into a single practice. For example, the practice "employee training and education" grouped the practices: training, employee training, training and education, employee training and development and training involvement of employees. The practice "strategic quality planning" grouped the practices: strategy, strategic planning, strategy planning, strategic quality planning, strategy and planning, strategic planning for the improvement, strategic planning management, strategic planning process in quality management and strategy, policy and planning. The same process was applied to other QMp of similar nature. The grouping of these variables resulted in a total of 32 QMp classified into 8 constructs, as shown in Table 4.

Table 3. QMp constucts

Autores / Numero de constructos de QMp						
SBS/8	**FSS/7**	**AGW/12**	**RSR/11**	**ST/6**	**ES/7**	**RBC/8**
The role of top management leadership and quality policy	Top management support: Quality leadership, Quality improvement rewards	Top management commitment	Top management support	Leadership	Top management commitment and leadership	Top management support: Leadership, Top management support, Top management commitment, Factual approach to decision-making, Strategic quality planning, Strategy, Policy and planning, Organisation for quality
			Strategic quality planning	Strategic planning	Strategic quality planning	
			Quality citizenship	-	-	
Training	Workforce management: Selection for teamwork potential, Teamwork	Employee Training	Employee training	People management	Human resources management	Human resources management: Human resources management, Training and education, Employee relations, Employee participation/involvement, Employee empowerment, Reward and recognition, Favorable working environment
Employee relations		Employee involvement	Employee involvement			
		Employee empowerment	–			
Product/service design	Product Design: New product quality, Interfunctional design process	Design quality management	Product /process design	-	-	Product design: Product design, Interfunctional design, New product quality
Supplier quality management	Supplier involvement: Supplier relationship	Supplier quality management		-	Supplier quality management	Supplier management: Supplier quality management, Supplier relationship, Supplier involvement
		Supplier performance				

Table 3. (Continued)

Autores / Numero de constructos de QMp						
SBS/8	**FSS/7**	**AGW/12**	**RSR/11**	**ST/6**	**ES/7**	**RBC/8**
Process management	Process management: Cleanliness and organisation	-	-	Process management	Process management	Process management: Process management, Business and service process management, Quality of process, Product/service, Process focus
Quality data and reporting	Quality information: Feedback, Process control	Internal quality information usage	Quality information usage	Information and analysis	Information and analysis - -	Process control: Information and analysis, Systemic approach and documentary evidence for quality system, Quality data and reporting, Measuring results and performance, Process monitoring and control, Process control, Selective application of tools and techniques, Statistical tools
		Statistical process control usage	-			
		Product quality	Quality information availability			
Role of the quality department	-	-	-	-		-
-	Customer involvement: Customer interaction	Customer focus	Customer orientation	Customer focus	Customer focus and satisfaction	Customer focus: Customer satisfaction focus, Customers focus, Customer relationships
-	-	Benchmarking	Benchmarking	-	-	Continuous improvement: Continuous improvements, Feedback, Prevention of non-conformance

SBS: Saraph, Benson and Schroeder (1989); FSS: Flynn, Schroeder and Sakakibara (1994); AGW: Ahire, Golhar and Waller (1996); RSR: Rao, Solis and Raghunathan (1999); ST: Samson and Terziovski (1999); ES: Ebrahimi and Sadeghi (2013); RBC: Ruales Guzmán, Brun and Castellanos Domínguez (2019).

Unlike the research of Ruales Guzmán et al. (2019), in this study, additional QMp were identified for each construct, which is attributed to the difference in both, the approach of the search and the employed inclusion/exclusion criteria. The grouping of the QMp resulted in 3 practices for the construct Top management support, 3 for Customer focus, 9 for Human resources management, 3 for Supplier management, 4 for Continuous improvement, 4 for Process management, 3 for Product design and 3 for Process control. The classification of the QMp proposed in this research will not only allow to carry out an analysis of the constructs as in previous studies, but will in addition allow to carry out an evaluation of each QMp individually, thus promoting the identification of relevant QMp to productivity and therefore continuous improvement.

