

# Past, present, and future of Product Management and Development: a bibliometric study on the contribution and challenges of PMD journal

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**Abstract:** The present work aims at studying the trajectory of *Instituto de Inovação e Gestão de Desenvolvimento do Produto* – IGDP’s research related to the management of New Product Development (NPD) along the past 17 years of Product: Management & Development journal (PMD). The journal was chosen as an object of study to identify how the IGDP community developed over the years, the dynamics of its scientific production, and which subjects have been approached with greater intensity and frequency. Bibliometrics was used as a research method to quantify data of all 268 articles published in the 35 issues of the journal since the first one in 2003 till the last in 2019. Through this analysis, we debate the evolution of academic research registered in PMD, identify characteristics and backgrounds of authors, and unveil some challenges to overcome. The final intent is to inspire actions and strategic paths for the IGDP and PMD community.

**Keywords:** management of new product development, bibliometrics, product: management & development journal.

## 1. Introduction

In the Brazilian context, Instituto de Inovação e Gestão de Desenvolvimento do Produtos (IGDP) is the academic/professional entity exclusively dedicated to New Product Development (NPD) subjects. Since 2003, studies conducted by the academic and professional community associated with IGDP have been published in the journal Product: Management & Development (PMD).

Over the years, the NPD-relates themes have not only gradually expanded, adding new methods and applications, but also we have seen the whole field of NPD studies being increasingly integrated into the wider debate of innovation (Bagno et al., 2017).

As a consequence, new and diverse disciplines have been added to the discussions, bringing new possibilities and opportunities for research. However, new challenges also emerge to IGDP community in its endeavor of building identity, clear perimeters of action, research strategies, and partnerships among members of the academic community.

Thus, aiming at understanding how IGDP academic production has been conducted, its thematic evolution, subjects, general aspects related to the research community, and also aiming at stimulating the discussion on nurturing actions for the future, this study brings a quantitative analysis of all articles published by the PMD journal until 2019’s last issue. To do so, we applied a bibliometric analysis. The final

intent is to offer an essentially descriptive and organized view of the publications’ data – a good picture of what has been done – to inspire the research community to engage in new and insightful ways to leverage the future of PMD.

The next sessions are organized as follows: in section 2, some information about other NPD-related associations in European and North American contexts are synthesized and, subsequently, the trajectory of IGDP is briefly reported. In session 3, we present details of the methodological approach used in this study, discussing the techniques, characteristics, and laws of bibliometrics. In session 4, the results obtained and some analyses from the data are presented. Finally, session 5 brings the final considerations and some implications of the present study for the continuity of works and research efforts related to the mission of IGDP.

## 2. IGDP in the context of other communities of research and practice in innovation management and product development

### 2.1. NPD-related organizations in European and North American contexts

Currently, several organizations around the world attract and congregate researchers and practitioners on new product development and management, usually seeking to promote

the technical progress in such field as a central mission. Like other strands and trends in science, technology, and management, there is a prominence of organizations based in Europe and the United States, a fact to some extent due to the dissemination of English literature and the industrial tradition of these regions.

In 1970, the R&D Management Journal was launched to promote and diffuse studies on the management of the Research and Development field, aiming at integrating the knowledge and practice of academics and the company's managers. The Research and Development Management Association (RADMA) came a bit later, to promote research's results and sponsor scientific research on the field (Research and Development Management Association, 2020). Since the first meeting occurred in Manchester in 1980, the association organizes conferences annually.

According to Research and Development Management Association (2020), the first publications on the general theme of "product" come from the 1920's. Later, members of the University of Manchester launched "The R&D Management Journal", the first European mean focused on studying the dynamics of research and development. In the US, one relevant organization is the Innovation Research Interchange (previously known as Industrial Research Institute – IRI). In the beginning, in 1938, IRI counted on 14 member organizations, which emphasized the need for extended cooperations to enhance the research and the appropriation of its benefits (Innovation Research Interchange, 2020). Efforts associated with the institute contributed to consolidate today's widely adopted models and concepts worldwide, such as Open Innovation, Front End of Innovation, and Stage-Gates. Therefore, IRI turned into a reference to many organizations around the world (Innovation Research Interchange, 2020). Its journal – Research-Technology Management - since 1958 presents studies of great relevance in technological innovation and product development fields as well as good practices in innovation management (Innovation Research Interchange, 2020).

