The use of management information in process innovation: effects of knowledge conversion by socialization

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Abstract
This study analyzes the effects of using managerial information and knowledge conversion by socialization on process innovation. A *survey* was conducted with 133 managers of Brazilian companies that received tax subsidies to develop technological innovation, and the data were analyzed using structural equation modeling. The results revealed that using management information to focus organizational attention, score keeping, and improve organizational learning triggered higher levels of process innovation. In contrast, to improve understanding, it indicated a negative influence. This suggests that the different uses of managerial information can bring contrasting results, an alert for discussing which uses managers should emphasize. Managers' skill to convert knowledge by socialization was found to precede process innovation. However, the moderating effect of knowledge conversion by socialization between managerial information and process innovation was not statistically significant. The finding that the use of management information to focus organizational attention, score keeping, and improve organizational learning reflects in higher levels of innovation can support the organization in promoting process innovation. Managers' skill to socialize their knowledge with colleagues and teams allows for disseminating the organization's tacit knowledge, which seems to stimulate innovations in processes.

Keywords: management information; knowledge conversion by socialization; knowledge management; process innovation; innovative companies.

1. Introduction
Innovation is of increasing interest in the management accounting literature (Magnier-Watanabe and Benton, 2017; Zia and Shafiq, 2017), generally related to improving performance and increasing the competitive advantage of organizations (Henri, 2006). Tarafdar and Gordon (2007) identified a direct relationship between characteristics of information systems in business process innovation and that both precede the organizational performance. In this context, understanding the link between the attributes of information systems and process innovation is fundamental since much of the innovation adopted and implemented is supported by the information systems used by companies based on information technology (Tarafdar and Gordon, 2007).

The use of managerial information helps identify and solve problems, monitor performance, and keep managers updated (Vandenbosch, 1999). The taxonomy outlined by the author comprises the use of managerial information by managers to improve understanding, focus organizational attention, score keeping, and improve organizational learning. Wee et al. (2014) empirically assessed the extent and frequency of use of the information made available to

managers for these purposes. The use of management information for score keeping has a more mechanistic characteristic than other information, which has a broader purpose, used by managers to identify weaknesses, generate learning, legitimize actions, and monitor results (Wee et al., 2014).

Vandenbosch (1999) found the influence of the use of managerial information on the competitiveness of companies. It is assumed that such variables of use of managerial information can also trigger innovation in organizations since innovation relates to competitive advantage (Henri, 2006). For example, the use of managerial information to focus organizational attention and improve organizational learning allows managers to intervene in the focus or direction of the organization (Vandenbosch, 1999). Wee et al. (2014) examined this typology of information use as components of Management Control Systems (MCS). They found a positive influence on improving organizational learning, suggesting that the use of MCS leads to creating knowledge, which will be interpreted and shared.

Organizational knowledge management is another critical element for organizations to thrive, and those that manage, combine, and share knowledge among their employees by socialization processes obtain several advantages (Nonaka and Takeuchi, 2002). Knowledge enables companies to promote innovation, which makes them stand out in the competitive realm (Mohamad et al., 2020). The individual's skill to convert knowledge by socialization refers to sharing experiences and technical skills through interactions and ensures the creation of tacit knowledge (Nonaka and Takeuchi, 2002). Socialization refers to the sharing of knowledge among colleagues to jointly create new knowledge (Nonaka, 1994; Sarwat and Abbas, 2021) and is provided at events, workshops, and during creation in work teams (Kulangara et al., 2016).

Managers' different uses of managerial information and their skill to convert knowledge by socialization in meetings and discussions with colleagues and their team (Huang and Wang, 2002) stimulate innovations in company processes. This favors the elimination of activities that do not add value to the production and delivery processes, increasing the quality of the results, among others (Gunday et al., 2011). Evidence on the use of managerial information to lead the organization and the skill of managers to convert knowledge by socialization proves to be influential and present in innovative contexts. However, studies focused on the relationship between knowledge creation and innovation deserve further discussion (Easa, 2011; Masrek et al., 2014).

In this perspective, the present study investigates the effects of the use of managerial information and the knowledge conversion by socialization in the process innovation in companies that received tax subsidies for research and development of technological innovation (RD&I). The study was operationalized from a *survey* with managers of companies benefited by Law No. 11.196, of November 21, 2005, known as The Good Law, aiming to offer a tax subsidy in the deduction of the sum of expenditures for companies focused on RD&I (Kaveski et al., 2020). Given that the sample comprises companies carefully selected to benefit from tax incentives aimed at innovation, these companies are assumed to innovate intensively in their internal processes.

The study contributes to the management literature in innovative contexts, assuming that management information favors innovation (Henri, 2006), by bringing additional evidence supported by examining the role of four different dimensions of use of managerial information in promoting process innovation. To add to previous research, the reflexes of each purpose of use were examined to point out which information to prioritize given the purpose of innovating in organizational processes. It also innovates by analyzing the moderating role of knowledge conversion by socialization in the relationship between managerial information and process innovation.