Table 4. QMp identified in the literature

Construct of QMp (Ruales Guzmán et al., 2019)	**QMp**	**Reference article number**
Top management support	Leadership	2, 3, 8, 9, 12, 14, 17, 22, 23, 27, 32, 40, 46, 48, 49, 63, 70, 72, 77, 96, 98, 101, 117, 118, 119
	Top management commitment	4, 7, 14, 17, 21, 24, 26, 27, 28, 32, 34, 35, 40, 43, 51, 52, 61, 66, 72, 73, 75, 78, 81, 83, 91, 95, 97, 107, 111, 115, 116, 117, 119
	Strategic quality planning	7, 12, 13, 15, 17, 19, 21, 23, 32, 39, 46, 48, 50, 51, 57, 64, 72, 78, 81, 86, 100, 101, 103, 106, 112, 113, 117, 118
Customer focus	Customer satisfaction	4, 8, 9, 11, 13, 14, 19, 24, 25, 28, 32, 34, 44, 51, 52, 57, 58, 61, 63, 64, 68, 69, 70, 73, 74, 78, 80, 83, 85, 90, 92, 107, 111, 117, 118
	Customer involvement	12, 33, 45, 48, 53
	Customer relationship	3, 9, 22, 25, 32, 65, 73, 74, 78, 85, 86, 111, 115, 117
Human resources management	Employee training and education	2, 3, 4, 8, 9, 10, 14, 16, 19, 21, 24, 25, 26, 28, 29, 32, 33, 40, 43, 44, 45, 47, 48, 57, 58, 60, 64, 66, 70, 71, 73, 74, 75, 83, 84, 85, 86, 88, 94, 96, 102, 103, 107, 108, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119
	Reward and recognition to Employee	2, 3, 7, 9, 11, 13, 14, 19, 21, 32, 41, 54, 61, 62, 64, 66, 65, 73, 85, 104, 107, 116, 119
	Employee relationship	16, 22, 25, 27, 29, 87
	Employee involvement	1, 4, 12, 32, 10, 11, 13, 17, 18, 20, 24, 26, 33, 40, 45, 51, 59, 61, 66, 81, 84, 88, 95, 104, 113, 119
	Employee empowerment	1, 4, 11, 13, 17, 18, 21, 24, 31, 32, 54, 75, 89, 114, 115
	Employee satisfaction	8, 9, 14, 17, 28, 57, 64, 73, 74, 86, 89, 103, 107, 112
	Teamwork	17, 19, 32, 44, 60, 70, 71, 89, 96, 101, 110, 114
	Working attitudes	3, 10, 27, 71
	Working environment	57, 60, 61, 64, 74, 75, 76, 78
Supplier management	Supplier involvement	16, 25, 32, 43, 48, 53, 61, 81, 97
	Supplier quality	4,12, 16, 22, 25, 27, 29, 32, 48, 50, 53, 56, 72, 88, 98, 100, 113
	Supplier relationship	3, 4, 16, 25, 29, 32, 42, 48, 53, 56, 57, 61, 66, 74, 78, 94, 105, 106, 111, 115
Continuous improvement	Feedback and auditing	3, 5, 6, 10, 11, 12, 14, 19, 24, 26, 41, 42, 44, 48, 53, 61, 63, 66, 67, 78, 93, 94, 96, 97, 111
	Benchmarking (comparison with standard)	4, 9, 14, 17, 22, 24, 32, 36, 44, 45, 57, 64, 71, 73, 74, 78, 81, 86, 95, 113, 115
	Continuous support	2, 7, 9, 13, 17, 21, 24, 28, 32, 36, 37, 40, 43, 44, 49, 57, 61, 63, 64, 68, 69, 73, 79, 81, 84, 90, 92, 95, 96, 101, 107, 110
	Prevention of non-conformance	43, 61, 69, 80, 90, 92, 105, 119

Table 4. (Continued)

Construct of QMp (Ruales Guzmán et al., 2019)	QMp	Reference article number
Process management	Technology management	24, 30, 32, 38, 48, 61, 73, 77, 78, 82, 93, 94, 99, 111
	Process focus	9, 14, 17, 20, 22, 28, 39, 41, 43, 49, 55, 63, 64, 66, 72, 81, 83, 84, 89, 95, 98, 101, 103, 107
	Standardization of process instructions	2,18, 27, 35, 36, 61, 73, 74, 76, 86, 97, 116
	Steady processes	16, 19, 24, 25, 34, 63
Product design	Inter-functional design	3,4, 9, 12, 14, 18, 19, 27, 33, 41, 53, 63, 66, 85, 101, 111
	New product quality	3, 4, 13, 16, 25, 41, 56, 91, 98, 108, 111
	Innovation	9, 32, 38, 40, 57, 60, 78, 84, 91, 99
Process control	Quality data analysis and reporting	4, 7, 14, 16, 22, 25, 27, 29, 43, 51, 52, 56, 70, 75, 85, 87, 96, 99, 101, 103, 109, 112, 116, 118
	Monitoring, documentation and control	12, 13, 21, 33, 43, 48, 53, 61, 64, 70, 78, 80, 92, 96, 100, 105
	Quality tools and techniques (e.g. diagrams, control charts, statistical methods)	16, 19, 23, 25, 29, 32, 42, 47, 51, 57, 61, 70, 75, 76, 97, 98, 101, 104, 108, 115, 119

The articles used for the literature review and their respective reference number are presented in appendix A.

4.1.2 Identification of productivity indicators.

Specific productivity indicators related to the economic, social and environmental sustainability of the dairy industry at the plant level were involved in this study.

The indicators were identified with the help of academic and industry experts based on the definition of productivity expressed as the relationship between outputs and inputs (Solow, 1957; Chew, 1988; Tangen, 2005; Shahin, 2008; Syverson, 2011). In this stage, 7 indicators were identified: 1 related to economic sustainability, 2 related to economic and social sustainability, and 4 related to economic and environmental sustainability (Table 5). The output (numerator) for each indicator was the amount in kilograms of the product obtained, while the inputs (denominator) were the amount of milk in kilograms, number of hours used per worker, number of workers required, electrical consumption in kilowatts per hour, water consumption in cubic meters, amount of whey in kilograms and amount of defective product in kilograms. The indicators refer to the following:

- "Kg of product/Kg of milk" evaluates the amount of milk used for the production of one Kg of product.
- "Kg of product/# h worker" evaluates the number of hours used for the production of one Kg of product.
- "Kg of product/# of workers" represents the number of workers required for the production of one Kg of product.
- "Kg of product/KWh" is the electrical consumption for the production of one Kg of product.
- "Kg of product/m^3 of water" refers to water consumption for the production of one Kg of product.
- "Kg of product/Kg of whey" evaluates the amount of whey obtained per Kg of product and only applies for products where the whey is a waste of the production process.