In turn, the Product Development and Management Association (PDMA), founded in 1976 concentrates its activities and debates on product life-cycle, product management, and innovation management guidance (Product Development and Management Association, 2020). The Journal of Product Innovation Management published by PDMA declares in its scope to have interest in themes that contemplate both the internal environment and the external environment of product development, besides encompassing organizations of various sizes and sectors as well as many associated disciplines (WILEY, 2020).

Another prominent organization is the Portland International Conference on Management Engineering and Technology (PICMET). Founded in 1989, the organization

promotes a series of annual conferences on technology and product management (Portland International Conference on Management of Engineering and Technology, 2020). Since 2004, through the International Journal of Innovation and Technology Management, PICMET encourages discussions about technological innovation and idea-sharing among the community. Lastly, the International Association for Management of Technology (IAMOT), founded in 1992, is a non-governmental and non-profit institution, focused on teaching and researching the field of technology management (International Association for Management of Technology, 2011). IAMOT's official academic journal is The International Journal of Technological Innovation, Entrepreneurship, and Technology Management (best known as Technovation) that, since 1981, has been enriching the debate on technological innovation and enjoying large recognition by the international community (Technovation, 2020).

At last, in the systems engineering field, it worth mentioning the International Council on Systems Engineering (INCOSE). Since 1990, the organization proposes to develop and disseminate the transdisciplinary principles and practices that enable the realization of successful systems (International Council on Systems Engineering, 2020). Its academic journal - The Journal of the International Council on Systems Engineering (SE Journal) - emphasizes the discussion on the knowledge practices and the perspectives for the field. Besides the aforementioned organizations, many other international institutions could be mentioned herein adjacent fields such as industrial design or project management. However, the selected ones offer us well-consolidated references that inspire the IGDP's mission and congregate some common members.

## 2.2. The IGDP

In 1999, the Instituto de Desdobramento da Função da Qualidade & Gestão de Desenvolvimento do Produto – IQFD & GDP was founded in Brazil. The proposal of the institute came from the need to promote the knowledge related to innovation and new product development. In 2001, its name changed to Instituto de Gestão de Desenvolvimento de Produto – IGDP and, in 2014, the institute added the term "Inovação" (innovation) in its name, becoming the Instituto de Inovação e Gestão do Desenvolvimento do Produto. The initials, however, kept the same - IGDP (IGDP, 2019).

The first president of the institute was Prof. Lin Chih Cheng, professor at Universidade Federal de Minas Gerais (UFMG) and one of the main precursors of the practice of QFD (Quality Function Deployment) in Brazilian settings (Blucher, 2020). Since then, many researchers and students from several educational institutions have been contributing to the institute, both from Brazil and other countries, employees of public and private companies of various

segments, as well as governmental and non-governmental entities interested in the theme of NPD.

IGDP organizes two biannual events in which the community can collaborate and get in touch to share ideas, studies, and knowledge. The Congresso Brasileiro de Inovação e Desenvolvimento de Produtos (CBGDP) occurs every odd year since the institute was founded in 1999 and is focused on academic production and emerging research trends. Always hosted by prominent academic institutions, in 2019, the 12<sup>th</sup> congress took place in the city of Brasília, Federal District (IGDP, 2019). In turn, the IGDP Workshop occurs every even year preferentially hosted by companies, tech parks, and the like, aiming at encouraging discussions on new practices and emerging trends of interest to the market, industry, and innovation-related professionals as a whole. The 11<sup>th</sup> workshop took place in 2018 in the city of Uberlândia, state of Minas Gerais (IGDP, 2019).

The main communication vehicle of IGDP to formally disseminate to the entire academic community the results and advances of its members' studies is the *Product: Management & Development* journal (PMD). Since its first issue, PMD publishes English-only written articles and is the main publication focused on NPD subjects in Brazil.