It also seeks to leverage the results of innovative companies by highlighting the reflexes of

business management and individual skill as antecedents of innovation in organizations, which is usually associated with greater competitiveness of companies. To intensify innovation in companies, it is necessary that managers, instead of just internalizing knowledge, socialize and share knowledge in interactions with colleagues and their team. This skill forms tacit knowledge, which has been shown to be influential for innovation (Nonaka and Takeuchi, 2002).

2. Theoretical Foundation and Hypotheses

2.1 Use of management information: typology disseminated by Vandenbosch (1999)

The typology of use of managerial information disseminated by Vandenbosch (1999) focuses on information on four dimensions/purposes: score keeping, improving understanding, focusing organizational attention, and improving organizational learning. These aspects form a robust typology to specify the use of managerial information by managers of organizations (Vandenbosch, 1999). Empirical research has also addressed the use of MCS, as observed in Wee et al. (2014), who found relationships between the design and use of MCS in organizational learning.

According to Vandenbosch (1999), the use of management information for score keeping, considered more mechanistic and of a routine nature, refers to standardized reports and helps review the measures and monitor the results. To improve understanding, management information is used to build scenarios, identify weaknesses and external events, and assist in problem solving (Vandenbosch, 1999; Wee et al., 2014). To focus organizational attention, information is aimed at problematic areas of the organization, with the potential to support managers in controlling companies by providing a broad view of the organizational environment (Vandenbosch, 1999; Wee et al., 2014). To improve organizational learning, information is used to legitimize and justify managers' actions, reinforce beliefs, increase focus, and formulate strategies to leverage organizational competitiveness (Vandenbosch, 1999; Wee et al., 2014).

2.2 Effects of using managerial information on process innovation

Among the various classifications of innovation, Lin et al. (2010) disseminated the concept of innovation that divides it by degree and scope. The degree of innovation is presented by radical innovation and incremental innovation. In contrast, the scope comprises five dimensions: product, process, administrative, marketing, and service innovation. The present study focuses on process innovation, which consists of implementing improvements or creating a new production or distribution method (Gunday et al., 2011; Pazetto et al., 2020).

Vandenbosch (1999) found a significant relationship between the dimensions (purposes) of using managerial information and the company's competitiveness, with managers generally using the information to legitimize their decisions. Emphasis is given to score keeping, negatively related to competitiveness. It led the author to question why managers continue to emphasize it, and one of the arguments is that this is probably one of the uses of control systems that are easier to develop. The other dimensions showed a positive association with competitiveness, but the use to improve understanding showed a weaker relationship in influencing competitiveness than the others (Vandenbosch, 1999).

Henri (2006) had already identified a relationship between MCS use with different organizational capabilities. Among them is the ability to innovate, with positive results from the interactive use and negative results from the diagnostic use of MCS, suggesting a balanced use of these MCS. Schäffer and Steiners (2004) found a positive relationship between managerial accounting information to promote learning and organizational performance. Previous studies (e.g., Gomez-Conde et al. 2021) pointed out the relevance of considering the use of information to assist management in organizational performance and innovation. There

may be differences in innovation results depending on how information is used (Citrin et al., 2007). Arguments outlining the following hypothesis:
H1. The use of management information (to improve understanding, focus organizational attention, score keeping, and improve organizational learning) positively affects process innovation.

2.3 Effects of knowledge conversion by socialization on process innovation
Nonaka (1994) emphasizes that tacit and explicit knowledge can interact in a spiral and encompass four dimensions: socialization, externalization, combination, and internalization. Tacit knowledge is not easily explained because it is associated with ideas, values, and emotions, and socialization is part of the tacit knowledge conversion (Nonaka, 1994). Knowledge management was positively related to organizational innovation, and innovative culture moderated this relationship (Mohamad et al., 2020).

Knowledge conversion by socialization occurs when individuals interact with each other. Nonaka and Takeuchi (2002) define it as the process of sharing experiences, ideas, and technical skills, which creates tacit knowledge. These interactions between actors help absorb knowledge, such as new technologies and new production processes (Berraies et al., 2014). Berraies et al. (2014) identified strong relationships between tacit knowledge and innovation, leveraging the company's competitive advantage. Masrek et al. (2014) found a positive relationship of the skill to convert knowledge by socialization in service and process innovation of Malaysian federal agencies.

Easa (2011) found a positive influence of the dimensions of knowledge conversion (socialization, externalization, combination, and internalization) on innovation in the Egyptian banking sector. The author found that such a model has effects reflected in innovation through the generation of ideas related to products, services, and processes. Berraies et al. (2014) found evidence that the knowledge creation process plays an essential role in innovation and the socialization dimension as a determinant of organizational innovation performance. Zia and Shafiq (2017) argue that knowledge conversion by socialization, externalization, combination, and internalization relates to technological innovation. Given this empirical evidence, the second hypothesis is:
H2. The knowledge conversion by the socialization of the manager with their colleagues has a positive effect on process innovation.

2.4 Moderating effect of knowledge conversion by socialization between use of managerial information and process innovation
Studies indicate that the relationship between information and innovation may involve other variables (Citrin et al., 2007). Information is considered an indispensable resource to create knowledge and conduct the organization's activities (Moraes et al., 2012). Nonaka (1994) argues that knowledge is idealized by the flow of information, with information being a means for creating knowledge. In this perspective, the interaction of knowledge conversion by socialization between managerial information and company innovation is an opportunity for investigation.

