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Process Innovation: Improving the Railroad Sector for Competitiveness.

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EXECUTIVE SUMMARY

The aim of this paper is to propose and discover the relationship between a set of variables of a conceptual model for the railroad industry, based on process innovation variables (PIV), which allows the managers of these companies, recognize, assess, decide and implement actions that improve the competitiveness(C) in the sector. The selection of the independent variables was performed through review of the literature discovering initially 16, and identifying 4 as independent variables. They were weighted in order of importance, applying Saaty's Theorem to 10 railroad specialists, resulting: Knowledge Management (KM), Logistics (LG); Information and Communication Technologies (ICT); Quality of Service (QoS). We applied 44 questionnaires of 4 dimensions, 20 indicators, 60 regeants to different railroad specialist managers: 14 from FERROMEX (FMX); 10 from FERROSUR (FSR); 10 from FERROVALLE (FVLL) and 10 from KANSAS CITY SOUTHERN of MEXICO (KCSM). The design of data collection instrument involved as a test pilot questionnaire to 10specialist managers of railroads and using the method of the 2 Halves to assure the reliability, with Pearson correlation on r = 0.9905 for adjustment. Using simple linear regression were obtained the variables that drive the PIV for C in railroad sector. These were: KM (65.6%), QoS (30%), ICT (47.3%) and LG (32%). Finally it is concluded, that in the railroad industry, managers should focus their efforts mainly to the independent variable: knowledge management, which is described with the organizational dimension and characterized by Talent Management, Use and Implementation, Creation and Acquisition, Storage, Sharing and Transfer as indicators to initially raise the competitiveness of the sector.

Keywords: Process Innovation, Railroad, Competitiveness

INTRODUCTION

According (WEF, 2010), Mexico is ranked in place 66 (of 139 countries) in the Global Competitiveness Index 2010-2011. The infrastructure is considered one of the 12 pillars of that index of competitiveness and in this sense, Mexico is ranked in railroad infrastructure in 75/139 (e.g. USA: 15/139, Argentina: 82/139; Brazil: 87/139), which is considered low because is the economy number 13 in the world and aspiring to occupy the 7th. place at 2020 (Somoza, 2012) .

CONTEXTUAL REFERENCE

The first evidence of a railway line was a line of 6 miles down the road Diolkos, used to transport boats across the isthmus of Corinth during the sixth century B.C. (Hylton, 2007). The platforms were pushed by slaves and were guided by grooves carved on the stone. The line was kept running for 600 years. The first record on a railway station in Europe at this period appears in a window in the cathedral of Freiburg about 1350 (Lewis, 2012). The development of the steam engine propelled the idea of steam locomotives could drag trains per line. The first was patented by James Watt in 1769 and revised in 1782 (Vaughn 1997; Dilts 1996). In 1811, John Blenkinsop designed the first locomotive appeared functional on the line between Middleton and Leeds. The locomotive, called Salamanca,was built in 1812 (Hamilton, 1968). The history of railroad in Mexico began in 1837, by decree in August 22 by Anastasio Bustamante the first concession granted to Francisco de Arrillaga for the construction of the railroad from Veracruz to Mexico City (called Ferrocarril Mexicano until 1848). After the Revolution, all the Mexican railroad system was nationalized between 1929 and 1937. In 1987, the government merged the five regional railroads, (FNM.-Ferrocarriles Nacionales de México) (Kuntz & Ruguzzi, 1996). In 1995, the Mexican government announced that FNM would be privatized and the rail network was divided into four networks: FERROMEX, KANSAS CITY SOUTHERN,FERROVALLE and FERROSUR. Since in recent years, the railroad industry was privatized in Mexico and taking into account that every company today is qualified based on their operating results, this raises the following research question (**RQ**): *What is the conceptual model for the railroad industry, based on process innovation variables (PIV), which allows the managers of these companies, recognize, assess, decide and implement actions that improve the competitiveness (C) in the sector?*

