

# The mediating role of socialization in the relationship between interdepartmental integration and product portfolio performance

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## Abstract

**Paper aims:** Analyze the relationship among interdepartmental integration (IDI), socialization, and product portfolio performance (PPP), mainly the effect of socialization's mediation on the relationship between the other two constructs.

**Originality:** No study has related both IDI and socialization for improving PPP, with the aim of overcoming the information absence and flow in this portfolio management. This work offers an alternative when compared to past studies, which is the importance of socialization for product portfolio's success.

**Research method:** Survey with 131 most innovative companies in Brazil. Results were provided by PLS-SEM.

**Main findings:** IDI has direct effect on socialization and no direct effect on PPP, besides the mediation of socialization is confirmed. Furthermore, IDI presents indirect effect on PPP.

**Implications for theory and practice:** Socialization's mediation opens space for other theories that can be beneficial to the product portfolio. Furthermore, Managers can prioritize IDI's actions to potentialize PPP through socialization.

## Keywords

Product Portfolio Management. Socialization. Interdepartmental Integration. PLS-SEM. Mediating effect.

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## 1. Introduction

One challenge for the decision-making process in portfolio management is to make decision in the absence of information (Cooper et al., 2000). According to Kester et al. (2011), some companies that rate mature in portfolio make use of evidence-based process as one of the decision-making for portfolio effectiveness. However, most companies still not use knowledge or information as it should be used, which make them to keep portfolio mistakes and undesirable outcomes, being the weakest area when it comes to managing new products (Jugend et al., 2017; Oostuizen et al., 2018). In this way, the need for improvements in managing new product portfolio is considered fundamental (McNally et al., 2009).

Some studies have been relating the involvement among departments for taking information on the selection of new product projects (Kester et al., 2011; Perks, 2007). Weissenberger-Eibl & Teufel (2011) say that the integration among departments is one of the best practices for product portfolio management. Pimenta et al. (2020) inform that the more complex is a phase of new product development in terms of diversity of knowledge and information required, the greater the need for this integration. This integration is a structure that presents informal and formal activities across departments, promoting improvements, such as the achievement of goals and mutual alignment (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010; Jeske & Calvard, 2020;



Kock et al., 2020; Pellathy et al., 2019; Weissenberger-Eibl & Teufel, 2011). In this way, many authors claim that integration among different departments supports the clarity and information flow and sharing (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010; Kahn, 1996; Pellathy et al., 2019).

Besides the need for information flow and sharing, loose information or individual knowledge is not functional until it has acquired it collectively, being the collective level of knowledge necessary, which makes the enterprise's employees to consider it as useful and strategically resources for performance and decision making (Singh et al., 2020). The transformation of knowledge into a collective level can be marked by socialization, which is a transformation mechanism from tacit to tacit knowledge through observing and experiencing (Nijssen & Van der Borgh, 2017; Takeuchi & Nonaka; 2008).

Issues involving knowledge were always portrayed at the beginning of the product development process (Kock et al., 2015), presenting a gap in studies that apply concepts related to knowledge when it comes to activities that precede this process, such as portfolio management. Thus, socialization also may promote adequate and relevant knowledge and information transparency for the portfolio management (Møller et al., 2016; Patanakul, 2015).

In addition, individuals are more likely to share their knowledge and information in cooperative contexts (Ghobadi & D'Ambra, 2012; Lin, 2006), where they have a shared identity and trust, or even in some atmosphere that able employees' interaction for sharing of knowledge (Singh et al., 2021). So, socialization does not happen if the establishment of common long-term goals and resources, which are characteristics of interdepartmental integration (IDI), does not occur (Xu et al., 2017). Furthermore, aspects of knowledge sharing are not so explored as would be in contexts among functional teams, which means that it needs more studies relating this issue (Ghobadi & D'Ambra, 2012).

Considering the previous paragraphs and that there is still a gap in literature about how to achieve new product portfolio management success (Kester et al., 2014), mainly because of the information issues, like the problem of absence of information (Cooper et al., 2000) and information flow (Oosthuizen et al., 2018), this study tries to give one more step in the product portfolio field considering the support of a structure that improves the relationship among departments involved (interdepartmental integration) in portfolio management (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010; Kahn, 1996; Pellathy et al., 2019), as well as the role of knowledge transformation and its management through socialization (Møller et al., 2016; Patanakul, 2015; Singh, 2020). Furthermore, no study has related interdepartmental integration and socialization with product portfolio.

In this way, the paper's aim is to analyze the relationship among interdepartmental integration, socialization, and product portfolio performance, mainly the effect of socialization's mediation on the relationship between the other two constructs. Thus, what essentially seeks to answer with this research is: Is there, in fact, a positive influence of IDI and socialization on PPP?; Is there a mediating effect of socialization on the relationship of IDI and PPP?

For answering these questions, this article presents data of a survey applied in large and innovative national and multinational companies operating in Brazilian market, besides the use of partial least squares approach into structural equation modelling method for evaluating the relationships among the constructs highlighted.

This research tries to bring some implications to theory and practice. Few works mention the relationship of IDI with product portfolio in empirical ways. Furthermore, this work presents advance of knowledge management theory through socialization in areas that were not so empirically related before, such as pre-development of products. News on practical implications are connected to the need of paying attention in how corporate culture behaves and how important it is to establish involvement among departments and their employees.

This article presents five more sections, the first concerns the theoretical framework and development of the model's hypotheses. Then, the method is presented, as well as the results of the quantitative analysis. The fourth section deals with the discussions and, finally, the conclusions are presented.

## 2. Theory and hypotheses

This section presents the theoretical background among the following constructs: PPP, IDI and socialization. As a result, we propose the hypotheses and the model to be tested.

## 2.1. Product portfolio problem

Product portfolio management is characterized by a decision process on the company's list of product projects, which is regularly updated (Cooper et al., 1999; Miguel, 2008; Jugend et al., 2015). Portfolio management presents some problems or challenges (Cooper et al., 2000). This study is related to the problem of absence of information, and the initial task to overcome it is to raise data from some departments or functions (Cooper et al., 2000). For Oostuizen et al. (2018), the quality, availability, accuracy, clarity and up-to-date information is related to the best projects selection in portfolio.