Its first issue was released in 2003, containing articles submitted in 2001 and 2002. Until June 2019, 35 editions and 268 articles were published. Currently, two editions are released per year and the journal lists the following topics of interest: Transdisciplinary Innovation, Product Management, Product Design, Engineering Design, Technology Management, Design, Ergonomics, Creativity, Systems Engineering, Project Management, Knowledge Management, and Entrepreneurship (PMD, 2020).

### 2.3. Assessing technology and innovation management journals

The overall importance and relevance of academic journals have long been assessed by the use of metrics. According to Kumar (2018), the impact factor (IF), one of the most used metrics, is obtained by dividing the total number of citations by the total number of articles published within specific periods. Linton (2006), for instance, uses a complementary metric, the modified impact factor (MIF), which considers all citations in a list of selected journals within a given period. In comparison, the IF measures the impact of all the articles published in a particular journal, i.e. the average number of articles published in the past two and five years cited in the present year (Singh et al., 2020). Therefore, the impact factor depends, directly, on the size of the field

In the field of Technology and Innovation Management (TIM), Cheng et. al (1999) suggested three metrics to evaluate a journal's centrality and contribution among the community. The first metric is the overall score, which

considers the base journals that result from a survey made by the research committee of the Academy of Management's Technology Innovation Management Division (TIMD). Such a survey provides a relative ranking of the journals. This metric assumes that if a journal is cited by a higher degree journal (from the top-ranked journals list), it should have more TIM-related articles that deserve such citations.

The second metric applied by Cheng et al.(1999) is the normalized score method. The normalized score is calculated by the total number of citations of a journal in the base period divided by the current year minus a reference year. This metric allows us to understand the effect of the logevity of a journal on the ranks and, then, reduce the age bias. According to Cheng et.al (1999), one of the factors that would have a direct influence on the citation's volume is the number of articles considered. In a given year, a journal that is published more frequently is likely to have a longer list of citations. The weakness of the first and second methods is that none of them take this fact into account. This problem is addressed by the third metric - the weighted score – that, in turn, uses the number of articles published by a journal in a given year in a base period as the weight for that year. By turn, this metric seeks to compensate a higher frequency of publications to shed light on how significant the average number of citations in the reference base is.

Aiming to understand the evolution of a specific journal over time, Singh et al.(2020) conducted a bibliometric study of the *Technological Forecasting and Social Change (TF&SC)* journal, considering 48 years of trajectory and a total of 4.248 articles. This study applied a systematic view that considered metrics and parameters to identify patterns over time, the main researchers involved, research themes and shifts, and also the most prominent institutions and countries in particular areas of research (Singh et al., 2020).

In summary, Singh et al. (2020) navigate over the elements which have influenced the journal, considering the total amount of publications, the most recurrent keywords, the evolution of the journal's general structure, central subjects, and the most prominent articles. Besides that, Singh et al. (2020) bring to the table a co-citations analysis made with those journals that approach subjects and research interests similar to TF&SC's (a co-citation occurs when two journals receive a citation from a third source).

Another study focused on assessing the trajectory of a specific journal is offered by Shum et al. (2019). Aiming at identifying relevant trends this study considered the 550 articles published over 20 years (1998-2017) of the *Research-Technology Management* journal, examining citations, authors, industry sectors, and topics. The analysis suggested that scholars and practitioners look to RTM primarily for thought leadership about knowledge and portfolio management and new product development.

Also, information technology was perceived as gaining prominence among other industry sectors over time.

### 3. Methodology

#### 3.1. Bibliometrics

Bibliometrics is based on a set of laws and principles that allow its users to examine the academic production in a field of interest. Thus, through the creation of indicators, it is possible to organize the data and generate concrete information about the most productive institutions and authors (Okubo, 1997), among other valuable information.

Bibliometrics is defined as a statistical tool to map and generate metrics about information and knowledge, especially from scientific and technology published documents and communication systems. Its results can increase the understanding of research production so that the planning, evaluation, and management of science and technology of a given scientific community or country can be leveraged (Guedes & Borschiver, 2005).