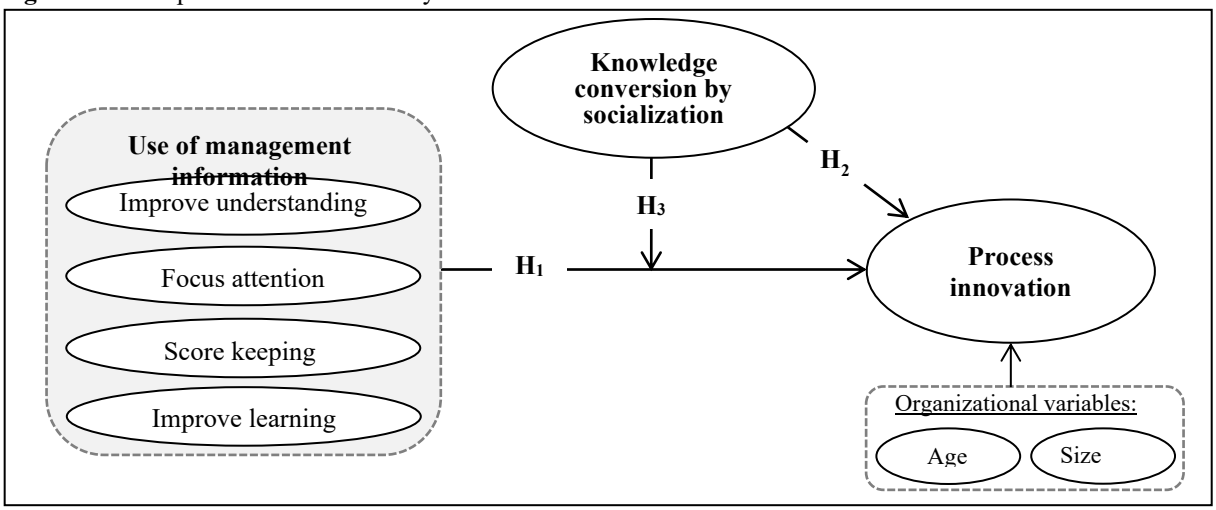
Citrin et al. (2007) found that strategic orientation can moderate the relationship between information use and product innovation. Ling (2013) points out that the people-centered knowledge management strategy (focuses on tacit aspects of knowledge in their interaction) moderates the relationship between structural capital and financial performance/global agility. Magnier-Watanabe and Benton (2017) found that tacit knowledge (of which socialization is a part) thoroughly explains the relationship between innovation management and the performance of Japanese companies. They concluded that knowledge leads company management to achieve greater performance, which implies aligning organizational

management strategies with knowledge management to obtain superior performance.

It is inferred that the knowledge conversion by socialization can intensify the positive effects of the use of managerial information in process innovation, as proposed in the third hypothesis: *H3*. The knowledge conversion by the socialization of the manager with their colleagues positively moderates the relationship between the use of managerial information (to improve understanding, focus organizational attention, score keeping, and improve organizational learning) and process innovation.

Figure 1 elucidates the conceptual model of the study and the hypotheses formulated.

Figure 1. Conceptual model of the study



Besides the three hypotheses outlined, which bring individual factors of managers preceding innovation, the innovation literature points to the influence of organizational characteristics, such as the company's operating time (age) (Jiménez-Jiménez and Sanz-Valle, 2011; Hui et al., 2013) and company size (Damanpour, 1992; Hui et al., 2013), inserted in the model as control variables.

3. Method

3.1 Data collection and participants

Data were collected through a *survey* with managers of Brazilian companies that received tax incentives under Law No. 11,196/2005 to boost innovation based on RD&I. Among the motivations for selecting this sample, companies considered innovative, encouraged to intensify technological innovation, a vital characteristic to identify their antecedents. The Ministry of Science, Technology, Innovation and Communications website lists 957 Brazilian companies that benefited from different sectors (pharmaceuticals, electronics, information, and communication technology, agribusiness and food, textiles, consumer goods, civil construction, among others).

From this list, we sought to identify companies and their managers on the *LinkedIn* network to establish direct contact with those in management positions. We chose to maintain a rate of sending three to five invitations per company, which resulted in contact with 1,526 managers, whose purpose was to establish a connection for sending the questionnaire. A total of 686 managers accepted the invitation to participate in the study, to which we sent a questionnaire link in *QuestionPro*. It resulted in 133 completed questionnaires.

The profile of the respondents reveals that the majority (91%) are male, and most of them attended postgraduate studies, with 73% having a *Master of Business Administration* (MBA), 15% a master's degree, and 1% a doctorate. Participants had a wide range of ages, between 28 and 64 years. When asked about their position in the company, the majority (68%) indicated

being a supervisor or manager. The companies where they work operate both in the national and international markets (65%), and 43% have been established for more than 50 years, only 4% less than 10 years, an average of 49 years. The companies' sectors of activity stand out for mechanics and transport (24%) and information technology (25%). The number of employees is quite dispersed, with an average of 3,548 employees.