When the challenge of information is not solved, managers are forced to make significant investment decisions using unreliable or insufficient data, which results in poor portfolio performance (Jugend et al., 2017). Improvements in the decision-making process in managing product portfolio can result in sustainable competitive advantage (McNally et al., 2009), even more when the problem of information flow is the second major one within organizations, promoting a great influence in portfolio (Oostuizen et al., 2018).

In this way, this study addresses the problem of absence of information in portfolio management, considering as possible improvements both the support of a structure of departments (IDI) and knowledge management through socialization.

## 2.2. Interdepartmental integration and product portfolio performance

It is well clear that interdepartmental or cross-functional integration helps to yield new product development performance because of its important role in decision-making (Jeske & Calvard, 2020; Pimenta et al., 2020). According to Hoopes (2001), the key objective of interdepartmental integration is to share knowledge across departments. However, few studies address the way in which the departments' structure and configuration involved specifically in product portfolio management can also help with the information challenge (Kester et al., 2011, Perks, 2007). For portfolio, continuous evolution among departments is even more important than for other activities (Kester et al., 2011). According to Pateli & Lioukas (2017), departmental interactions can result in multiplicative synergistic effects for a firm. Singh et al. (2020) mention that employees who have different backgrounds, being from other departments and even from different hierarchical levels, can influence organizational performance.

Despite the different terms used, like interfunctional, interdepartmental and cross-functional integration, all of them explain the organizational structure among departments, teams or functions, presenting two dimensions, in essence (Jeske & Calvard, 2020; Kahn, 1996). The first is interaction, which represents the formal and coordinated activities across departments, including routines of information flow (Kahn, 1996; Pellathy et al., 2019). The second one, collaboration, it is considered more informal and intangible, representing the affective part of interdepartmental relationships (Kahn, 1996; Pellathy et al., 2019). In the course of time, this discussion evolved to other dimensions (Pellathy et al., 2019), however, they are essentially part of both. When achieved, integration supports proactively other groups in achieving goals, it maintains mutual alignment, makes the departments' activities more systematic, information flow more reciprocal, shares relevant information and ensures clarity of intent, furthermore it is considered one of the best practices for portfolio management (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010; Jeske & Calvard, 2020; Kock et al., 2020; Pellathy et al., 2019; Weissenberger-Eibl & Teufel, 2011).

Few empirical studies explored the use of IDI directed linked to product portfolio. They relate that integration presents a positive correlation with the fulfillment of PPP objectives (Jugend et al., 2016), and also that collaboration dimension is proved to be beneficial to the evidence-based decision-making process in portfolio (Kester et al., 2011). Concerning theoretical studies, Weissenberger-Eibl & Teufel (2011) relate that conflicts and politic activities by a departmental champion in portfolio decision-making are influenced by the lack of common goals, which can be solved by collaboration dimension. In this case, IDI may improve PPP. The following hypothesis is established:

H1. IDI has a significant and positive effect on PPP.

## 2.3. Interdepartmental integration and socialization

Integrated teams by different functions work as a structure which helps to promote a mechanism for knowledge transformation, necessary for product development and product innovation performance (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010). According to Oliva (2014), the knowledge dissemination

process presents the greatest barriers within large established Brazilian organizations. These barriers are human and organizational, and as examples of them we have the lack of a sharing culture among employees and the lack of organizational encouragement (Oliva, 2014). Aspects that are part of IDI, such as sharing ideas, information and resources, seeking mutual understanding, achieving collective goals and participating in committees and meetings, can help to overcome these human and organizational barriers for further knowledge transformation.

In this way, knowledge and information from diverse employees can be shared in order to be further transformed by actors in different departments through informally way. This informally knowledge transformation is related to socialization (Hirunyawipada et al., 2010), defined as the transformation of tacit to tacit knowledge (Takeuchi & Nonaka, 2008), considering the transformation of internal cognition of a team member in collective cognition of a whole team (Hirunyawipada et al., 2010), being related to knowledge management (Gonzalez & Martins, 2015). In this case, not only a common understanding is developed among different functions, but also patterns for creating, transferring, recombining and using information and knowledge, which may be used for decision making in product development (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010; Lin, 2006).

Regarding the decision making, this process can be carried out by people with insufficient knowledge, which brings negative consequences. These failures involved in the socialization mechanism is considered knowledge waste (Ferenhof, 2015). In this way, the argument is that interdepartmental integration may present the role of helping with the reduction of these gaps in knowledge by providing access to broader individual tacit knowledge from other sources, people and departments for effective decision-making.

Looking at this individual level, Singh (2021) say that knowledge exchange promoted by routines or even by individual's psychological motivation for helping colleagues enhance collective learning. This routines or collaborative spirit can be performed by IDI through interaction and collaboration to promote socialization. According to Ghobadi and D'Ambra (2012), individuals are more likely to share their knowledge and information in cooperative contexts, where they perceive that the collective use of this shared knowledge as a search for common interests, so these authors report that there is a positive association between cooperation among departments and high quality in knowledge sharing.

Finally, according to Xu et al. (2017), aspects of socialization do not occur if the establishment of common long-term goals and resources, which are characteristics of IDI. Overall, formal (interaction) and informal (collaboration) aspects of IDI may establish a link between different departments through the search for common goals, proximity, and alignment, so that the integrated environment becomes more conducive for creating new knowledge with the transformation of tacit to tacit knowledge (socialization). In this case, socialization may be facilitated by IDI. The following hypothesis is established:

H2. IDI has a significant and positive effect on socialization.

## 2.4. Socialization and product portfolio performance

Socialization also refers to the perceptions and learning obtained by the subject from something new or little known (Takeuchi & Nonaka, 2008), being important for the employee's awareness of their environment (Nijssen & Van der Borgh, 2017), with evidence that it is the knowledge transformation mechanism that most occurs in processes involving product development (Silva & Rozenfeld, 2003). According to Gonzalez & Martins (2015), organizations that are considered more innovative show great interest in tacit knowledge through group activities, as they prioritize group learning among different members, for example.