The main parameters considered in a bibliometric study include authors, journals, keywords, and citations. At the end of the study, scientific and technological information is organized and systematized to contribute to the decision-making processes (Guedes & Borschiver, 2005). Moreover, bibliometric studies measure the productivity rates of research centers and individual researchers to detect the most productive institutions and individuals, reveal the areas with the greatest potential, and help to establish priorities for investment allocation (Vanti, 2002).

Bibliometrics is also known as the area of study that uses mathematical and statistical methods to investigate and quantify the processes of written communication (Pao & Lee, 1989 apud Guedes & Borschiver, 2005). Therefore, it allows organizations to identify emerging business areas or patents of the greatest market interest, among other highlighted benefits of the method (Vanti, 2002).

It is alleged that the emergence of the term “Bibliometrics” is due to Paul Otlet, who published “*Traité de Documentation*” in 1934 (Vanti, 2002). For some authors, such as Macias-Chapula (1998) and Guedes & Borschiver (2005), the term is pioneered by Alan Pritchard through the article “*Statistical Bibliography or Bibliometrics*” published in 1969.

According to Araujo (2006), initially, bibliometric studies were deeply focused on the measurement of academic production recorded in books and later began to be used in other publication formats, such as journal articles. Macias-Chapula (1998) states that the advancement of scientific knowledge must be transformed into information accessible to the scientific community. Thus, over the last few years, the need to quantitatively evaluate scientific advances, and to determine the degree of development

achieved by the various subjects of knowledge increased in relevance (Vanti, 2002).

Guedes & Borschiver (2005) consider as the most important laws of bibliometric studies: Lotka’s, Zipf’s, and Bradford’s Law. In general, a common principle in bibliometrics is that most of the knowledge produced is due to the work of a few individuals or entities. Guedes & Borschiver (2005) consider that Bradford’s Law turns possible to estimate the degree of importance of a journal focused on a specific theme since the journals that produce the most tend to become references to the community and are legitimized as high-quality sources. Thus, this law contributes to establishing the core and the areas of dispersion on certain topics (Vanti, 2002). In special, Bradford’s Law, according to Guedes & Borschiver (2005), is a useful tool to establish policies for the acquisition and disposal of journals at the level of the management of information retrieval systems, information management, and scientific and technological knowledge. It brings the possibility to estimate the magnitude of a given bibliographic area and the cost of its fractions (Guedes & Borschiver, 2005). The group of studies/authors that produce the highest number of articles on a given subject, tend to determine the quality or relevance of the whole area.

The Zipf’s law also called the Law of Minimum Effort, is about the frequency of specific terms within texts and other publications (Vanti, 2002). Regarding the term “minimum effort”, Araujo (2006) indicates that Zipf realized, often, few words will be used several times in a given text, and such words indicate which will be the article’s central subjects. Finally, Lotka’s Law, proposed in 1926, affirms that a small group of scientists is responsible for the building of a large literature while a large group of scientists is responsible for a small part of the studies that only equates to what is produced by the main authors (Araujo, 2006).

However, there are barriers and limitations to be faced when developing a study of this nature such as information errors in databases; variation of criteria used in distinct countries to select the texts that will integrate the database; citation errors; different citations norms adopted; excess of self-citations, among others (Macias-Chapula, 1998). The diversity of areas that use Bibliometrics as a way of organizational and systematization of data indicates the consolidation of the method concerning scientific research and contemporary claims of complex thinking (Morin, 1986). As a final consideration, bibliometric methods are increasingly concerned with more accurate readings of reality (Morin, 1986, apud Araujo, 2006).