3.2 Variables and research tool

The variables were measured based on tools from previous research, adapted to the investigated context, and aimed at managers (Appendix A). To measure the use of managerial information, the tool by Wee et al. (2014), based on the study by Vandenbosch (1999), who assessed the extent/frequency of use of information by managers to: improve understanding, focus organizational attention, score keeping, and improve organizational learning. To access the extent of use of information for the purposes of the typology, managers were asked to indicate the frequency of use of information (financial and non-financial) from the company's MCS for each of the situations presented, considering the scale of 1= very low to 5=very high.

The knowledge conversion by socialization was supported by the tool by Huang and Wang (2002), in which socialization is one of the skills addressed. In the agreement scale (1= totally disagree to 5= totally agree), it was questioned about the attitude of managers in the company in the face of situations in which they can socialize with their colleagues and team. Based on the study by Gunday et al. (2011), to measure process innovation, through the scale of 1= innovations not implemented to 5= innovations of original processes were implemented, it was estimated how much companies have implemented innovation in their processes in the last three years in production and delivery activities to reduce costs with activities that do not add value and increase results.

Organizational characteristics that may associate with innovation are part of the model as control variables. The innovation literature highlighted associations of age (Jiménez-Jiménez and Sanz-Valle, 2011; Hui et al., 2013) and company size (Damanpour, 1992; Wagner and Hansen, 2005; Hui et al., 2013) with innovation. Binary variables were used, and two groups were defined: (i) newer companies, with up to 30 years of establishment (34.7% of the sample); (ii) size, classified according to the 2013 SEBRAE classification, which resulted in small and medium-sized companies and large companies, but because the group of large companies is exponential in this sample (65.3% of the sample), this was used as a control parameter, representing those with more than 500 employees.

3.3 Analysis procedures

The latent variables were accessed using a multiple scale, so the questions that compose them were initially assessed in an exploratory way, with *varimax* rotation and the *Kaiser* normalization criterion. This made it possible to verify the theoretical groupings of the indicators and their reliability. The management information use variables were rotated based on four fixed components. After excluding the last question of the improve understanding variable, due to low commonality (<0.6), the index showed adequate levels (KMO=0.87), with high cumulative variance (73.5%). The knowledge conversion by socialization resulted in excluding the last two questions from the tool due to the low commonality. After exclusion, it presented good fit measures (KMO=0.85; variance extracted = 64%). Process innovation showed adequate measures (KMO=0.82; variance extracted = 63%).

In the application of partial least squares structural equation modeling (PLS-SEM), initially, the fit of the factor loading of the indicators of each variable was attested, which represents how much the variation of the statement is explained by the variation of its variable (>0.70) (Hair et al., 2017), attested in all statements. To test the assumed relationships in the hypotheses, the PLS-SEM modeling was operationalized by the measurement and structural models (Hair et

al., 2017). The moderating effect postulates that the knowledge conversion by socialization positively affects the strength of the relationship between purposes of use and process innovation. Their analysis followed the recommendations of Hair et al. (2017), and as the moderating variable is continuous (scale from 1 to 5), the moderating effect analysis was performed by interaction term.

3.4 Method bias tests

The common method bias refers to the limitations of cross-sectional studies, in which all variables are collected at the same time by the same source of information. Among the precautions, we asked managers to respond that there are no right or wrong answers according to their perception. After the collection, it was verified how much the factors were grouped when analyzing all the statements in exploratory factor analysis. No factor explained a large part of the total variation of the set of variables. Of the five factors formed, the first component represented only 15.96% of the total variance, below the 50% threshold established by Podsakoff et al. (2003). Harman's single-factor test demonstrated that the data do not have limitations of common method bias.

Also, we verified possible sample distortions resulting from non-response bias with the analysis methodology of Wåhlberg and Poom (2015). This study did not have contact with the entire sample nor control over who actually responded. Therefore, possible biases of non-respondents were measured by comparing firsts-lasts, where the late ones represented those who chose not to participate (Wåhlberg and Poom, 2015). The answers of the first 27 respondents (20%) were compared with the last 27, and the t test of independent samples indicated that there are no differences between the groups, at a significance level of 5%. Therefore, non-response bias should not be a factor concerning sample representativeness and result interpretation.

4. Results

4.1 Measurement model

In the measurement model (Table 1), quality indicators of the constructs are assessed to ensure the internal consistency and validity of the multiple scale measures and analyzed according to Hair et al.'s (2017) precepts. Panel B presents the results of model fit indicators and descriptive analysis of the variables.