Hirunyawipada et al. (2010) emphasize that the variety of different experiences among members makes them to develop different angles of understanding that touch other ones. In this case, it is seen that human capital is an avenue for socialization happens, and according to Singh et al. (2020) an important resource for performance. The most valuable is the power of enterprise's employees to stay aware of which knowledge is relevant and presents the potential to be leveraged (Singh et al., 2021) to be transformed collectively.

Martinsuo & Lehtonen (2007) state that the availability of information for decision-making in portfolio management is the most significant factor to contribute to the achievement of the objectives of this management. Thus, according to Møller et al. (2016) and Patanakul (2015), knowledge management, regarding socialization, can guarantee adequate and relevant knowledge and information transparency for the portfolio management. Therefore, the following hypothesis is established:

H3. Socialization has a significant and positive effect on PPP.

## 2.5. The mediating role of socialization

Considering insights from Cousins et al. (2008), where socialization mediates the relationship of communication measure on business performance, and insights from Singh et al. (2020), who mention that the environment is important for influencing the knowledge sharing practices in an organization, the socialization seems to have the role of guarantee this environment among employees through the development of encouraging cooperative work, use and transformation of knowledge that has relevance within the company. For example, knowledge human resource management practices, such as cross-functional teams (Lopez-Cabrales et al., 2009), strengthens knowledge sharing, as well as networks among employees, so this behavior in the workplace changes, including the fostering of innovation (Singh et al., 2021).

In the case of this research, if IDI assumes an organizational structure in which formal and informal ways of information is shared, socialization creates an environment where employees can transform the information received plus its own knowledge into collective, with the aim of benefiting PPP in the problem of lack of information and knowledge to decision-making. The willingness of employees to engage in new interactions that promotes the knowledge sharing is increased when an atmosphere of relationships is created (Singh et al., 2021). The need of creating an environment conducive to the company's objective is valid. In the case of this research, socialization may create an important atmosphere for aspects of IDI to affect the PPP. Besides, knowledge sharing has the potential to generate new ideas and develop new business opportunities through socialization and learning process of knowledge workers (Lin, 2006). In this way, it would be interesting the mediating role to be tested to know if PPP is high level improved by IDI when in presence of socialization.

Hypothesis 4: Socialization mediates the positive effect of IDI on PPP.

From the presentation of all the hypotheses, the conceptual model is presented in Figure 1.

Next topic presents the methodological steps used in this research.

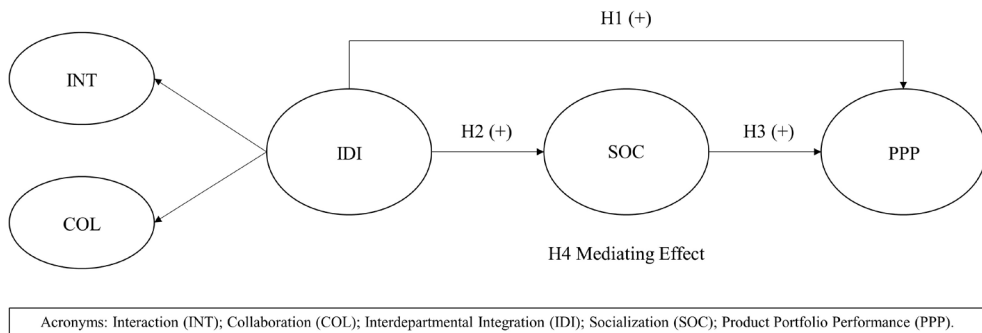


Figure 1. Conceptual Model Proposed. Source: Own Authors.

## 3. Methodology

This topic describes the scales of the model used, the steps of the survey and sample characteristics, as well as the structural equations modeling for handling and analyzing data.

### 3.1. Structural equation modeling and conceptual model

This research was conducted using structural equation modeling (SEM) with partial least squares (PLS) approach (Hair et al., 2009). According to Hair et al. (2016) and Ringle et al. (2014), PLS-SEM has the advantage of adapting to models with multiple relationships, being useful for some characteristics, like not demanding normally distributed data. Besides, the approach was chosen because the fact that constructs are reflectives (all indicators are caused by the construct) and because the sample size, which indicated a better precision for PLS-SEM estimations. So, PLS-SEM was also preferred because of the exploratory model developed in this research. Therefore, in this study, data were analyzed using the SmartPLS 2.0 M3 software.

### 3.2. Questionnaire

The questionnaire was structured using scales already validated in the literature for each of the constructs. For IDI construct, the scale of Kahn (1996) was used, which is a classical validated scale used by other authors, such as Li & Chen (2016). For socialization construct, the validated scale of Becerra-Fernandez & Sabherwal (2001) was considered, which was also used in other works, such as Li et al. (2009). For PPP construct, the validated scale of Jugend et al. (2016) was used, which were based on the portfolio management objectives (Cooper et al., 2000).

For all the scales, the six-point Linkert’s scale was used, in which there was a variation from “totally disagree” to “totally agree”, or from “never” to “very often”. The final model was constituted by 19 items for the constructs. In order to understand the sample, the size of the company, its segment of operation, region located in Brazil, the department, the role played by the respondent, and the frequency of reviews of the company’s product portfolio were considered for sample control.

A pre-test was performed and the questionnaire was sent to two doctoral students, three specialist professors from renowned Brazilian universities, and to two company employees that are engineers working in product portfolio activities. This company had a profile similar to the companies of the population studied.

The questions of the questionnaire (seen in Appendix 1) was placed online using the Google form tool. The questionnaire was divided into five parts, the first referring to the characterization of the sample and the other 3 parts referring to questions involving the constructs of the studied model. The questions were randomly shuffled in order to minimize automatic responses by the respondent. Figure 2 presents the structure of the questionnaire.