#### 3.2. Procedures

The study has a predominant quantitative character, aiming to obtain numerical data, collected and interpreted according to the principles of bibliometrics. The following

steps were conducted on all 268 articles published throughout 35 editions of the PMD journal. The articles were separated into four periods (P1, P2, P3, and P4), to allow us to study more clearly the evolution of publications and research linked to them over the years. The about four-year period was selected because this interval corresponds, reasonably, to the period of formation of a new cycle of interest and is also adherent to the time of formation of new PhDs. In addition, a four-year period encompasses at least two CBGDP events and two IGDP Workshops, consolidating most of the debate in a given time. Thus, articles written between 2003 and 2006 correspond to P1, between 2007 and 2011 to P2, 2012, and 2016 to P3 and, finally, P4 comprises studies from 2017 to 2019. As can be seen, the P4 period is a little shorter than the previous periods, but this beginning coincides with the most pronounced rise of digital transformation themes in the universe of management and industry, a theme that marks the realization of CBGDP 2017. Moreover, the pandemic crisis that arose in early 2020 is seen as a big and unpredictable event with the potential to dramatically change or even accelerate paths of research interests and the course of every organization in a wider context. Hence, there is a great possibility that a new wave of studies is rising meanwhile this text is prepared to publish.

Information related to each article was recorded in spreadsheets such as year and period of publication; title; the number of authors; authors' affiliations at the time of the publications; institution's data; the number of pages of each article; keywords and citations in Google Scholar database. Regarding the authors' academic backgrounds, most of this

information was obtained from the CNPq Lattes' resumes platform. In a few cases when an author didn't have a profile on the platform, we sent direct e-mails to check the information needed. At last, only nine authors weren't localized and didn't have their data registered. Regarding the institutions, the Universidade de São Paulo was revealed to be of greatest predominance, which stimulated a specific deployment of data over its internal departments. Finally, each article was analyzed in terms of its keywords, title, and abstract (and, in some cases, the broader content of the text) to identify which subjects, industrial sectors, and research methods were considered.

In the next sessions, we present the results, detailing, when relevant, other details on the methodological aspects related to the analyses.

## 4. Results and analysis

In total, 16 volumes of the PMD journal were published from 2003 to 2019. Each volume comprises two issues, released semiannually. The exception is volume 1, which includes previous efforts of the IGDP community to prepare and send articles, but whose publication is effectively dated in 2003 and that is why it comprises three issues.

The four periods considered in this study and the distribution of the articles among them are shown in Table 1.

In terms of academic recognition and impact, some articles published in the journal present some distinction. Table 2 shows the most cited articles in the Google Scholar database. The platform was used as a reference, due to its reliability and wider scope. It is important to note that the number of citations presented here is a picture from the platform on June 24, 2020.

### 4.1. Authors

Table 3 ranks the authors who most (and often) published in PMD. It is possible to identify authors that contributed regularly during the four periods, such as Kaminski, Silva,

**Table 1.** Periods of analysis and article distribution.

PERIOD	BEGIN	END	# of Articles	%
P1	2003	2006	67	25,00%
P2	2007	2011	85	31,72%
P3	2012	2016	72	26,87%
P4	2017	2019	44	16,42%

**Table 2.** Relation of articles most cited and published in PMD.

AUTHORS	ARTICLE	# CITATIONS
Padovani, Muscat, Camanho and Carvalho (2008)	Looking for the right criteria to define projects portfolio: Multiple case study analysis	47
Miguel (2005)	Modularity in product development: a literature review towards a research agenda	22
Estorilio and Simião (2006)	Cost reduction of a diesel engine using the DFMA method	20
Romano, Back, Ogliari and Marini (2005)	An introduction to the reference model for the agricultural machinery development process	15
Costa and Rozenfeld (2007)	Proposal of the BPM method for improving NPD processes	15
Miguel (2005)	The potential of new product development in the automotive industry in Brazil: an exploratory study	14
Puglieri, Ometto and Miguel (2011)	Eco-design methods for developing new products based on QFD: a literature analysis	13
Marini and Romano (2009)	Influencing factors in agricultural machinery design	11
Martens and Carvalho (2013)	An exploratory study of sustainability evaluation in project management	10