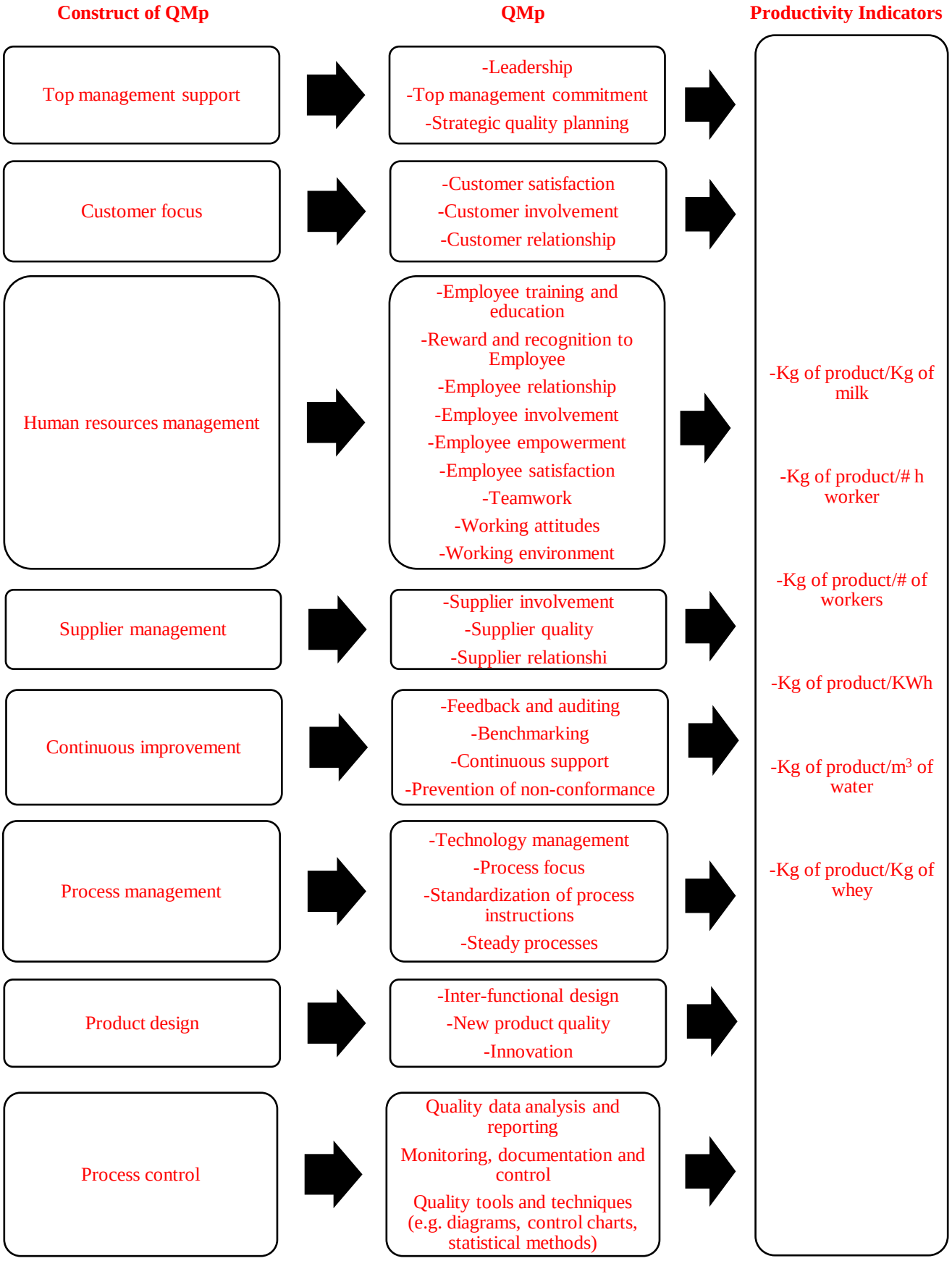
- "Kg of product/Kg of defective product" evaluates the amount of defective product for each Kg of product obtained.

Table 5. *Productivity Indicators*

Output	Input	Sustainability indicator
Amount of product in kilograms (Kg)	Amount of milk (Kg)	Economic
	Number of hours used per worker (H man)	Economic and social
	Number of workers required (#)	Economic and social
	Electrical consumption (KWh)	Economic and environmental
	Water consumption (m^3)	Economic and environmental
	Amount of whey (Kg)	Economic and environmental
	Amount of defective product (Kg)	Economic and environmental

Taking into account the variables identified in this section, the framework proposed for this study is shown in Figure 2. The framework was constructed in order to visualise the possible links between the variables and identify the constructs and the relevant QMp for the strengthening of each one of the seven productivity indicators of the dairy industry.

Figure 2. Study Framework



4.2 Development of instruments

In order to promote the triangulation of data, to strengthen the research results and to minimise the limitations of the use of a single resource, a questionnaire, an interview and a checklist for observation were developed in this section to address the RQ3.

4.2.1 Questionnaire

A questionnaire is a list of questions related to the research problem, where respondents record the answers according to their own interpretation (Kumar, 2011; Hernández, Fernández and Baptista, 2014). The instrument was designed considering as reference those developed in the studies by Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Rao et al. (1999), Samson and Terziovski (1999), Van Der Spiegel et al. (2005), Psomas et al. (2013) and Patyal and Koilakuntla (2017). The structured instrument is composed of four independent sections with instructions that facilitate the evaluation. It includes open questions in section A and closed ones in the subsequent sections. According to Hernández et al. (2014), the closed questions encourage an efficient coding and analysis of the results. The sections that compose the questionnaire are the following:

- General information: This section includes the name of the company, the position and the time that the respondent has been working in it.
- QMp Implementation: This section evaluates the implementation level of each QMp in the company, using a Likert scale of 5 points with the following considerations: 1 = not implemented; 2 = little implemented; 3 = partially implemented; 4 = mostly implemented; and 5 = fully implemented.
- Changes in productivity indicators after the QM implementation: This section evaluates the change in each productivity indicator after the QM implementation. Each dairy product has particular characteristics; for this reason, in this study we only take as example the Parmesan cheese. The evaluation uses a Likert scale of 5 points where 1 = decrease significantly; 2 = decrease slightly; 3 = remained constant; 4 = increase slightly; and 5 = increase significantly.
- Relevance of QMp for productivity indicators: In this section, a codification for each of the productivity indicators was made in the following way: kilograms of milk used for the production of one kilogram of Product = KgM; number of hours of workers required for the production of one kilogram of product = hW; number of workers involved in the production of one kilogram of product = #W; kilowatt-hours of electric consumption for the production of one kilogram of product = KWh; cubic meters of water used for the production of one kilogram of product = m^3; kilograms of whey obtained in the production of one kilogram of product = KgW; and kilograms of defective product per kilograms of produced product = KgD.