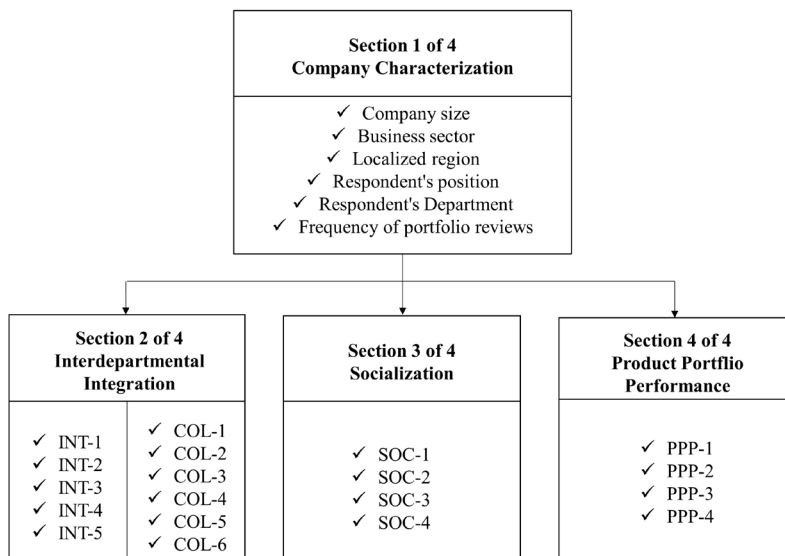


Figure 2. Structure of the questionnaire. Source: Own Authors.

### 3.3. Population

According to Global Innovation Index (GII), Brazil is one of the most innovative economies in the globe. Following this context, the results of the last five yearbooks Valor Inovação Brasil were considered for the definition of the population. This yearbook presents the most recognized innovative companies in the Country, besides it is carried out by Strategy&, which is a strategic consultancy of the Network PwC, in partnership with the newspaper Valor Econômico, which is the main Brazilian newspaper of economics and finance. Special care was taken for the non-repetition of the same company according to the five annuals (2015–2019).

The choice of population was made based on the research objective. These companies should be considered innovative, at least at an incremental level, so that products are launched periodically. Thus, they would necessarily present structured product development processes, as well as product portfolio management. According to

Valor Inovação Brasil, the companies that belong to the selected yearbooks are considered innovative due to some pillars, among which there are some aspects such as strategy and vision, use of resources, processes and structures, general and specific results, recognition in the market, as well as generation of knowledge.

To ascertain whether the population size can provide the minimum number of respondents that the literature asks for, according to the recommendation of Ringle et al. (2014), Cohen (2013) and Hair et al. (2009), a calculation was performed using the G\* Power 3.1.9 software. The minimum number of respondents required is 68. According to the population size of 252 companies, it is possible for the validation and reliability of the study.

### 3.4. Population contact and respondents

Regarding the method of contact with the population, the social network LinkedIn was selected. For this, the official page of each of the population's companies was searched and, from the employees' tab, three to five professionals (front line employees, middle managers and top managers, see in Appendix 1) who worked in departments related to product development and portfolio management were selected: Marketing and Sales, Research and Development, Manufacturing and Production (De Luca and Atuahene-Gima, 2007; Venturini et al., 2019). This number of employees was selected so that there would be reserve employees in case the first option did not respond to the first contact message, made by the linkedIn chat. If the collaborator agreed to respond to the survey, the questionnaire link was sent through the same interface.

Only one employee of each company responded the questionnaire for not occurring overestimation. Thus, n respondents mean n companies in the sample. It is important to share that anonymity of the respondents was maintained.

### 3.5. Preparation of input data

The questionnaire was available online from July 15, 2019, to August 18, 2019, and 132 questionnaires were received (52% return rate) with no suspicious response or missing data.

In order to ascertain the presence of outliers, an analysis of the boxplot graphics was performed for each of the variables generated by the SPSS software. It was decided to remove only extremes (1 respondent) in the first analysis. Outliers were kept, because only 1.5 times is not accurate 50% of the time and 2.2 times the interquartile value would be more valid for most cases (Iglewicz & Hoaglin, 1987). Also, the outliers (25 respondents) were companies that showed themselves as outliers in only one, two or three indicators of constructs, not being outliers in all questions of the questionnaire. Following this fact, the multigroup analysis (Henseler et al., 2009) in the SmartPLS software was considered to ascertain whether these 25 companies showed a significant difference from the rest of the sample, which proved not to occur. It was decided to keep the 25 companies in the sample, indicating homogeneity between the two groups. Therefore, the final sample remained with 131 respondents.

The next session shows the results of data.

## 4. Analysis and results

### 4.1. Data description

The results described in this section were collected through the first part of the questionnaire applied (Appendix 1) to the population of companies under study. From that results, about 94% of respondents are large size companies - 500 or more employees, according to the criteria of the Brazilian Micro and Small Business Support Service (acronym SEBRAE in Portuguese). In this case, it was decided to generalize the sample. Regarding the sectors of the respondent companies, the large number of different sectors was already expected because of population's profile. The sectors most cited were the agrobusiness, automotive, consumer goods, electronics, pharmaceutical, food and ingredients, means of payment, steel and telecommunications sectors. All other results about the control variables of the sample are found in Table 1.

It is noted that there is an equal inclination to all portfolio review frequencies. This raises one more question for research on portfolio performance: if there is a correlation between PPP and the frequency of portfolio review. A correlation analysis was performed with SPSS software. It was observed that does not exist correlation between PPP and reviews (observed  $p > 0.01$ ), besides Spearman's R values are low (less than 0.3).

Table 1. Control variables of the sample.

Region		Respondents		Department		Review frequency	
Southeast	57%	Front line	42%	R&D	35%	once a semester	23%
All	35%	Top managers	35%	Production	28%	once a quarter	23%
South	7%	Middle managers	23%	Engineering	17%	once a month	22%
Midwest	1%			Marketing	12%	once a year	21%
				Sales	7%	not every year	11%

Source: Own Authors.

### 4.2. Path diagram

As there is a second order construct in the model, according to Bido & Silva (2019), the indicators of INT and COL should be repeated in IDI for the analysis. The model with the indicators is shown in Figure 3. All constructs are reflective, as they came from scales already validated in the literature.