THEORETICAL FRAMEWORK

COMPETITIVENESS. OECD (2009) and Mejía (2009), define it as *the ability of firms, regions and nations to generate relatively higher income and levels of sustainable employment for the benefit of shareholders at the time that they are exposed to international competition*. Competitiveness is an multidimensional issue, with differents perspectives about use Ambastha & Momaya, 2004. Porter (1998c) notes that international competitiveness is described from a *macroeconomic analysis of certain factors such as available and affordable labor, abundant natural resources budget deficit, exchange rates, interest rates, low unit labor costs, management practices, the competitive advantages derived of different, a positive trade balance, and a high and increasing industry productivity*. Flanagan (*et al.,* 2005) a firm that *the main objective derived from the competitiveness of a nation is human development, as well as improving quality of life of its inhabitants.* Another approach is the perspective of the industry level, considered as the extent to a business sector that satisfies the needs of consumers through offering a proper mix ratio of manufactured goods based on service features and characteristics such as cost, value, and originality. In other words, it must satisfy the requirements of its constituents, and to that end, seek to offer attractive return on investment (Flanagan *et al.*, 2005). Schuller, & Lidbom (2009) afirm that competitiveness depends on market's performance where an elevated efficiency could be considered the key to success. Kay (1993) described trough four factors: *the capacity to innovate, key internal and external relationships referring the strategically relations both, Reputation and Strategic assets*. It is necessary to understand competitiveness not exclusively as productivity, rather than the ability of a company to design, produce and/or market products superior to those offered by competitors, considering the perceived value for customers Vilanova, et al. (2009).

INNOVATION. According DRALE (2010) it means: create or modify a product, and its introduction into a market. It depends on creativity from the individuals involved. For an enterprise, an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. (OCDE, 2005, par.146; Mejía 2011).

Process Innovation (PI) is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. (OCDE, 2005, par.163; Mejía 2011, 2012a, 2012b). Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products (OCDE, 2005, par.164). Delivery methods concern the logistics of the firm and encompass equipment, software and techniques to source inputs, allocate supplies within the firm, or deliver final products.(OCDE, 2005, par.166). Process innovations include new or significantly improved methods for the creation and provision of services. They can involve significant changes in the equipment and software used in services-oriented firms or in the procedures or techniques that are employed to deliver services (OCDE, 2005, par.167). Process innovations also cover new or significantly improved techniques, equipment and software in ancillary support activities, such as purchasing, accounting, computing and maintenance. The implementation of new or significantly improved ICT is a process innovation if it is intended to improve the efficiency and/or quality of an ancillary support activity (OCDE, 2005, par.168).

To make the proposed conceptual model is necessary to discover the PIV, so in the literature review are analyzed the following works:

- Process Innovation : OECD (2005)
- Competitiveness: OECD (2009); Porter,(1998); Sánchez, J. (2010);Sánchez, J. (et. al., 2011); Azua, J. (2008); IMCO (2010)
- Organizational Design: Mejía (2009), Daft (1978)
- Information and Communication Technologies: Laudon & Laudon (2012)
- Logistics. Rai (et al., 2012)
- Knowledge Management: Nonaka & Takeuchi (1995); Lundvall (1992); Johnson & Lundvall (1994); Madhoushi & Sadati (2000)
- Quality of Services: Parasuraman (et al. 1985)

The search criteria and selection of variables, involving the relationship of each generation in innovation to raise the competitiveness of companies that are related into the process innovation. The next stage was to ask the order of importance of PIV to 10 railroad specialists, using Saaty's theorem (Analysis Hierarchical

Process, AHP). They were questioned about the importance of each 16 PIV alternatives, using the criteria: *Individual; Organizational (Endogenous) and Environmental (Exogenous)*. The 4 final weights of PIV were: Knowledge Management (KM=15.67%), Logistics Infrastructure (LI=13.41%), Information and Communication Technologies (ICT=9.14%), Quality of Service (QoS=8.59%), rest of the 12 PIV (less than 8.6 and totaling 53.19). In this way, are proposed the following PIV:

Knowledge Management (KM). There are two principal types by codification: explict and tacit (Nonaka and Takeuchi, 1995). Both kinds of knowledge are necessary in the innovation process, and this is one of the main reasons why geography matters. By Lundvall (1992) we can distinguishing further 3 types of knowledges: know-what (knowledge of facts and transfer of codified knowledge); know-why (scientific knowledge about basic principles, rules and ideas); know-who (knowledge about specific and selective social relations. Building of trust in relations. These 3 types of knowledge differ in regard to knowledge creation and knowledge transfer. Johnson and Lundvall (1994). It is also considered, the model proposed by Mehrdad and Sadati (2000), which involves the steps: creation and acquisition, storage, sharing and transfer, utilization.

Quality of Service (QoS). It takes into account the model proposed by Parasuraman (et al., 1985, cited in Mejia, 2009), which consists of: a). Knowledge-gap, conceptualized as the difference between what consumers expect from a service and what management believes that they expect.b).-Standards-Gap, defined as the difference between what management perceives that consumers expect and established standards of quality in the provision of the service.c).-Provision-Gap. It is the difference between the quality standards set for delivery the service and the actual quality of it. d) Communication-Gap. It results from the difference between the actual quality of service provided and what was promised and / or described in the external communication of the company, and e). Service-gap. It is the gap between patient expectations regarding their perception of service and when it has provided.