  For the evaluation of the relevance of each QMp for each of the productivity indicators, a Likert scale of 5 points is used, where 1 = no relevance; 2 = low relevance; 3 = medium relevance; 4 = relevant; 5 = high relevance.

4.2.2 *Interview*.

An interview is the exchange of information through questions and answers between the interviewee and the interviewer (who records the information), and is usually done face-to-face. The interviewer is free in terms of content, writing and order of the interview questions, and in addition has the opportunity to explain the questions by obtaining in depth information (Kumar, 2011; Hernández et al., 2014).

The interview was designed taking into account the instruments developed by Robinson and Malhotra (2005), Qui and Tannock (2010), Holschbach and Hofmann (2011) and Agarwal, Green, Brown, Tan and Randhawa (2012). It addresses the same items of the questionnaire in section 4.2.1, in order to obtain additional information and deepen the answers to the first instrument. The semi-structured interview includes open questions in 5 sections (interview protocol) as follows.

- General information: This section includes the company name and the position of the interviewee.
- QM implementation: Open questions about the QM implementation, motivations and difficulties are included.
- Changes in productivity indicators after the QM implementation: Open questions related to changes in each productivity indicator assessed in this study are included.
- Relevance of QMp to productivity indicators: The section covers open questions related to the most implemented QMp and why each of them are relevant or not-relevant to the productivity indicators studied.
- Suggestions: This section includes open questions about suggestions that the interviewee wants to give about the research topic.

4.2.3 Check list for observation

It is a way of collecting primary data through the intentional, systematic and selective observation of an interaction or phenomenon in which a format can or cannot be used (Kumar, 2011; Hernández et al., 2014). In this article, we propose a non-participant observation format that includes the categories “there is” or “there is not” evidence of each QMp and each productivity indicator.

4.3. Validation of instruments

The instruments proposed in this research were developed taking as models instruments used in previous research. The reference instruments for the questionnaire were tested via survey research, using rigorous methods to evaluate their reliability and validity, which guarantees a previous evaluation.

As in the studies of Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Rao et al. (1999), Samson and Terziovski, 1999), Kafetzopoulos, Psomas and Gotzamani (2015), Bouranta, Psomas and Pantouvakis, 2017), Patyal and Koilakuntla (2017) and Anil and K.P. (2019), in this research the content validity of the developed instruments was guaranteed through the exhaustive literature review carried out in section 4.1.1. In addition, the content validity of the instruments was reinforced with the advice of academic and industry experts and finally, with a pre-test carried out by the top managers of the dairy

industry of 5 Colombian and 2 Italian companies that included the evaluation of grammar, writing, ease of comprehension, ambiguity and technical vocabulary. Additionally, possible suggestions were requested. The participants were contacted in Colombia through the Universidad Nacional de Colombia and ASOLECHE, and in Italy, through the Politecnico di Milano and ASOLATTE.

At the end of the evaluation of the instruments, the suggestions and minor changes were incorporated to improve its comprehensibility and clarity.

4.4 Proposed instruments

The instruments were adjusted according to the suggestions and comments of the academic experts, industrial experts and top managers of the companies of the industry. The questionnaire is located in Appendix B, the interview is in Appendix C, and the observation checklist in Appendix D.

The fundamental differences between the instruments developed in other studies (including the papers that analyse the food industry as part of manufacturing) and those developed in this research are the following: The first ones have focused mainly on evaluating the efficiency of the QM implementation or on evaluating its relationship with performance and using frequently only one data collection resource that is usually a questionnaire. These have been applied in traditional contexts such as the general manufacturing and services sectors and in developed countries. The instruments that have been developed for the food sector were not used in specific subsectors, except designed by Sunil Kumar et al. (2018) in the citrus industry. The works of Psomas, Vouzas and Kafetzopoulos (2014), Danyen and Callychurn (2015) and Anil and K.P. (2019), analysed the impact or effect of QM on performance, but did not use longitudinal studies to fulfil its objective, which evidences the inconsistency between the purpose and the research approach. Finally, none of the papers studied specific indicators of productivity or the relevance of the QMp in them.

The data collection instruments developed in this research were a questionnaire, an interview and a checklist and will allow the identification of the relevant QMp for each of the productivity indicators of a scarcely studied context such as the dairy industry. They can be used in the same work in in-depth studies to promote triangulation of data. They address 32 QMp grouped into 8 constructs. And in addition, they will also allow to analyse the change in productivity indicators that participants perceive after the implementation of QM.

Like the other studies, ours included the basic information of the company and included a section to analyse the degree of implementation of the QMp.

The instruments developed in this study addressed the shortcomings of the previous ones, therefore, they can be considered as useful, innovative, rigorous and reliable tools for future research.

5. Conclusions and future research

The development of data collection instruments is an important step in research and should not be relegated to a second rank, since the rigor, reliability and usefulness of the results found depend on it. In this paper, innovative and rigorous data collection instruments were developed, that unlike those proposed in previous studies, will allow to identify relevant quality management practices to specific productivity indicators from an economic, social and environmental sustainability focus and of great importance for the dairy industry. The instruments include a questionnaire, an interview and a checklist for observation, which were developed and validated within the context of one developing country and one developed country. In addition, they can be used simultaneously in the same unit of analysis, which will increase the rigor and reliability of the results of the research, representing a useful tool for future research and therefore, for decision-makers of companies and government. The main findings are summarised in the following paragraphs.