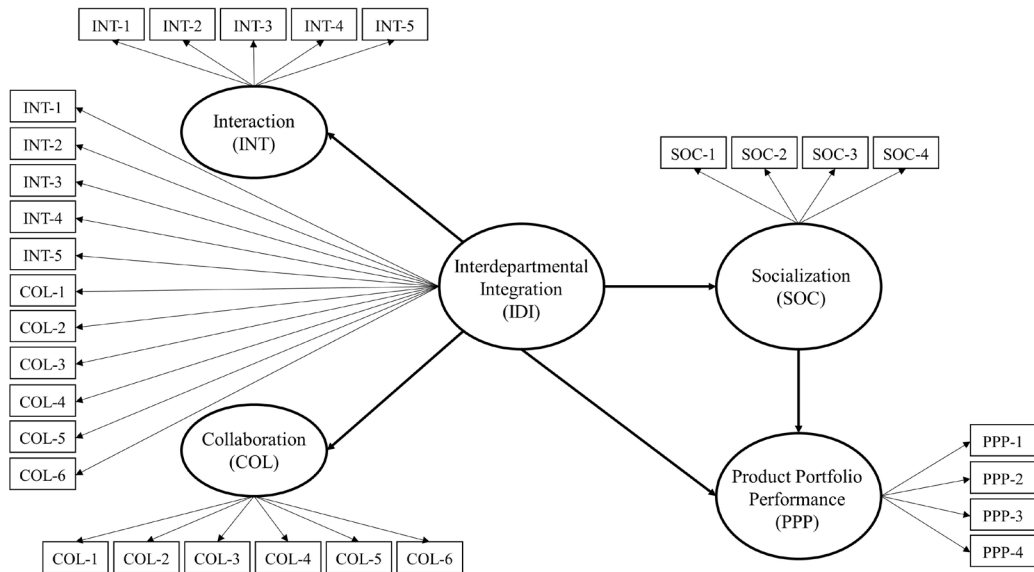


Figure 3. Path diagram with indicators. Source: Own Authors.

### 4.3. Measurement model

The factor and crossed loadings of the first order constructs (COL, INT, SOC and PPP) were analyzed for excluding indicators if necessary (Bido & Silva, 2019). The loadings are shown in Table 2. Factor loadings are shown in bold and all of them are significant at 1%. All factor loadings are above 0.4, indicating that no indicator needs to be excluded at first analysis, especially when reliability, convergent and discriminant validities are adequate (Hair et al., 2016), measures that will be shown later.

Next, the correlation matrix among the latent variables that relate to the hypotheses of the structural model is shown in Table 3. In this table, Cronbach's alpha, composite reliability and average variance extracted (AVE) values for the constructs IDI, SOC, and PPP are presented. According to Bido & Silva (2019), only constructs referring to the model's hypotheses are considered for this analysis, that is the reason why the latent variables of INT and COL are not presented in Table 3. However, with the aim of turning the results more robust, it is important to highlight that Cronbach's alpha values for INT and COL are within the expected range, respectively (0.715 and 0.861). Diagonal values in bold are the square root of AVE (correlations are significant at 1%).

For the values of the second order latent variable IDI presented in Table 3, some precautions were taken, according to the approach of repetition of the indicators by Bido & Silva (2019), which is calculating the AVE and the composite reliability from the path coefficients, since the software does not perform these calculations



Table 2. Factor and crossed loadings matrix for first order latent variables (\*p<0.01) (n=131).

Items	COL	INT	SOC	PPP
COL_1	0.840*	0.454*	0.585*	0.495*
COL_2	0.820*	0.366*	0.561*	0.478*
COL_3	0.513*	0.290*	0.349*	0.156*
COL_4	0.851*	0.525*	0.595*	0.476*
COL_5	0.779*	0.340*	0.602*	0.579*
COL_6	0.794*	0.426*	0.522*	0.414*
INT_1	0.351*	0.637*	0.197*	0.095*
INT_2	0.436*	0.768*	0.370*	0.252*
INT_3	0.316*	0.595*	0.261*	0.194*
INT_4	0.266*	0.639*	0.150*	0.033*
INT_5	0.400*	0.769*	0.303*	0.115*
SOC_1	0.506*	0.292*	0.783*	0.390*
SOC_2	0.544*	0.407*	0.812*	0.467*
SOC_3	0.507*	0.153*	0.795*	0.447*
SOC_4	0.676*	0.362*	0.843*	0.551*
PPP_1	0.521*	0.233*	0.561*	0.865*
PPP_2	0.510*	0.223*	0.410*	0.848*
PPP_3	0.412*	0.041*	0.438*	0.730*
PPP_4	0.474*	0.180*	0.516*	0.895*

Source: Own Authors.

Table 3. Correlation matrix among constructs of the structural model (n = 131) (\*p<0.01).

	PPP	IDI	SOC
PPP	0.837*		
IDI	0.514*	0.863*	
SOC	0.580*	0.671*	0.808*
Cronbach's alpha	0.856	0.854	0.824
Composite reliability	0.903	0.852	0.883
AVE	0.701	0.744	0.654

Source: Own Authors.

with the indicators that were repeated in the second order construct. This formatting job can be found in Appendix 2, where Figure 2A presents the path coefficients of IDI, besides Table 2A, Table 2B and Table 2C present the calculus for AVE and composite reliability of IDI.

Regarding the results from Table 3, it is observed that for each latent variables of the structural model that relate to the hypotheses, the AVE value is greater than 0.5 and its square root is greater than the correlations with the other latent variables, as well as the composite reliability and Cronbach's alpha are greater than 0.7. In addition, Henseler et al. (2015) propose a multitrait-multimethod matrix with the aim of assessing discriminant validity in a more reliable way: the heterotrait-monotrait ratio of correlations (HTMT). Concerning the robustness of discriminant validity, the values for all the construct's relationships are below 0.9 (Henseler et al., 2015; Benitez et al., 2020). Therefore, convergent validity, discriminant validity and reliability are adequate.

Looking at the results of the cross loadings shown in Table 2, it is noted that the indicators COL-3, INT-1, INT-3 and INT-4 present factor loadings less than 0.7. For the COL and INT variables, its values of composite reliability and AVE are in accordance with the established values, reinforcing the discriminant validity.

After all these considerations, when it comes to the structural model, all the indicators of the original model are maintained, with no need for exclusions and extra analyzes.

#### 4.4. Structural model

Following the suggestions of Hair et al. (2016), it was performed a bootstrapping procedure (with 5,000 sub-samples) to test the statistical significance of each path coefficient using t-tests. Table 4 presents the results of the structural model.