**Table 3.** Authors that published the most.

#	Authors	Articles					Citations on Google Scholar
		P1	P2	P3	P4	Total	
1	Miguel, P.A.C.	5	9	5	0	19	7294
2	Toledo, J.C.T.	11	3	2	2	18	3615
3	Amaral, D.C.	6	5	3	2	16	3727
4	Forcellini, F.A.	8	4	3	0	15	N/A
5	Romeiro Filho, E.	2	3	4	4	13	311
5	Rozenfeld, H.	6	4	2	1	13	4877
5	Kaminski, P.C.	3	4	4	2	13	1098
8	Carvalho, M.M.	1	6	2	0	9	9128
8	Ogliari, A.	5	3	1	0	9	859
8	Silva, C.E.S.	0	5	3	1	9	2312
11	González, M.O.A.	0	0	5	3	8	520
11	Scalice, R.K.	2	2	2	2	8	1755
11	Silva, S.L.	2	1	2	2	7	3607
11	Possamai, O.	4	3	0	0	7	N/A
15	Cziulik, C.	1	2	1	2	6	N/A
15	Trabasso, L.G.	2	2	2	0	6	466
17	Mello, C.H.P.	0	3	2	0	5	4041
17	Loureiro, G.	0	5	0	0	5	544
17	Mendes, G.H.S.	2	0	2	1	5	686
17	Naveiro, R. M.	0	3	2	0	5	N/A
17	Barbalho, S.C.M.	1	1	1	2	5	237

and Scalice. It is also possible to identify those authors that gradually reduce their contribution over the periods, such as Toledo and Forcellini. Also, some authors gradually increase their contribution, such as González.

It's possible to affirm that the first five authors of the ranking are the most influential and productive members of the community. In this case, we can consider 8 authors who have 13 or more published articles since we have a tie on the 5<sup>th</sup> place: Miguel, Toledo, Amaral, Forcellini, Romeiro Filho, Rozenfeld, and Kaminski. Another information considered is the author's academic background, to allow us to get an understanding of the heterogeneity of formations that contribute to the journal. According to the data gathered, we can affirm that most professionals come from hard science and engineering fields. Table 4 indicates the five groups that predominate among the author list:

Within the scope considered, a total of 486 authors published in the journal. However, about 80% of the authors published only once in PMD. At the other extreme, less than 4% of the authors have more than five articles published, considering the whole period.

In order to refine this analysis, Table 5 shows the publication's frequencies per period, ratifying the high representativeness of authors with few/lone publications (and that may, eventually, represent a potential for the journal's growth and advance), even in the face of the balance caused by the recurrent authors.

**Table 4.** Authors' main academic backgrounds.

#	Graduation	Amount
1	Mechanical Engineering	106
2	Production / Industrial Engineering	94
3	Industrial Design	41
4	Management Sciences	27
5	Electrical Engineering	21

## 4.2. Institutional affiliations

A total of 95 institutions are represented in the PMD articles, evidencing a diverse network of people and economic activities. From this set, a total of twenty-two private companies were found, representing 23,15% of the total institutions while the rest is accounted for Brazilian universities, most of them are public institutions (Table 6). However, it is observed that 86,4% of the private institutions contributed only once to the journal, which suggests a rich space for the articulation of new partnerships and attraction of insightful research for publication in PMD.

Of the nine educational institutions that appear in Table 6, four are from the state of São Paulo, two from Santa Catarina, two from Minas Gerais and the other two from Rio Grande do Sul. Both USP and UFSC have a distinctly higher number of published articles compared to the other institutions. Together, these two universities have 121 articles, while others summed 104. Considering

the available data, we can consider these two institutions as the main local references in the trajectory of scientific dissemination on new product development-related subjects, although the preponderance of any individual institution is gradually decreasing over the years.

As stated by Table 6, USP is an important center of academic production along three periods. UFSC, in turn, during P1, responded for the greater number of articles, with a total of 19 contributions. From P2 to P4, the institution gradually decreased its contribution although it remained among the top ones. The third place in the table, UFSCAR, also had in P1 its best period of production. Considering the list of all institutions that had articles published in PMD, the most prominent of all time is USP. The institution is represented in a total of 71 articles published in the journal. Table 7 deploys the data throughout USP's internal units.

Considering the absolute number of articles published by the USP's School of Engineering of São Carlos and Universidade Federal de São Carlos, we can affirm that the city of São Carlos – SP is one of the main Brazilian

centers of scientific production in the field of New Product Development.