The QMp found in the literature review were grouped into practices of similar nature resulting in 32 QMp grouped into 8 constructs named Top management support, Customer focus, Human resource management, Supplier management, Continuous improvement, Process management, Product design and Process control.

The report of specific productivity indicators is scarce in the literature, for this reason, in this research taking into account the definition of productivity and with the collaboration of experts, 7 specific productivity indicators for the dairy industry at the plant level were proposed. The productivity indicators are: Kg of product/Kg of milk, Kg of product/# h worker, Kg of product/# of workers, Kg of product/KWh electrical consumption, Kg of product/m3 of water, Kg of product/Kg of whey, Kg of product/Kg of defective product. In addition to being related to economic sustainability, these indicators are related to social sustainability from the employment generation and to environmental sustainability from the appropriate use of resources such as water and energy, as well as the disposal of waste or by-products such as whey and defective products.

The robustness of the instruments lies in several respects. First, they were developed taking into account successful models of previous research and the suggestions of books of research methodologies. Second, they took as input an exhaustive literature review for the identification of variables. Third, academic and industry experts advised the development of the instruments. Fourth, they were validated by top managers in terms of grammar, writing, ease of comprehension, ambiguity, technical vocabulary used relevance of the proposed productivity indicators.

This is an original and novel research because, for the first time, data collection instruments are developed for the identification of relevant QMp for specific productivity indicators. They are designed considering the particularities of the dairy industry, a sector of great importance for the economic, social and environmental sustainability of developing countries. It took into account and addressed the suggestions and limitations of the last works and, unlike many previous studies, this paper shows in a transparent and rigorous way the development of each one of the instruments, as well as its final version to be used in any future research.

The relevance of the study is that the instruments developed will allow to identify relevant individual QMp and their respective constructs to each productivity indicator in the dairy industry, identify the degree of implementation of the QMp, study the change in productivity indicators after the QM implementation and will promote the triangulation of the data to ensure greater reliability of the results. These instruments may be easily replicated or adapted to other agro-industrial sectors and ultimately, contribute to the consolidation of the theory of QM since, as several authors have reported, the research on the relationship between QM and productivity in agro-industry is still scarce.

The implications of this study for research are focused on the usefulness of the developed instruments for future works, since these will allow to identify relevant QMp to each productivity indicator of the dairy industry at the plant level. It will also allow to implement improvement actions in order to strengthen these indicators, contributing to the consolidation and growth of the theory of QM and productivity. Regarding the implications for practice, the study provides tools that will allow obtaining interesting results that will guide managers in strengthening the productivity of their production processes, focusing on the relevant QMp for each productivity indicators analysed. To conclude, the findings that will be found with the use of the instruments proposed in this study are linked to the implications for society, since the strengthening of the productivity of the companies fosters the generation of employment, the economic development of the regions and the strengthening of relations with the other links in the production chain. In addition, they will be an input for policy makers in the formulation of projects to strengthen the relevant QMp of productivity indicators.

The limitations of our article are mainly focused on that it was developed within the context of the dairy industry, for which the indicators used only refer to this industry. For future research, we suggest: carrying out studies with different contexts that allow the generation of additional productivity indicators; to test empirically the instruments developed in this study and enrich them with the particularities of each context; to use the constructs and practices proposed in this study to promote the standardization of terms and ensure continuity in research results; and, to encourage the use of more than one of the data collection resources proposed in this research in order to promote the triangulation of data, deepen the subject investigated and have greater rigor in the results of studies.

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Appendix A. Sample articles for the literature review

Reference number	Author	Reference number	Author
1	Powell (1995)	38	Pinho (2008)
2	Anderson, Rungtusanatham, Schroeder, and Devaraj (1995)	39	Fening, Pesakovic, and Amaria (2008)
3	Flynn, Schroeder, and Sakakibara (1995)	40	Su, Li, Zhang, Liu, and Dang (2008)
4	Ahire et al. (1996)	41	Martıínez-Costa, Martıínez-Lorente, and Choi (2008)
5	Hendricks and Singhal (1997)	42	Bayo-Moriones, Bello-Pintado, and Merino-Díaz-de-Cerio (2008)
6	Rao, Ragu-Nathan, and Solis (1997)	43	Padma, Ganesh, and Rajendran (2008)
7	Choi and Eboch (1998)	44	Mady (2009)
8	Samson and Terziovski (1999)	45	Gadenne and Sharma (2009)
9	Anderson and Sohal (1999)	46	Kumar, Choisne, De Grosbois, and Kumar (2009)
10	Huarng, Horng, and Chen (1999)	47	Pont, Furlan, and Vinelli, (2009)
11	Brah, Wong, and Rao (2000)	48	Anh and Matsui (2009)
12	Cua, Mckone, and Schroeder (2001)	49	Wali and Boujelbene (2010)
13	Rahman (2001)	50	Zakuan, Yusof, Laosirihongthong, and Shaharoun (2010)
14	Brah, Tee, and Rao (2002)	51	Fotopoulos and Psomas (2010)
15	Prajogo and Sohal (2003)	52	Psomas and Fotopoulos (2010)
16	Kaynak (2003)	53	Phan and Matsui 2010)
17	Sila and Ebrahimpour (2003)	54	García-Bernal and Ramírez-Alesón (2010)
18	Merino díaz De Cerio (2003)	55	Sedani and Lakhe (2011)
19	Yeung, Lee, and Chan (2003)	56	Baird, Hu, and Reeve (2011)
20	Taylor and Wright (2003)	57	Valmohammadi (2011)
21	Sohail and Hoong (2003)	58	Vanichchinchai and Igel (2011)
22	Lin, Madu, Kuei, and Lu (2004)	59	Parast, Adams, and Jones (2011)
23	Prajogo (2005)	60	Albacete-Sáez, Fuentes-Fuentes, and Bojica (2011)
24	Seth and Tripathi (2005)	61	Jain and Ahuja (2012)
25	Kaynak and Hartley (2005)	62	Agarwal et al. (2012)
26	Chang and Lo (2005)	63	Prajogo, Huo, and Han (2012)
27	Nair (2006)	64	Ooi, Lin, Teh, and Chong (2012)
28	Lakhal, Pasin, and Limam (2006)	65	Duh, Hsu, and Huang (2012)
29	Demirbag, Tatoglu, Tekinkus, and Zaim (2006)	66	Abdullah and Tarí (2012)
30	Shrivastava, Mohanty, and Lakhe (2006)	67	Han, Sim, and Ebrahimpour (2012)
31	Sharma (2006)	68	Kafetzopoulos, Gotzamani, and Psomas (2013)
32	Sila (2007)	69	Psomas, Pantouvakis, and Kafetzopoulos (2013)
33	Joiner (2007)	70	Ali and Alolayyan (2013)
34	Singh (2008)	71	Talib, Rahman, and Qureshi (2013)
35	Feng, Terziovski, and Samson (2008)	72	Ebrahimi and Sadeghi (2013)
36	Arumugam, Ooi, and Fong (2008)	73	Abusa and Gibson (2013)
37	Dick, Heras, and Casadesús (2008)	74	Laosirihongthong, Teh, and Adebanjo (2013)