As observed in Table 4, among the three hypotheses tested in this research, two of them were confirmed (H2 and H3). There was no significant influence of the direct effect of the IDI on PPP, this fact will be deeply analyzed further, when hypothesis 2 of the conceptual model is evaluated.

In summary, considering  $f^2$ , p-value and t-value, it is noted that the relationship between IDI and socialization is the strongest, most significant (t-value = 15.131 and p-value = 0.000) and relevant ( $f^2 = 0.820$ ) among all the relationships tested. Still in Table 4, it is clear that the value of the determination coefficient  $R^2$  for the endogenous constructs (SOC and PPP) are considered high according to Cohen (2013) and Bido & Silva (2019), having the construct of IDI explaining 44,6% of the variance of the socialization construct and having the constructs of IDI and socialization together explaining 35.5% of the variance for the PPP construct. Regarding the structural coefficient, that is, the path coefficient, such measures mean that if the path directed from the latent variable IDI to the latent variable SOL has 0.671, it means that the increment of a unit in IDI implies an increase of 0.671 in SOL.

Table 4. Structural model (n = 131).

Structural Relationship	Hypotheses	$f^2$	Structural Coefficient	t-Value	p-Value	Adjusted $R^2$
IDI $\Rightarrow$ SOC	H2 (+) Confirmed	0.820	0.671	15.131	0.000	0.446
IDI $\Rightarrow$ PPP	H1 (+) Not Confirmed	0.044	0.226	1.774	0.076	0.355
SOC $\Rightarrow$ PPP	H3 (+) Confirmed	0.159	0.429	3.864	0.000	

Source: Own Authors.

Finally, it is observed that collaboration has more importance for IDI than the interaction, when it comes to the responses of the structural coefficient of PPP on collaboration and interaction compiled by the sample, which are 0.948 and 0.768, respectively.

#### 4.5. Mediating effect

From the results of the bootstrapping in SmartPLS software, in the option of results of direct and indirect effects, the results of Table 5 were obtained. It was noticed that IDI has no direct effect on PPP, however, it has an indirect effect, that is, there is total mediation by socialization in this relationship. Therefore, H4 is confirmed.

In addition to Table 5, Figure 4 shows the graph from SmartPLS software that relates the total effects (importance) with the performance (average scores on a scale from 0 to 100). It is observed that, although the IDI does not have a direct effect on PPP, it is part of the total effect, being ahead of socialization in terms of priority. In these cases, considering the sample, in order to improve PPP, managers would improve IDI of a score ranging from 70 to 100.

Table 5. Specific (detailed) effects (n = 131).

Effects	Coefficient	Standard error	t-Value	p-Value
Direct IDI $\Rightarrow$ PPP	0.226	0.127	1.774	0.076
Indirect IDI $\Rightarrow$ SOC $\Rightarrow$ PPP	0.288	0.075	3.820	0.000
Total IDI $\Rightarrow$ PPP	0.514	0.087	5.893	0.000

Source: Own Authors.

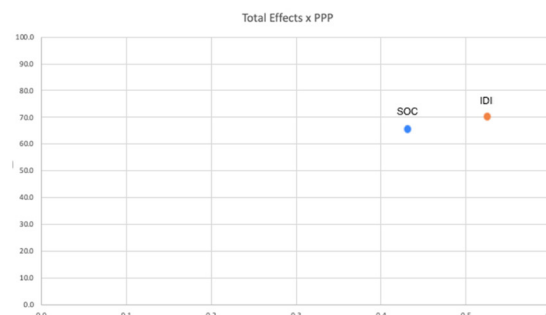


Figure 4. Performance-importance map (or priority map). Source: Own Authors.

The next section presents the discussions about the results.

## 5. Discussion

### 5.1. Hypothesis considerations

The first hypothesis evaluated in this study was that the IDI has a significant and positive effect on PPP, which was not confirmed. This result implies some considerations. Many authors claim that the integration among different departments supports the clarity and information flow and sharing (De Luca & Atuahene-Gima, 2007; Hirunyawipada et al., 2010; Kahn, 1996; Pellathy et al., 2019; Pimenta et al., 2020; Weissenberger-Eibl & Teufel, 2011). However, the most important implication is that integration is not sufficient, it means that the simple collaboration or interaction among departments in product portfolio management needs more intention and care, which will be deeply explained when hypothesis 3 to be considered. Furthermore, the fact that IDI does not present direct effect on PPP may be related to improvements in knowledge and information sharing that this structure should promote in order to become more interesting for nowadays' demands, like information and communication technologies for support in innovation performance through virtuous flow of knowledge (Scuotto et al., 2017).

When considering some studies which stated that the integration among departments is relevant for product portfolio, the present study did not show the same, as direct effect of IDI on PPP did not occur. Kester et al. (2011) used collaboration dimension as being beneficial to the evidence-based decision-making process, which uses technological, financial and market data combined to make evidence-based portfolio decisions. Jugend et al. (2016) inform that there is a positive correlation between the integration of departments involved in the product portfolio management and the fulfillment of the performance objectives of the product portfolio, however, their sample was mostly represented by small companies, which differs from the sample of this work that is mostly composed of large companies, suggesting that there may be a difference between the way of working in relation to the integration among departments and the size of the companies.

On the other hand, Oostuizen et al. (2018), for example, state that some practices are important for decisions in portfolio, which is to find a way of obtaining accurate, relevant and up-to-date information. In this case, this work reinforces what is addressed by Oostuizen et al. (2018), since the fact that the analyzed sample does not present that IDI have a direct effect in PPP, it means that organizations shows that the problem of flow of information is relevant, so mistakes around obtaining accurate, relevant and up-to-date information depends on more factors besides IDI, reinforcing the fact that IDI, although necessary, is not sufficient for PPP, which reveals that other variables can be considered to help in this management. In the case of this work, socialization has a primary role.