As said, private companies usually contributed to PMD only once. However, three companies are the exceptions and from those, the most prominent private institution in this context is Embraer, with six published articles as is presented in Table 8:

### 4.3. Keywords

An important source of information on the evolution and thematic diversity of the journal is the keywords list. Few keywords indicate the central subjects of an article and, since some keywords are present in several articles, most prominent/emphasized topics are revealed.

Although the keywords do not always follow a standard list, they can refer to the economic sectors that served as settings and application fields for the studies. Table 9 presents the data filtered by the main economic sectors as mentioned in the articles' keywords.

**Table 5.** Number of authors and articles published per period.

Criteria (publications)	P1		P2		P3		P4	
	# authors	% articles						
>2	9	28.5%	15	26.7%	11	17.0%	2	4.9%
=2	11	12.3%	17	14.4%	25	21.8%	13	18.2%
=1	106	59.2%	139	58.9%	140	61.2%	110	76.9%

**Table 6.** Main institutions represented in PMD articles in compassion with their sizes.

#	INSTITUTION Pos-grad students		Size parameters*		Number of Articles				
			professors		P1	P2	P3	P4	Total
1	Universidade de São Paulo	USP	29.926	5.561	18	31	16	6	71
2	Universidade Federal de Sta. Catarina	UFSC	10.779	2.649	19	15	11	5	50
3	Universidade Federal de São Carlos	UFSCAR	11.083	1.324	13	7	6	5	31
4	Universidade Federal de Minas Gerais	UFMG	14.343	3.593	5	5	6	3	19
5	Universidade do Estado de Sta. Catarina	UDESC	2.809	1.213	2	5	7	4	18
6	Universidade Federal de Itajubá	UNIFEI	843	509	0	5	3	2	10
7	Universidade Estadual de São Paulo	UNESP	14.422	3.305	0	4	4	1	9
7	Universidade Federal de Santa Maria	UFSM	2.400	2.026	1	3	4	1	9
9	Instituto Tecnológico de Aeronáutica	ITA	1.200	150	2	4	2	0	8

\* Based on the most recent publicly available data on institution's websites.

**Table 7.** Articles published by USP's internal departments.

USP	ARTICLES				
	P1	P2	P3	P4	Total
Polytechnic Institute – POLI	10	20	9	3	42
School of Engineering of São Carlos	7	9	5	3	24
Economics and Management Faculty – FEA	1	2	2	0	5

**Table 8.** Private companies that appear, at least, twice or more times in PMD articles.

#	Private Companies	Number of Articles				TOTAL
		P1	P2	P3	P4	
1	EMBRAER	2	2	2	0	6
2	Ford	0	1	1	0	2
2	Volkswagen	0	2	0	0	2

One can see that the automotive industry was the main context of study among all economic sectors, echoing the central role that this industry had as the research setting for many of the early studies on the field of New Product Development. Once the level of formalization of product development-related activities and the work structure, and the staged linear logic of product development processes are

prominent characteristics of the Automotive and Aerospace industries, they were among the first settings of NPD studies (Bagno et al., 2017; Salerno et al., 2015). Table 9 also evidences the protagonism of the Food industry.

Back to the role of thematic identification provided by the keyword's analysis, a complete view of the terms used is presented in Table 10. To build this table, since PMD

**Table 9.** Main sectors studied in PMD articles.

Keywords	P1	P2	P3	P4	Total
Automotive	6	14	7	0	27
Food	5	2	3	1	11
Aerospace	2	5	2	0	9
Furniture	1	2	2	1	6
Agriculture / Agricultural machinery	1	3	1	0	5
Health / Medical equipment	1	1	3	0	5
Metalworking	1	3	1	0	5
Pharmacist	1	1	1	1	4
Automation	1	0	1	1	3
Chemical / Petrochemical	0	3	0	0	3
Toys	1	0	1	0	2
Energy	0	0	1	1	2
Capital goods	0	1	0	0	1