Appendix A. (Continued)

Reference number	Author	Reference number	Author
75	Cheng and Choy (2013)	98	Chen (2015)
76	Clegg, Gholami, and Omurgonulsen (2013)	99	Modgil and Sharma (2016)
77	Agbola (2013)	100	Parvadavardini, Vivek, and Devadasan (2016)
78	Shrivastava and Gorantiwar (2014)	101	Basu and Bhola (2016)
79	Youssef, Youssef, and Saleh (2014)	102	Phan, Nguyen, Luong, and Matsui (2016)
80	Kafetzopoulos and Gotzamani (2014)	103	Psomas and Jaca (2016)
81	Psomas, Vouzas, and Kafetzopoulos (2014)	104	Yazdani, Attafar, Shahin, and Kheradmandnia (2016)
82	Kibe and Wanjau (2014)	105	Sinha, Garg, and Dhall (2016)
83	Lakhal (2014)	106	Elshaer and Augustyn (2016)
84	Benavides-Velasco, Quintana-García, and Marchante-Lara (2014)	107	Attia (2016)
85	Al-Refaie and Hanayneh (2014)	108	Brkić, Dondur, Klarin, and Golubovic (2016)
86	Akgün, Ince, Imamoglu, Keskin, and Kocoglu (2014)	109	Nair and Choudhary(2016)
87	Herzallah, Gutiérrez-Gutiérrez, and Munoz Rosas (2014)	110	Sweis, Saleh, Al-etayyem, Qasrawi, and Mahmoud (2016)
88	Mahmood, Qureshi, and Nisar (2014)	111	Patyal and Koilakuntla (2017)
89	Hassan, Nawaz, Shaukat, and Hassan (2014)	112	Bouranta et al. (2017)
90	Kafetzopoulos et al. (2015)	113	Mehralian, Nazari, Nooriparto, and Rasekh (2017)
91	Ismyrlis and Moschidis (2015)	114	Gutierrez-Gutierrez, Barrales-Molina, and Kaynak (2018)
92	Psomas and Antony (2015)	115	Escrig-Tena, Segarra-Ciprés, García-Juan, and Beltrán-Martín (2018)
93	Dubey and Gunasekaran (2015)	116	Nguyen, Phan, and Matsui (2018)
94	Dubey (2015)	117	Singh, Kumar, and Singh (2018)
95	Danyen and Callychurn (2015)	118	Basu, Bhola, Ghosh, and Dan (2018)
96	Wu (2015)	119	Androwis, Sweis, Tarhini, Moarefi, and Amiri (2018)
97	Jain and Ahuja (2015)		

Appendix B. Questionnaire

QUESTIONNAIRE: QUALITY MANAGEMENT PRACTICES RELEVANT TO THE PRODUCTIVITY OF THE DAIRY INDSUTRY

Thank you for your participation. All the information you provide will be handled confidentially

1. GENERAL INFORMATION

1.1 Name of the company _____

1.2 What is the position that you play in the company? _____

1.3 How long have you been working in the company? _____

2. IMPLEMENTATION OF QUALITY MANAGEMENT PRACTICES

Evaluate the level of implementation of each of the quality management practices in your company (mark with an X the assessment of the implementation level of each quality management practice)

Evaluation:
1 = not implemented; 2 = little implemented; 3 = partially implemented; 4 = mostly implemented; 5 = fully implemented.

Construct	Quality Management Practice	Evaluation				
		1	2	3	4	5
Top management support	Leadership					
	Top management commitment					
	Strategic quality planning					
Customer focus	Customer satisfaction					
	Customer involvement					
	Customer relationship					
Human resources management	Employee training and education					
	Reward and recognition to employee					
	Employee relationship					
	Employee involvement					
	Employee empowerment					
	Employee satisfaction					
	Teamwork					
	Working attitudes					
	Working environment					
Supplier management	Supplier involvement					
	Supplier quality					
	Supplier relationship					
Continuous improvement	Feedback and auditing					
	Benchmarking (comparison with standard)					
	Continuous support					
	Prevention of non-conformance					
Process control	Quality data analysis and reporting					
	Monitoring, documentation and control					
	Quality tools and techniques					
Process management	Technology management					
	Process focus					
	Standardization of process instructions					
	Steady processes					
Product design	Interfunctional design					
	New product quality					
	Innovation					

3. CHANGES IN PRODUCTIVITY INDICATORS AFTER QUALITY MANAGEMENT IMPLEMENTATION

Evaluate the change of each of the following parameters after the implementation of quality management. (Mark with an X the evaluation of the change of each productivity indicator).