Considering the gap in literature about how to achieve new product portfolio management success (Kester et al., 2014) due to the problem of absence of information (Cooper et al., 2000) and information flow (Oostuizen et al., 2018), this study adds important points in the product portfolio management. Hypothesis 1 raises the fact that the literature indicates that IDI produces positive effects on PPP. However, this work does not confirm it, showing that it is interesting to study and indicate other antecedents, which may be new and modern ways of structuring involved parts in product portfolio management. Or even new reflections are generated about changes in the context of product portfolio management, which indicate that perhaps, nowadays, some emerging technologies can provide the support that was done by IDI.

The second hypothesis evaluated in this study was that the IDI has a significant and positive effect on socialization. This hypothesis was confirmed and in accordance with some studies considerations. Some authors believe that the structure of integration among departments can accelerate the transformation of knowledge through its cognitive and social process (Hirunyawipada et al., 2010), besides the congruence of goals or objectives in a common orientation increases the opportunities for sharing experiences (Ghobadi & D'Ambra, 2012; Hirunyawipada et al., 2010; Xu et al., 2017), the central activity of socialization. Finally, the results of this study show that the integration among departments facilitates the socialization. It means that employees need to have an organizational structure in which the contact with information and knowledge can be absorbed and, posteriorly upgraded with individual experience in order to result in collective information and knowledge for a better decision-making. Furthermore, employees are more likely to share their knowledge and information in cooperative contexts (Ghobadi & D'Ambra, 2012). This context is achieved when the structure of IDI occurs.

Another confirmed hypothesis was that socialization has a significant and positive effect on PPP. Again, the results of this study is aligned with insights of other researches. Hirunyawipada et al. (2010) say that an employee's tacit individual knowledge is not functional until the team has acquired it collectively. The results

suggest that no matter if formal or informal information and knowledge are available, in order to help the better decision-making, these initial information and knowledge need to be transformed from individual experience to collective conclusions about the better decision to take. It is necessary that employees understand and learn new perspectives and skills out of their only department, besides learning from the diversity of employees. Furthermore, socialization helps to ensure the continuity of common goals, the similarity of values, the responsibilities of each member, the interaction between them (Smale et al., 2015), besides the awareness of their environment (Nijssen & Van der Borgh, 2017). So, according to the results of this study, knowledge management, with regard to socialization, presents evidence of ensuring adequate and relevant knowledge for the information transparency when in portfolio management contexts. The next considerations explore the socialization's role of being essential for the relationship between PPP and IDI.

Concerning the fourth hypothesis, in which socialization mediates the positive effect of IDI on PPP, it was confirmed. This consideration is the most important one of this study and highlights an evidence which has never been seen before with product portfolio management literature. Since seminar studies, such as the study of Kahn (1996), other studies that analyzed only the pre-development and PPP (Cooper et al., 2000; Jugend et al., 2016; Perks, 2007) appear to realize that this integration could help in the lack of information in the definition making process. However, several models (Kester et al., 2011; Jugend et al., 2016) highlighted this relationship with other constructs and theories, but never with aspects of knowledge management, such as socialization in its pure meaning. In this case, this work highlights that IDI can only promote positive effects on the PPP when providing that all the knowledge and information from the several departments that work with the portfolio is transformed by the organizational collaborators, in a collective way. Therefore, it is understood that information without a convenient environment (Singh et al., 2020) to be transformed cannot solve one of the problems of product portfolio management. IDI seems to have the role of guarantee this environment for employees through the development of encouraging cooperative work, use and then, socialization can transform knowledge that has relevance within the company.

Regarding the problem of information absence (Cooper et al., 2000) and information flow (Oosthuizen et al., 2018) for product portfolio management, the role of knowledge transformation through socialization (Møller et al., 2016; Patanakul, 2015; Singh et al., 2020) opens new avenues for reflection on portfolio management theory as well as knowledge management theory. It is noteworthy that the way of transforming information for specific purposes is appropriate when in decision-making contexts. In this case, access to this information is not enough, but access with its adequacy. Portfolio management theory, therefore, brings the need for information and knowledge refinement.

It was learned that concepts of knowledge management can assist product portfolio management. Besides, this work brings the first theoretical framework for understanding better ways of promoting knowledge transformation through ideal contexts and environments with the final proposal of support product portfolio objectives for overcoming problems related to information.

## 5.2. Theoretical implications

The results of this study suggest the link between important theories in the field of management. The first contribution is to deepen the knowledge about the PPP through an empirical study that deals with its antecedents. Few works mention the relationship of IDI with product portfolio. In addition, this work brings new results, as the direct effect of IDI on PPP was not accepted, indicating that this relationship needs more care, perhaps some analysis and insertion of new variables to IDI that brings more strength to its purpose in current days.

The second contribution is the advance of knowledge management theory through socialization in areas that were not so empirically related, that is, to show the importance of knowledge management for the pre-development of products.

The third theoretical contribution deals with the mediation of socialization in the relationship between IDI and PPP. This contribution can be seen as the most interesting of this article, as it shows that regardless of the structure involved between the departments, the transformation of knowledge is necessary for satisfactory results in the portfolio to occur. This need for socialization had not previously been seen in the literature and this fact arouses curiosity and new interests in the role that socialization can promote in areas of management and product development to transform tacit knowledge.

### 5.3. Managerial implications

Managers can prioritize actions related to IDI in order to potentialize socialization and, consequently, improve PPP. The practical implications are connected to the need of paying attention in how corporate culture behaves and how important it is to establish involvement among departments, as well as their employees.

The results inform that the incentive to increase informal ways of involvement, like the achievement of common goals, mutual understanding, informal means of communication, sharing of ideas, as well as information and resources, sharing the same vision and working together, provide subsidies for high PPP. As facilitating means for a healthy relationship among departments, there is the movement of personnel, the development of self-managing teams and decentralization, the leadership support for knowledge sharing practices and recognition of knowledge value, increased accessibility among people, and even the use of technological means to guarantee communication, among others. Besides, concerning the raise of collective knowledge for better decision-making in portfolio, it is advisable the adoption of employee rotation in different departments in order to learn new perspectives and skills, the encouragement of informal “brainstorming” among employees, the support for the formation of self-managed and multidisciplinary teams, as well as the encouragement of work diversity.