Table 1. Assessment of the measurement model

Panel A: Indicators of reliability and discriminant validity of latent variables (*n* =133)											
	AVE	**CR**	**α**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1.Use_improve underst.	.625	.830	.731	**.791**	.886	.506	.687	.294	.245	.085	.048
2.Use_focus attention	.723	.838	.628	.597	**.850**	.732	.765	.299	.549	.129	.084
3.Use_score keeping	.696	.873	.787	.398	.507	**.834**	.706	.299	.483	.107	.088
4.Use_improve learning	.736	.893	.820	.528	.572	.584	**.858**	.442	.512	.080	.101
5. Knowledge social.	.640	.899	.860	.246	.225	.224	.367	**.800**	.421	.059	.049
6. Innovation processes	.628	.894	.851	.230	.412	.419	.431	.368	**.792**	.157	.110
7. Company_age ≤30	-	-	-	.072	.101	-.083	-.040	-.020	.133	**1**	.097
8. Large_size	-	-	-	.002	-.072	.060	.092	-.008	.100	.097	**1**

Panel B: Model fit indicators and descriptive analysis of latent variables (*n* = 133)									
	SRMR	**NFI**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Model fit	0.069	0.694								
Mean			3.74	3.89	4.37	3.95	4.08	3.83	49	3.548
Median			4	4	5	4	4	4	46	1.000
% variation (S.D./mean)			25%	20%	15%	18%	15%	22%	48%	89%

Note 1: Variables 7 and 8 are qualitative with a binary scale. Company_age represents the group of companies established less than 30 years ago (46 companies). Large_size represents the group of large companies, with a number of employees equal to or greater than 500 (87 companies).
Note 2: In panel A, the coefficients on the lower diagonal represent the results of discriminant validity by the Fornell-Larcker criterion; the coefficients on the upper diagonal demonstrate discriminant validity results by the *Heterotrait-Monotrait* (HTMT) criterion; the diagonal values are the square root of the AVE.
Legend: AVE= average variance extracted; CR= composite reliability; α= Cronbach's alpha; SRMR= standardized root mean square residual; NFI= Normed Fit Index.

The reliability of the structural model is attested. Composite reliability presents indices greater than 0.7. Convergent validity, indicating whether the variable effectively expresses what it should measure, presents higher values (AVE>0.5) than those recommended by Hair et al. (2017). When estimating the internal consistency of the measures reflected in latent variables, using Cronbach's alpha, it was identified that, except for the variable of use of managerial information for focus organizational attention, all obtained values greater than 0.7, showing good internal consistency of the measures. The modeling continued with all variables, given that the value found for the variable in question is slightly below the threshold (α=0.628), and that this dimension presented convergent validity of 0.838, which is the main way to attest to the reliability of measurements (Hair et al., 2017).

Discriminant validity, which reflects the ability of the variable and its indicators to be distinguished from the others, was met using the Fornell-Larcker and *Heterotrait-Monotrait* (HTMT) criteria and parameters set out in Hair et al. (2017). The correlations between the central variables indicated to be positively correlated with each other, more strongly in the correlations between the four purposes of use of managerial information. This indicates that they are positively interrelated. For example, managers who use managerial information to focus attention also tend to use it to improve understanding (corr.=0.597). The correlations indicated positive association coefficients of all model antecedents with process innovation at different intensities.

The descriptive statistics of the variables showed that, on the scale from 1 to 5, most respondents were in the highest quadrant of the scale, with a mean variation of around 20%. Regarding the use of managerial information, managers showed that, on average, they use it more frequently information for score keeping (mode=5). Vandenbosch (1999) already pointed out as likely to be the easiest way to use, a factor that outlines the context of the sample as a predominantly formalized management. When questioning the extent of process innovations implemented in companies in the last three years, the sample mean was 3.83, and the most recurrent point in the managers' responses was 4.

The age and size of the company are qualitative control variables, representing the portion of the sample of companies established up to 30 years ago (34.6%) and large companies, with more than 500 employees (65.4%). Descriptive statistics comprise managers' responses before segmentation between analysis groups. Despite the high variation, the companies proved to be in the market for a long time (mean=49 years) and large (mean=3,548 employees).

The model fit indicators, presented in Panel B, demonstrate an adequate fit, based on SRMR<0.8 and NFI<0.9 measurements (Henseler et al., 2016). After verifying the fit of the measurement model, we proceeded to analyze the paths proposed in the structural model.

4.2 Structural model

In the structural model analysis, the proposed paths were estimated by modeling structural equations by partial least squares, as shown in Table 2.

Table 2. Structural model analysis

Path analysis→		Structural coeff.	f^2	*t-Statistics*	*p-value*	R^2
H1	Use_improve understanding→ innovation	-0.158	0.021	1.307	**0.096**	
	Use_focus attention→ innovation	0.226	0.037	2.045	**0.020**	
	Use_score keeping→ innovation	0.194	0.032	1.894	**0.029**	
	Use_improve learning→ innovation	0.174	0.021	1.641	**0.050**	
H2	Knowledge by socialization→ innov.	0.250	0.070	3.031	**0.001**	
H3 Moderating effect	Use_ understanding * sociali.→ innovation	-0.024	0.000	0.149	0.441	**0.36**
	Use_ focus attention * sociali.→ innovation	-0.153	0.012	0.929	0.177	
	Use_score keeping * sociali.→ innov.	0.010	0.000	0.068	0.473	
	Use_improve learning * sociali.→ innovation	0.105	0.007	0.703	0.241	
Control Variables	Company_age ≤30 years→ innovation	0.164	0.039	1.911	**0.028**	
	Big_size → innovation	0.097	0.014	1.310	**0.095**	

Note: *n* =133; variable redundancy index (innovation): Q^2 =0.197; variance inflation factor (VIF) max = 2.35; f^2 = effect size, Cohen's (1988) size classification: 2% low, 15% medium, and 35% large.
Legend= *indicates moderating effect per interaction term.