If your company does not have the certification yet, but it is in the process of implementation, please evaluate the changes you have seen so far.

Evaluation:
1 = decreased significantly; 2 = decrease slightly; 3 = remained constant; 4 = increase slightly; 5 = increase significantly.

Parameter	Evaluation				
	1	2	3	4	5
Kilograms of milk used to produce 1 kilogram of Parmesan cheese					
Number of hours of workers required to produce 1 kilogram of Parmesan cheese					
Number of workers involved in the production of 1 kilogram of Parmesan cheese					
Kilowatt-hours of electrical consumption to produce 1 kilogram of Parmesan cheese					
Cubic meters of water used to produce 1 kilogram of Parmesan cheese					
Kilograms of whey obtained in the production of 1 kilogram of Parmesan cheese					
Kilograms of Parmesan cheese defective by kilograms of Parmesan cheese produced					

4. RELEVANCE OF QUALITY MANAGEMENT PRACTICES FOR PRODUCTIVITY INDICATORS

Consider the following encoding for each parameter:

Parameter	Code
Kilograms of milk used for the production of 1 kilogram of Parmesan cheese	KgM
Number of hours of workers employed for the production of 1 kilogram of Parmesan cheese	HW
Number of workers involved in the production of 1 kilogram of Parmesan cheese	#W
Kilowatt-hours of electric energy used for the production of 1 kilogram of Parmesan cheese	Kwh
Cubic meters of water used for the production of 1 kilogram of Parmesan cheese	m^3
Kilograms of serum obtained in the production of 1 kilogram of Parmesan cheese	KgW
Kilograms of Parmesan cheese defective by kilograms of Parmesan cheese produced	KgD

Evaluate the relevance of each quality management practice for each of the productivity indicators. (Mark with an X the relevance you consider each quality management practice has for each productivity indicator)

Evaluation:
1 = no relevance; 2 = low relevance; 3 = medium relevance; 4 = relevant; 5 = high relevance

Enter the corresponding evaluation number below each parameter

Construct	Quality Management Practice	Parameter						
		KgM	HW	#W	Kwh	m^3	KgW	KgD
Top management support	Leadership							
	Top management commitment							
	Strategic quality planning							
Customer focus	Customer satisfaction							
	Customer involvement							
	Customer relationship							
Human resources management	Employee training and education							
	Reward and recognition to employee							
	Employee relationship							
	Employee involvement							
	Employee empowerment							
	Employee satisfaction							
	Teamwork							
	Working attitudes							
	Working environment							
Supplier management	Supplier involvement							
	Supplier quality							
	Supplier relationship							
Continuous improvement	Feedback and auditing							
	Benchmarking (comparison with standard)							
	Continuous support							
	Prevention of non-conformance							
Process control	Quality data analysis and reporting							
	Monitoring, documentation and control							
	Quality tools and techniques							
Process management	Technology management							
	Process focus							
	Standardization of process instructions							
	Steady processes							
Product design	Interfunctional design							
	New product quality							
	Innovation							

Thank you for your time and active participation.

Appendix C. Interview

INTERVIEW: QUALITY MANAGEMENT PRACTICES RELEVANT TO THE PRODUCTIVITY OF THE DAIRY INDUSTRY

Thank you for your participation. All the information you provide will be handled confidentially.

1. GENERAL INFORMATION

1.1 Name of the company _____

1.2 What is your role in the company? _____

2. QM IMPLEMENTATION

2.1 How long ago did the QM implementation begin?
2.2 What was the motivation for the implementation of QM? What were the expectations?
2.3 Why do you select this QM and not another? Why HACCP and not ISO, or TQM?
2.4 Could you please describe how the QM implementation was in the company?
2.5 Could you please describe the difficulties you had in the implementation?
2.6 How have you overcome these difficulties?
2.7 Which QMp are the most implemented? Why?
2.8 What are the QMp that have not yet been implemented or those less implemented? Why?
2.9 In what QMp did you have to focus more? Why? Because they were not implemented, because they needed many changes, because they saw that it would help more to improve productivity, because someone suggested them?

3. CHANGES AFTER QM IMPLEMENTATION

3.1 Were there changes in process productivity after the implementation of QM? Has it improved? Is It worse? Why is that?, How?

3.2 Did you see changes in the kilograms of milk used to produce 1 kilogram of Parmesan cheese after the implementation of QM? Increased? was it maintained? decreased?

- 3.2.1 If the answer is no or was maintained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.2.2 If the answer is yes, what were the changes? how did, they occur?
- 3.2.3 How long have you seen the changes? Have the improvements been maintained?
- 3.2.4 What were the key steps in getting those changes?

3.3 Did you see changes in the number of hours of workers employed to produce 1 kilogram of Parmesan cheese after the implementation of QM? Increased? was it maintained? decreased?

- 3.3.1 If the answer is no or remained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.3.2 If the answer is yes, what were the changes? how did they occur?
- 3.3.3 How long have you seen the changes? Have the improvements been maintained?
- 3.3.4 What were the key steps for getting those changes?

3.4 Did you see changes in the number of workers involved in the production of 1 kilogram of Parmesan cheese after the implementation of QM? Increased? was it maintained? decreased?