### 6. Conclusions

About the state of the art, it is considered that the study provided subsidies for confirming the total mediation of socialization in the relationship between IDI and PPP in large and established innovative companies in Brazil. Another important consideration states more clearly that IDI is important, but not sufficient, for PPP, and socialization is necessary for the latter. Regardless of the structure involved between the departments, the transformation of knowledge is necessary for satisfactory results in the portfolio to occur.

With regard to limitations and suggestions for future work, this study presents data from a specific sample. Regarding the size of the companies, as the sample is considered to be already established large companies, future analyzes of this model can be performed with other country companies or even small companies to assess the difference. In addition, the fact that socialization has been proved to be a mediator, it opens space for other theories that can be beneficial to the product portfolio, such as other mechanisms of knowledge transformation or other knowledge management processes. Another research that could be interesting is whether the same model, considering IDI and socialization, can also benefit aspects of other phases of product development and organizational performance, or even the addition of mechanisms to obtain external knowledge, outside the company, such as the absorptive capacity construct.

Therefore, from the contribution made in this research, far from intending to exhaust the topic, it can be seen as the opening door for further investigations and future paths with regard to interdepartmental relations and knowledge management in aspects of product development or any other business process.

### Data availability

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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## Appendix 1. Applied Questionnaire.

Section 1 of 5

Each question allows the choice of only one alternative.

All questions must be answered for the questionnaire to be valid.

The estimated time for completion is 10 minutes.

If in doubt, send a message to the researcher who contacted you.

Section 2 of 5

Check only one alternative or write when necessary for the characterization of your company.

What is the approximate number of employees in your company/organization?

- 1 to 19
- 20 to 99
- 100 to 499
- 500 to 1000
- Above 1000

What is the business segment of your company/organization?

---

Where is your company/organization located?

- Midwest
- North East
- North
- Southeast
- South
- All locations above

What is your current position?

- Director
- Manager
- Supervisor
- Coordinator
- Engineer
- Analyst
- Other

What is your acting department?

- Sales
- Marketing
- Research and Development
- Engineering
- Manufacturing / Production
- Other

How often are product portfolio reviewed?

- At least once a month
- At least once a quarter
- At least once a semester
- At least once a year
- Not done every year

Section 3 of 5

Regarding the degree of involvement of the different departments of your company, indicate the option that best reflects your perception according to the scale below.

Never ⇒ 1

Always ⇒ 6

Attending meetings.



1	2	3	4	5	6
---	---	---	---	---	---

Participation in committees/task forces.

1	2	3	4	5	6
---	---	---	---	---	---

Phone calls.

1	2	3	4	5	6
---	---	---	---	---	---

E-mail exchange.

1	2	3	4	5	6
---	---	---	---	---	---

Exchange of documents (reports, memos, forms, etc.).

1	2	3	4	5	6
---	---	---	---	---	---

Achieving goals collectively.

1	2	3	4	5	6
---	---	---	---	---	---

Search for mutual understanding.

1	2	3	4	5	6
---	---	---	---	---	---

Working together with informal means of communication.

1	2	3	4	5	6
---	---	---	---	---	---

Sharing ideas, information and resources.

1	2	3	4	5	6
---	---	---	---	---	---

Sharing the same vision for the company.

1	2	3	4	5	6
---	---	---	---	---	---

Joint work is done as a team.

1	2	3	4	5	6
---	---	---	---	---	---

Section 4 of 5

Regarding knowledge management within your company, indicate the option that best reflects your perception according to the scale below.

Strongly disagree ⇒ 1

Strongly agree ⇒ 6

Does your company adopt and support employee rotation in different departments to understand and learn new perspectives and skills/ competences?

1	2	3	4	5	6
---	---	---	---	---	---

Does your company encourage the organization of informal brainstorming meetings among employees?

1	2	3	4	5	6
---	---	---	---	---	---

Does your company support the formation of self-managing and multidisciplinary teams with members from different departments?

1	2	3	4	5	6
---	---	---	---	---	---

Does your company encourage joint and cooperative work between experienced employees and newcomers/ apprentices?

1	2	3	4	5	6
---	---	---	---	---	---

Section 5 of 5

Regarding the performance of your company's product/service portfolio, indicate the option that best reflects your perception.

Strongly disagree ⇒ 1

Strongly agree ⇒ 6

Is the portfolio generally aligned with the company's strategic objectives?

1	2	3	4	5	6
---	---	---	---	---	---

Do product development projects meet the company's financial target/ goal?

1	2	3	4	5	6
---	---	---	---	---	---

Does the company have a balanced mix of projects: appropriate number of projects with varying (high and low) degrees of technological risk and innovation, as well as duration (short and long term) and focus on different markets?

1	2	3	4	5	6
---	---	---	---	---	---

Do the resources allocated to the portfolio effectively reflect the company's strategic planning?

1	2	3	4	5	6
---	---	---	---	---	---

Your answer was registered.

Thank you for participating!

Appendix 2. Calculation of AVE and composite reliability for IDI.

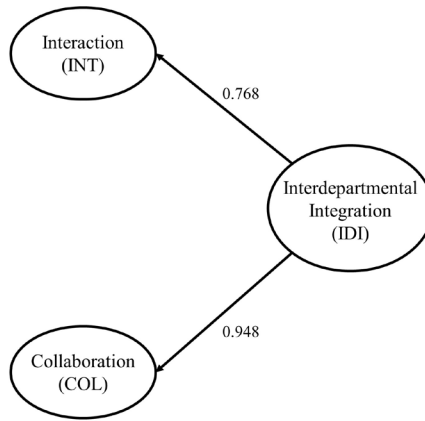


Figure 2A. IDI's path coefficients.

Table 2A. Preparation of path coefficients values.

Loading	0.768	0.948
(1 - Loading) <sup>2</sup>	0.410176	0.101296

Table 2B. New AVE and Composite Reliability values.

AVE	0.744 (Result from Formula 1)
Composite Reliability	0.852 (Result from Formula 2)
Square Root of AVE	0.863

Table 2C. Calculation formulas for AVE and Composite Reliability.

Formula
$\frac{0.768^2 + 0.948^2}{2} \quad (1)$
$\frac{(0.768+0.948)^2}{0.410176+0.101296+(0.768+0.948)^2} \quad (2)$

Note: The formula (1) and (2) are based on Bido & Silva (2019).