In the structural model, there is an absence of multicollinearity between the variables (VIF<5) and an acceptable index of general redundancy of the model to determine the variations of process innovation (Q^2 >0) (Hair et al., 2017). The results provide statistical support to accept H1 partially, finding a positive effect of the use of managerial information on process innovation in the dimensions focus organizational attention, score keeping, and improve organizational learning ($p \leq 0.05$). Nevertheless, these precepts are rejected regarding the use of information to improve understanding in innovation, which showed statistical significance, but a negative coefficient, contrary to the hypothesis postulated.

H2 is confirmed, as it attests to the positive effect of knowledge conversion by socialization on the innovation of business processes ($p \leq 0.01$). However, it was not possible to attest to the moderating effect of knowledge conversion by socialization in the relationship between information use and process innovation ($p > 0.10$), so H3 is rejected. The effects of organizational control variables on innovation showed that the group of newer companies (established up to 30 years ago) are positively associated with innovation ($p < 0.05$), and the group of large companies, compared to small and medium ones, also shows a positive association with innovation ($p < 0.10$).

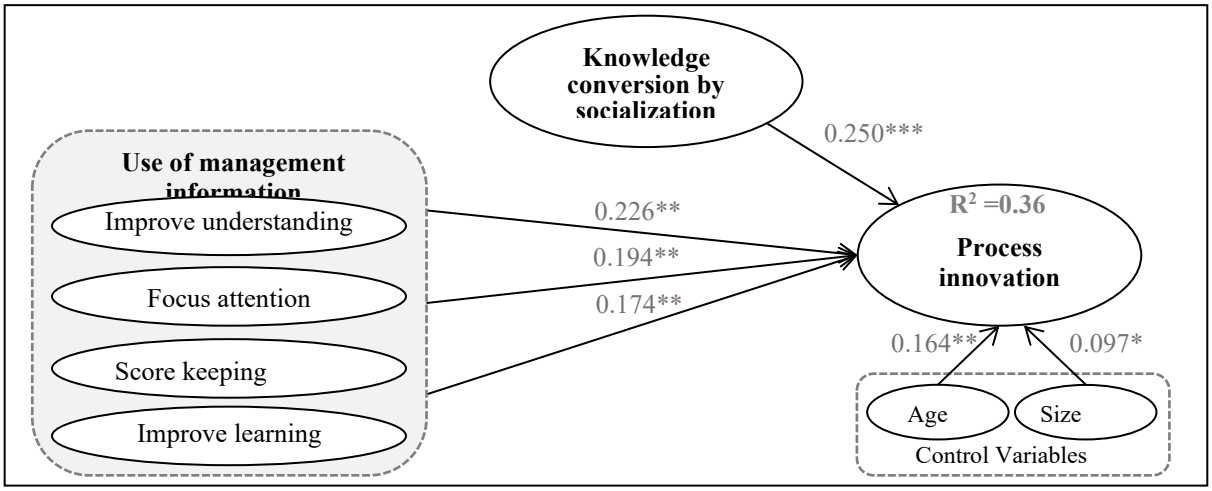
The effect size (f^2) shows that, although several relationships are statistically significant, the effect size of each isolated relationship is low (Cohen, 1988). However, when analyzing the model's predictive power, it was identified that the conceptual model explains 36% of the variations in the process innovation variable (R^2). The value represents a coefficient of determination of the model on the variations in the dependent variable of great magnitude, according to the parameters of Cohen (1988).

5. Discussion and Implications

5.1 Discussion of results

The results of the accepted relationships are presented in Figure 2, and the interpretation of the results is presented below.

Figure 2. Research results – relationships accepted



Note: n=133. Significance at the level of *p<0.10; **p≤0.05; ***p≤0.01.

The results support accepting H1 regarding using managerial information for organizational focus attention, score keeping, and improving organizational learning as antecedents of process innovation, and rejecting the effect of using managerial information to improve understanding in process innovation. The positive association found corroborates what Henri (2006) pointed out about the superiority of the interactive use of MCS to stimulate the organization's ability to innovate and the arguments of Citrin et al. (2007) on the relevance of using the information to assist in performance management and organizational innovation. The findings show that the use of managerial information helps managers innovate in company processes, including implementing improvements or creating new production methods (Gunday et al., 2011).

In line with the results, companies that seek to innovate should basically focus on three purposes for the use of management information: focus organizational attention (highlight problem areas, prevent threats), score keeping (follow progress towards goals, assess achievements and results), and improve organizational learning (identify weaknesses in the strategy and its reformulation and improve competitiveness). The use of management information to improve understanding indicated constraining process innovation. A result contrary to the hypothesis, but in line with the argument by Citrin et al. (2007), that previous studies, besides demonstrating the relevance of the use of information to support management, point out that the use of managerial information can lead to different innovation results.