**Table 10.** Keywords associated with PMD journal themes.

Keywords	P1	P2	P3	P4	Total
NPD	37	24	12	0	73
Design	23	25	18	0	66
Product Development	20	21	12	8	61
Innovation	8	14	16	6	44
Model	15	14	2	0	31
Strategic	9	13	5	0	27
Tools	10	4	12	0	26
Life Cycle	5	12	4	3	24
Project	6	13	4	0	23
Method	7	8	7	0	22
Methodology	7	8	4	0	19
Systems	7	7	5	0	19
Literature Review	3	4	9	2	18
Decision Making	5	10	2	0	17
Engineering	8	7	2	0	17
Integration	5	7	4	1	17
Product Conception	10	6	1	0	17
Quality	9	4	2	2	17
Practices	3	9	3	1	16
Project Management	0	10	4	2	16
SMEs	6	7	2	1	16
Cost	5	7	3	0	15
Performance	0	11	4	0	15
QFD	7	5	2	1	15
Collaboration	8	4	2	0	14
Concurrent Engineering	3	8	3	0	14
Supplier	7	3	4	0	14
Environment	4	5	2	1	12
Manufacturing	3	5	4	0	12
Processes	5	5	2	0	12
Teamwork	5	4	3	0	12
Food	5	2	3	1	11
Software	3	7	1	0	11
R&D	3	3	2	2	10
Sustainability	0	3	5	2	10



themes of development processes, simultaneous engineering, and knowledge management. Also, they seem to be strongly influenced by the legacy of quality management studies and support tools such as QFD.

Gradually, the term “Product Development” shares space with “Innovation” and “Design”, while “Quality” and “Knowledge Management” diminish in influence. Terms such as “Automotive” start to show less predominance, sharing space with other sectors, such as “Medical”, “Furniture”, “Biotechnology” or “Food”. Yet, the most recent publications mark the consolidation of studies in Product-Service Systems, Agile Methods, User-Centered Design (UCD), among others.

## 5. Final considerations

This study aimed at understanding how IGDP academic production has been conducted, its thematic evolution, subjects, general aspects related to the research community, and also at discussing some paths to nurture actions. To do so, we used quantitative analysis of all articles published in the PMD journal until 2019’s last issue. The article offers a short picture of all the efforts made and put data in evidence to nurture actions for improvement.

In general, it is perceived that the PMD trajectory is marked by a prominent group of authors who start their academic work focused on classic subjects of NPD at the beginning of the journal’s history. Academic backgrounds most associated with technical disciplines and the outstanding role played by large manufacturing industries are landmarks of the first periods of the journal. Over time, it is observed a gradual reduction in the contribution of groups and authors who led the initial debate, although new groups are not emerging with the same strength. At the same time, there is a diversification of authors and subjects, which is positive for the field of study in terms of the connections established with broader innovation-related research, influencing thoughts in different areas of application, and offering integrating opportunities to other disciplines. On the other hand, the myriad of options, subjects, and application settings may hide a threat of disconnection among groups and an ill-defined identity for the community. Therefore, mapping and getting accurate knowledge of the complementary competences and interests among the research groups, establishing common goals, and new focuses over a vaster opportunity space would be of greatest strategic importance for the IGDP members to pave the future as a strong, valuable and influential community.

Besides that, good international references related to innovation and product development fields are depicted to exemplify some possible paths to follow. The indexation to the main academic databases and attracting the attention of a broader international community are points of central importance to allow PMD to pursuit relevance in standard

metrics. Once PMD and IGDP Team counts on very internationally recognized researchers among its top-ranked authors, citing PMD papers on other innovation journals is a possible path to leverage the high-quality research published in PMD as well as bringing inside PMD issues contribution from international connections of IGDP members. In addition, motivating new generations of researchers from the IGDP’s main knowledge centers as well as attracting more partners from other universities and companies are also possible ways to face the challenges.

For future studies, we expect that contemporary subjects associated with digital transformation, entrepreneurial behavior, and alternative innovation scopes and themes, as well as the exploration of the increasing centrality of the customer and social behavior for the conception of new products, tend to be the hot topics for the next periods. It is expected that the present study inspires subsequent discussions among people involved with the journal, to subsidize strategic decisions towards growth and greater consolidation of the PMD and the IGDP itself in the local and international scenario of Innovation and New Product Development.

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