Logistics (LG). It follows the model proposed by Rai (et al., 2012), involving: interfirm communications (business development, ICT development); interfirm ICT capabilities profiles (logistics automation, logistics coordination, logistics integration, logistics synchronization) and relational value (share of wallet and loyalty)

Information and Communications Technologies (ICT). It follows the model proposed by Laudon & Laudon, on the implementation and impact of ICT, which involved: the administration, organizational structure and technology.

RESEARCH QUESTIONS AND HYPOTHESES

To solve the **RQ,** are proposed:

Q1: What are the dimensions and indicators of PIV variables to improve the C?

Q2: What is the relationship between PIV, to improve the C?

Q3: Which of the PIV and its dimension is the most influential for the improvement of the C?

The approach of general hypotheses to answer **Q2**:

H1: The higher KM, higher level of improvements in C.

H2: The higher QoS, higher level of improvements in C.

H3: The higher LG, higher level of improvements in C.

H4: The higher ICT, higher level of improvements in C.

HG: The relationship into the railroad companies to improve the C, directly depends on the PIV: (KM), (QoS), (LG) and (ICT).

METHODOLOGY

After determining the four mean PIV: (KM),(QoS),(LG),(ICT) influencing the competitiveness (C) from the theoretical framework, this research applied, a test pilot questionnaire using Likert scale (in order to determine the degree of agreement or disagreement with each item), to 4 managers of railroads companies, using the method of the 2 Halves to assure the reliability by use of Pearson correlation with adjustment. After that, were applied 44 final questionnaires involving: 4 dimensions, 20 indicators and 60 regeants to different railroad specialist managers: 14 from FMX, 10 from FSR; 10 from FVLL and 10 from KCSM. To probe the hypotheses we analyzed the results using simple linear regression (SLR) and multiple linear regression (MLR) through the use of SPSS 20. After this, it was necessary to code the information, and them tabulated by capturing the data from each of the questionnaires that we considered as valid.

ANALYSIS OF RESULTS

In order to operationalize the PIV, methodological matrices were created as evidence of validity, based on theoretical framework to explain the origin of variables, dimensions and indicators for measurement. In this way, **Q1 was reached at 100%.**On the other hand, was initially proposed by the conceptual model detailed, generating the questionnaire design and performed a pilot reliability test by the method of the 2 halves with a Pearson (r) Correlation: 0.9905 and degree of adjustment (r^2) of: 0.9810. Descriptive statistics is applied to the dependent variable Competitiveness (C) and independent variables: (KM), (QoS), (LG), (ICT) obtaining by simple linear regression (RLS) to PIV and C for bivariate behavior separately. The positive correlations of variables were: KM (r = 0.656), QoS (r = 0.30), ICT (r = 0.473) and LG (r =0.32). In testing hypotheses**: H1, H2, H3** and **H4 were reached at 100%**; only **H2** was rejected; so **Q2 was reached at 100%**. By statistical inference by multiple linear regression (**MLR**) is determined by the behavior of independent PIV: KM and its dimension: *Talent Management Implementation* as the most influential.**So Q3 was reached at 100%**.See **Tables: 1,2**

Table 1.-ANOVA Dependent PIV: C

Model		Suma de Cuadrados	Gl	Media Cuadrática	F	Sig.
1	Regresión	124816,644	1	124816,644	243,236	,000(a)
	Residual	21552,356	42	513,151		
	Total	146369,000	43			
2	Regresión	143107,348	2	71553,674	899,452	,000(b)
	Residual	3261,652	41	79,552		
	Total	146369,000	43			
3	Regresión	145595,863	3	48531,954	2510,911	,000(c)
	Residual	773,137	40	19,328		
	Total	146369,000	43			
4	Regresión	146369,000	4	36592,250	2349340157 4615660,00 0	,000(d)
	Residual	,000	39	,000		
	Total	146369,000	43			

a Predictive Variables: (Constant), KM**;**
b Predictive Variables: (Constant), KM, QoS;
c Predictive Variables: (Constant), KM, ICT, QoS;
d Predictive Variables: (Constant), KM, LG, ICT, QoS;
e. Dependant Variable: PIV**;**
Source: Own