Use to improve understanding encompasses identifying the interdependence of business units, identifying weaknesses, and assessing the impact of an external event (Vandenbosch, 1999). This approach is speculated to be less linked to the companies' production process since the use with the highest mean was for score keeping. These findings may contain the bias of the attributions of the hierarchical level investigated. Management positions may not act directly at the strategic level, where questions about the business units, assessment of weaknesses, and impacts are usually formulated and discussed. Therefore, the use of management information to improve understanding is conducted by directors. This purpose is more critical than monitoring the score, which advocates accountability and information produced to comply with legal obligations. Critical analyses are suppressed to understand the results and encourage feedback on the company's strategy based on this new learning.

In H2, a positive and significant relationship between knowledge conversion by socialization in process innovation is confirmed. This finding is in line with what is pointed out in the literature (Berraies et al., 2014; Masrek et al., 2014; Zia and Shafiq, 2017), that the knowledge conversion by socialization, the interaction of managers with their peers in the organization and exchange of experiences and ideas drives process innovation. Given that socialization reflects the level of communication and interaction between individuals in solving problems (Kulangara

et al., 2016), it is understood that the organizational processes of production and distribution lead to problems that can be solved by sharing knowledge between managers via socialization. The individual skill to convert knowledge by socialization has been shown to create tacit knowledge across the organization (Nonaka and Takeuchi, 2002). This leads companies to process innovation and can bring organizational benefits, such as increased results in manufacturing processes, techniques, machines, and software, as well as productive efficiency by identifying activities that do not add value (Gunday et al., 2011).

Moderation of knowledge conversion by socialization was not confirmed in the relationship between managerial information and process innovation, which does not allow accepting H3. The knowledge conversion by socialization does not intensify the effects of information on innovation in the present study may be because that process innovation in most large companies is not so dependent on individual variables (of their managers), which also explains the small effects found in direct relationships. For example, Mohamad et al. (2020) found a positive association between knowledge management and organizational innovation and confirmed the moderation of innovative culture. The use of managerial information and the knowledge conversion by socialization influence process innovation in a direct, but disassociated way, denoting the relevance of the model that encompasses these two antecedents. Information is an indispensable resource in creating knowledge and performing organizational activities (Moraes et al., 2012). In contrast, knowledge is idealized by the flow of information, that is, information is a means that enables the creation of knowledge (Nonaka, 1994). This instigates greater alignment between managerial information and knowledge socialization skills and suggests that both the information used and the socialized knowledge are geared towards innovation.

The control variables indicate that the age and size of companies are associated with process innovation, especially for newer and larger companies. Companies operating in the market for up to 30 years showed a positive association with process innovation, evidence that denotes a more active profile in activities aimed at innovation in these companies. This is corroborated by Hui et al. (2013), who found that innovation brings more benefits to newer companies. The size of the company also showed a positive effect, in that large companies are positively associated with innovation, and this group is the most representative of the sample (approx. 67%). Jiménez-Jiménez and Sanz-Valle (2011) add that larger companies generally have more resources to invest in innovation, results in line with Damanpour (1992), who found a positive relationship between company size and innovation.

5.2 Theoretical and managerial implications

Theoretical implications are observed in the study about the dimensions of the use of managerial information, which, analyzed in a segregated way, show the role of each purpose of use. This analysis brought a surprising result, finding a negative influence of managerial information to improve understanding. A counterpoint to the literature that analyzes it as part of the comprehensive use presents itself with differences and stimulates further investigation. By restricting the research focus to knowledge conversion by socialization, we contribute to the research gap pointed out by Zia and Shafiq (2017), that research around knowledge creation variables restricts the skill set of knowledge conversion by socialization, and there is a lack of studies that specifically address them. The rejection of H3, which assumed a moderating effect of knowledge conversion by socialization, indicates that managerial information and knowledge sharing influence innovation in an isolated way and are not intensified by the interactive effect, unlike the hypothesis postulated.

When investigating whether the four purposes of use were associated with the competitiveness of organizations, Vandenbosch (1999, p. 87-88) highlighted that, insofar as "the results enhance executives' understanding that MCS can shape their organizations, it has been shown that the information used can result in what the organization focuses on". In this

line, it is suggested that managers aim to align information to innovate, to direct management to provide such support, in addition to emphasizing the use of managerial information for focus organizational attention, score keeping, and improve organizational learning, so that the companies in the sample can transfer the tax benefits extended to them to the processes. The companies in the sample, on average, still have room to intensify their process innovation, given the average intensity of reported innovation.

The knowledge conversion by socialization as preceding innovation should lead companies to promote such behaviors in their managers. Avenues to intensify these interactions imply promoting a more participatory management and an organizational climate that encourages communication, bringing managers closer to sharing knowledge in meetings and discussions with their colleagues and staff. Kulangara et al. (2016) highlight the promotion of events and workshops and creating teams to encourage interaction. Managers who socialize their knowledge favor the creation of tacit knowledge in the organization, leading to innovation (Nonaka and Takeuchi, 2002). This impacts the organizational climate, promotes well-being in the work environment, greater team spirit, and alignment of interests among members. Social skills also allow employees to keep up to date and connect them to knowledge by exchanging experiences and creating ideas, where innovations originate.