- 3.4.1 If the answer is no or remained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.4.2 If the answer is yes, what were the changes? how did they occur?
- 3.4.3 How long have you seen the changes? Have the improvements been maintained?
- 3.4.4 What were the key steps in getting those changes?

3.5 Did you see changes in kilowatt hours of electric energy used to produce 1 kilogram of Parmesan cheese after the implementation of QM? Increased? was it maintained? decreased?
- 3.5.1 If the answer is no or remained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.5.2 If the answer is yes, what were the changes? how did they occur?
- 3.5.3 How long have you seen the changes? Have the improvements been maintained?
- 3.5.4 What were the key steps in getting those changes?

3.6 Did you see changes in the cubic meters of water used to produce 1 kilogram of Parmesan cheese after the implementation of the QM? Increased? was it maintained? decreased?
- 3.6.1 If the answer is no or remained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.6.2 If the answer is yes, what were the changes? how did they occur?
- 3.6.3 How long have you seen the changes? Have the improvements been maintained?
- 3.6.4 What were the key steps in getting those changes?

3.7 Did you see changes in the kilograms of serum obtained in the production of 1 kilogram of Parmesan cheese after the implementation of QM? Increased? was it maintained? decreased?
- 3.7.1 If the answer is no or remained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.7.2 If the answer is yes, what were the changes? how did they occur?
- 3.7.3 How long have you seen the changes? Have the improvements been maintained?
- 3.7.4 What were the key steps in getting those changes?

3.8 Did you see changes in the kilograms of defective Parmesan cheese per kilograms of Parmesan cheese produced after the QM implementation? Increased? was it maintained? decreased?
- 3.8.1 If the answer is no or remained, why do you think there were no changes? What are the limitations? Commitment, money, employee training, time, resistance to change?
- 3.8.2 If the answer is yes, what were the changes? how did they occur?
- 3.8.3 How long have you seen the changes? Have the improvements been maintained?
- 3.8.4 What were the key steps in getting those changes?

3.9 What do you consider were the productivity indicators that changed the most with the QM implementation, why?

4. QMp RELEVANT TO PRODUCTIVITY INDICATORS

4.1 Why do you consider the QMp evaluated in the questionnaire as relevant or very relevant for the indicator "kilograms of milk used for the production of 1 kilogram of Parmesan cheese?", Why do you consider that the others are not relevant?

4.2 Why do you consider the QMp evaluated in the questionnaire as relevant or very relevant for the indicator "number of hours of workers required for the production of 1 kilogram of Parmesan cheese"? Why do you consider the others are not relevant?

4.3 Why do you consider the QMp evaluated in the questionnaire as relevant or very relevant for the indicator "number of workers involved in the production of 1 kilogram of Parmesan cheese"? Why do you consider the others are not relevant?

4.4 Why do you consider as relevant or very relevant to the QMp evaluated in the questionnaire for the indicator "kilowatt hours of electrical consumption for the production of 1 kilogram of Parmesan cheese"? Why do you consider the others are not relevant?

4.5 Why do you consider the QMp evaluated in the questionnaire as relevant or very relevant for the indicator "cubic meters of water used for the production of 1 kilogram of Parmesan cheese"? Why do you consider the others are not relevant?

4.6 Why do you consider the QMp evaluated in the questionnaire as relevant or very relevant for the indicator "kilograms of whey obtained in the production of 1 kilogram of Parmesan cheese"? Why do you consider the others are not relevant?

4.7 Why do you consider the QMp evaluated in the questionnaire as relevant or very relevant for the indicator "kilograms of defective Parmesan cheese per kilogram of produced Parmesan cheese"? Why do you consider the others are not relevant?

5. SUGGESTIONS

5.1 What recommendations would you give to other companies to improve their productivity indicators through QM?

5.2 What recommendations would you give to associations, government or political decision makers and to the academy regarding this issue?

Appendix D. Checklist for observation

CHECKLIST: QUALITY MANAGEMENT PRACTICES RELEVANT TO THE PRODUCTIVITY OF THE DAIRY INDUSTRY

Item	Variable	Documentary evidence		Other evidence Which?	Observations
		Yes	No		
Top management support	Leadership				
	Top management commitment				
	Strategic quality planning				
Customer focus	Customer satisfaction				
	Customer involvement				
	Customer relationship				
Human resources management	Employee training and education				
	Reward and recognition to employee				
	Employee relationship				
	Employee involvement				
	Employee empowerment				
	Employee satisfaction				
	Teamwork				
	Working attitudes				
	Working environment				
Supplier management	Supplier involvement				
	Supplier quality				
	Supplier relationship				
Continuous improvement	Feedback and auditing				
	Benchmarking (comparison with standard)				
	Continuous support				
	Prevention of non-conformance				
Process control	Quality data analysis and reporting				
	Monitoring, documentation and control				
	Quality tools and techniques				
Process Management	Technology management				
	Process focus				
	Standardization of process instructions				
	Steady processes				
Product design	Interfunctional design				
	New Product quality				
	Innovation				

Item	Variable	Documentary evidence		Other evidence Which?	Observations
		Yes	No		
Productivity indicator	Kilograms of milk used to produce 1 kilogram of Parmesan cheese				
	Number of hours of workers employed to produce 1 kilogram of Parmesan cheese				
	Number of workers involved in the production of 1 kilogram of Parmesan cheese				
	Kilowatt-hours of electric energy used to produce 1 kilogram of Parmesan cheese				
	Cubic meters of water used to produce 1 kilogram of Parmesan cheese				
	Kilograms of serum obtained in the production of 1 kilogram of Parmesan cheese				
	Kilograms of Parmesan cheese defective by kilograms of Parmesan cheese produced				