Table 2. - ANOVA Independent PIV: KM

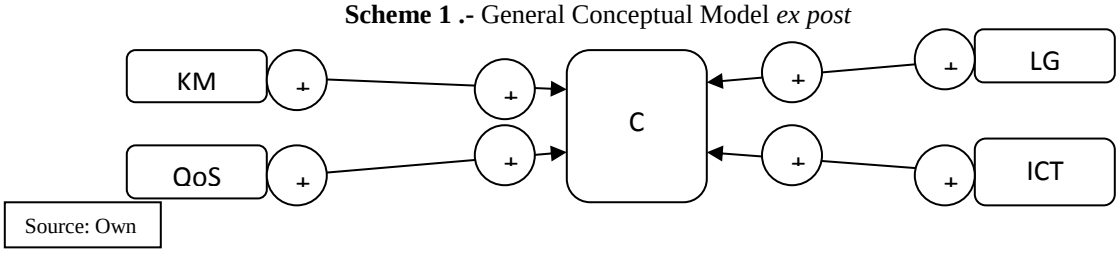
Modelo		Suma de cuadrados	GL	Media cuadrática	F	Sig.
1	Regresión	105666,337	1	105666,337	344,413	,000(a)
	Residual	12885,663	42	306,801		
	Total	118552,000	43			
2	Regresión	114682,486	2	57341,243	607,568	,000(b)
	Residual	3869,514	41	94,378		
	Total	118552,000	43			
3	Regresión	117262,829	3	39087,610	1212,798	,000(c)
	Residual	1289,171	40	32,229		
	Total	118552,000	43			
4	Regresión	117912,956	4	29478,239	1799,017	,000(d)
	Residual	639,044	39	16,386		
	Total	118552,000	43			
5	Regresión	118552,000	5	23710,400	23303732539 925620,000	,000(e)
	Residual	,000	38	,000		
	Total	118552,000	43			

a Predictive Variables: (Constant),Talent Management Implementation;

b Predictive Variables: (Constant), Talent Management Use and Implementation, Creation and Acquisition;
c Predictive Variables: (Constant), Talent Management Use and Implementation, Creation and Acquisition, Storage;
d Predictive Variables: (Constant),Talent Management Use and Implementation, Creation and Acquisition, Storage, Sharing and Transfer
e Dependent Variable (PIV):KM
Source: Own

In this way, we obtained the *ex post* conceptual model answering the **RQ an HG at 100%.** See **scheme 1**

Scheme 1 .- General Conceptual Model *ex post*



Source: Own

There were high dispersion in 4 indicators belonging to LG variable urgent to correct: *logistics automation, logistics coordination, logistics integration and logistics synchonization due to low of knowledge, installation and operation of IC Technologies.* Levels of C (3,590 points; only 48% covered by the design), showing that the command staff, has average shares of PIV, with C participation: KM = 42%; QoS = 43% ;ICT = 50%; LG = 37%

CONCLUSIONS

To propose and discover the relationship between a set of variables of a conceptual model for the railroad industry, based on process innovation variables (PIV), which allows the managers of these companies, recognize, assess, decide and implement actions that improve the competitiveness(C) in the sector, we conclude:

1 .- Remarkable ignorance of the railroad managers of the significance of improvements in competitiveness based on process innovation, since the results obtained are based, in most of the time, in considerations of what should be and not on real facts.

2.-The determination of PIV: (KM),(QoS),(ICT),(LG) to be those with more references and in order of importance of experts in the railroad sector.

3.-The finding of PIV: KM and its dimension: Talent Management Implementation, as the most influential, to improve the C.

4.-Positive correlation for the generation of PIV: (KM),(QoS),(ICT),(LG)

5 .-The *ex post* conceptual model and measurement of levels of IFC with a total of 4 dimensions, 20 indicators, 60 questions which are considered useful for its comprehensiveness and depth.

6.-The discovery of 4 indicators belonging to LG variable, urgent to correct: logistics automation, logistics coordination, logistics integration and logistics synchronization due to low of knowledge, installation and operation of IC Technologies..

7.-Low levels of C (3,590 points; only 48% covered by the design), showing that the command staff, has average shares of PIV, but insufficient in the C participation: KM = 42% ; QoS = 43% ;ICT = 50%; LG = 37%

8.-We obtained the basis for future studies about the performance monitoring if the railroad companies decide to implement the conceptual model .

Finally, we conclude that the variables: Knowledge Management (KM), Quality of Service (QoS), Information and Communications Technologies (ICT) and Logistics (LG) contribute positively to the Process Innovation, as a variables, to improve the Competitiveness (C); however, the management efforts are still insufficient.

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