The negative influence of the use of managerial information to improve understanding in innovation, as opposed to other purposes of using information, such as score keeping (ex: contrasting planned *versus* accomplished), one speculates that it may come from the fact that managers of the sampled companies are not considering the use of managerial information based on strategic analyses. This indicates an opportunity to review the organizational strategy so that management information is used in critical analyses, for example, to: (i) identify the interdependence of business units; (ii) identify weaknesses; (iii) assess the impact of an external event. Information and analyses can feed back the company's strategy with the help of strategic planning techniques, such as the *SWOT* matrix (*strengths, weaknesses, opportunities, threats*).

6. Conclusions

This study analyzed the effects of using managerial information and knowledge conversion by socialization on process innovation in Brazilian companies that received tax subsidies to develop technological innovation. The finding that managers' use of management information to focus organizational attention, score keeping, and improve organizational learning reflects in higher levels of innovation supports that the management of organizations can help companies achieve innovation in their processes, but this requires information aligned with the organizational strategy. In turn, the use of managerial information to improve understanding was shown to be associated with less innovation, which suggests that the use of managerial information can bring contrasting results, as in the study by Henri (2006), who found complementarity of controls for innovation (interactive use + and diagnosis -).

Despite being an individual characteristic, the potential of the skills that managers exert on organizational results, when socializing them with their colleagues and team, they expand and disseminate tacit knowledge in the organization, stimulating innovations in the company's processes. The moderating effect of knowledge conversion by socialization between the use of managerial information and process innovation was not confirmed, indicating that these factors, even when disassociated, precede innovation. Moderate levels of innovation were observed in the sample companies, which suggests that they can intensify the results of the benefit obtained through implementing new processes in production and their deliveries. Among the possibilities to intensify innovation, emphasis is recommended on managing the use of information and the socialization of knowledge (model antecedents), which together explained the 36% variation in process innovation in the companies surveyed.

The findings reflect the panorama of Brazilian companies with tax incentives to innovate,

which have already passed through selection criteria to obtain the benefit, increasing the homogeneity of the sample and limiting the interpretation of the results. In this way, it is urged that future studies aim to identify the relationships proposed in the theoretical model in a different context, traditional and/or family-run companies. Methodological choices also limit some interpretations. Other procedures can be adopted, such as longitudinal analysis, which has the potential to compare the impact of managerial information and knowledge conversion by socialization on process innovation before and after grating The Good Law tax benefit. It is also possible to conduct a qualitative study to verify in-depth the content and importance of management reports with the information provided to managers and in interviews to verify justifications for the negative result of the use of management information to improve understanding in innovation.

Researchers are also able to identify aspects related to the strategy of these companies in future research to determine whether the tax benefit gain is previously analyzed and incorporated into the strategy and whether the use of managerial information is aligned with the organizational strategy. The processes of knowledge socialization can be analyzed in other contexts, such as the modality of remote work, which has been expanding worldwide to suggest which would be the facilitators of the development of this skill. Research that seeks to understand the interrelationships between the four purposes of using managerial information is also encouraged to find out how to encourage the use of one of the purposes and discourage the other, as suggested by Vandenbosch (1999).

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Appendix A: Questionnaire

Use of management information (Wee et al., 2014, extracted from Vandenbosch, 1999)
Improving understanding
1. Identify interdependency of business unit.
2. Identify weaknesses.
3. Evaluate impact of external event.
4. Explore options*.
Focusing attention
5. Highlight problem areas.
6. Signal impeding threats to the organisation.
Score keeping
7. Track progress towards goals.
8. Measure archievement to critical sucess factors.
9. Compare outcomes to expectations.
Improving learning
10. Identify weaknesses of existing strategy.

11. Formulate new strategies.
12. Improve competitiveness of products/services.
Note: *items excluded due to low commonality, according to parameters by Hair et al. (2017).

Knowledge conversion by socialization (Huang and Wang, 2002)
13. In team discussion, I will actively share my experience with others.
14. In my work team, my teammates and I will share life or work experience with each other.
15. During group discussion, I try to find out others' opinions, thoughts and other.
16. During discussion, I will bring out some concepts, thoughts or ideas.
17. I often encourage others to express their thoughts*.
18. Before team discussion, I will collect necessary information and show it to my teammates*.
Note: *items excluded due to low commonality, according to parameters by Hair et al. (2017).

Process inovattion (Gunday et al., 2011)
19. Determining and eliminating non-value adding activities in production processes.
20. Decreasing variable cost components in manufacturing processes, techniques, machinery and software.
21. Increasing output quality in manufacturing processes, techniques, machinery and software.
22. Determining and eliminating non-value adding activities in delivery related processes.
23. Decreasing variable cost and/or increasing delivery speed in delivery related logistics processes.

Company age
24. When the company was founded?

Company size
25. What is the current number of employees in your company?