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Article abstract

This article is part of a PhD research and investigates the impact of rapid technological evolution, focusing on the adoption of smart mobile devices (SMD), such as smartphones, tablets and laptops, and applications (app) in the personal lives of higher education professors in the area of Information Science. In addition, gaps are identified in existing research, emphasizing the need to understand how SMD is used in personal activities for personal knowledge management (PKM) practices and infocommunication. Specific objectives include identifying the most commonly used SMDs and apps, the frequency of such use, and how they are used for those practices. The methodology is qualitative, triangulating the integrative review with a questionnaire (N=10). The results point to interest in device ecologies for PKM and Info-communication, with communication apps (text and voice) and e-mail being the most important for teachers. It is hoped that the results of this study can contribute to the advancement of knowledge about the use of SMD by teachers and to the development of a generic descriptive model of infocommunicational behaviour and PKM that can be applied in other contexts.

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Exploring the use of Smart Mobile Devices and their applications for infocommunication and Personal Knowledge Management in the personal lives of teachers

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This article is part of a PhD research and investigates the impact of rapid technological evolution, focusing on the adoption of smart mobile devices (SMD), such as smartphones, tablets and laptops, and applications (app) in the personal lives of higher education professors in the area of Information Science. In addition, gaps are identified in existing research, emphasizing the need to understand how SMD is used in personal activities for personal knowledge management (PKM) practices and infocommunication. Specific objectives include identifying the most commonly used SMDs and apps, the frequency of such use, and how they are used for those practices. The methodology is qualitative, triangulating the integrative review with a questionnaire (N-10). The results point to interest in device ecologies for PKM and Info-communication, with communication apps (text and voice) and e-mail being the most important for teachers. It is hoped that the results of this study can contribute to the advancement of knowledge about the use of SMD by teachers and to the development of a generic descriptive model of infocommunicational behaviour and PKM that can be applied in other contexts.

Keywords: higher education professors, infocommunication, personal knowledge management, smart mobile devices, technological evolution impact

Introduction

The rapid evolution of technology has significantly impacted how people communicate, work, and learn, driving significant changes in various contexts of individuals' lives. The adoption of digital technologies in everyday life has been increasingly necessary. Smart mobile devices (SMD), such as smartphones, tablets, and laptops, have been widely used worldwide by students, teachers, and researchers at various levels of education, including higher education (Bakirov et al., 2021; Shchedrina et al., 2020).

A quick search on sites such as Statista, the Pew Research Center, and the International Data Corporation (IDC) allows us to retrieve several SMDs that are widely used worldwide. However, this study will focus on the most widely used criteria referred to by Firtman (2010) these are: portability and autonomy, allowing them to be easily transportable and equipped with batteries to support use without the need to connect to external power sources; must ensure connectivity, allowing access to the internet to use a variety of applications and services in both online and offline modes; they must support

communication and collaboration, with features that facilitate interaction and information sharing through messaging apps and social networks; they must have functionalities for the production and consumption of content, including tools for capturing and organizing information, such as cameras and audio recorders, and storage and processing capabilities for data management; finally, they must be customizable, allowing users to adapt their devices to individual preferences and functional requirements, making them truly personal and adaptable to different contexts of use.

On the other hand, Firtman's (2010) criteria do not include devices that lack portability, such as desktops; that do not offer the necessary flexibility for use in transit; who cannot connect to the internet; that are unable to access online applications and/or services, or that cannot be used for communication, production and consumption of content; that lack basic data storage and processing functionalities – such as some smartwatches or fitness trackers; that do not have tools for capturing, storing, organizing and sharing information, collaborating, creating and sharing content.

The SMDs investigated will be smartphones, laptops, tablets and smartwatches. Apps were retrieved from online rankings, such as those in PC Magazine and SimilarWeb, and grouped into 18 categories. The grouping of apps aims to reduce the obsolescence of this study because, on the one hand, apps tend to change and incorporate new features; on the

other hand, the promise of super app aggregator services (Ota et al., 2020) makes the investigation of single apps unwise. Table 1 shows how the apps were categorized.

With the proliferation of these SMDs and the variety of software and apps created to use them, teachers can access a large volume of information, contributing to infocommunication and personal knowledge management (PKM) practices.

On the one hand, some studies in the literature investigate how SMD impact the practices of teachers and students in educational institutions (Firmansyah et al., 2020; García-Martínez et al., 2019; Giannakopoulos & Eybers, 2015; Nurbanati et al., 2021; Sophonhiranrak, 2021). On the other hand, little has been investigated about the impacts of these SMDs on the day-to-day lives of higher education teachers and even less of those in Information Science. However, through studies in the professional area, it is possible to extract knowledge that can create a background for the presentation of this work.

Still, regarding the use of SMDs, some studies investigate the simultaneous use of SMDs and other devices - not necessarily SMDs (Lohmüller & Wolff, 2019) - as well as the simultaneous use of different SMDs for various activities (Lyle et al., 2020). Alluding to the biological root of the concept of "ecology," this study uses the term to indicate the network of SMDs with which an individual interacts in a connected manner within a specific context (Jung et al., 2008). The term "ecology" is also used by authors such as Cecchinato and others (2017) when referring to the simultaneous or connected use of various devices, including SMDs.

Despite the differences between the conceptualization of the term infocommunication in English, where the term is more used in a business or technical context (Sallai, 2012) and is also understood as a branch of the economy or as a technical-technological system (Petro, 2018). In this work, infocommunication and its correlates, such as infocommunication processes, will refer to the impact of technology on society and communication in general (Gouveia & Silva, 2020). All interactions between the individual and the SMD for communication should be read as an infocommunicational process.

In this regard, Kavun and others (2020) communicate a need to redefine the infocommunication needs of higher education institutions through their information streams to identify the modern requirements for their information systems and infocommunication infrastructure. The authors propose specific recommendations for integrating infocommunication flows and information systems in universities.

Regarding the practice of PKM, Frand and Hixson's landmark work (1998) defines it as a set of individual processes focused on managing knowledge and personal skills involving collection, categorization, storage, retrieval, and sharing of this knowledge (Cheong & Tsui, 2010).

About PKM, Chen and Huang (2010) highlight the impor-

tance of the relationship between PKM practices and mobile devices. They show that mobile devices, such as smartphones and tablets, play a crucial role in acquiring, storing, sharing, and applying personal knowledge. Additionally, they suggest that choosing devices with larger screens can positively impact the effectiveness of these PKM practices. Therefore, the relationship between mobile devices and PKM is critical to enhancing individuals' learning and problem-solving ability. It can also contribute to increasing the capacity of teachers to mentor personal knowledge management (PKM) practices (Cakula & Sedleniece, 2011).

While SMDs are useful for infocommunication and PKM, they can also present challenges. The literature mentions distractions (Schneider, 2018; Aznar-Díaz et al., 2020), legal issues involving copyright, accessibility, and cost (Valencia-Arias et al., 2018), lack of training (Boude Figueredo & Sarmiento, 2017), cultural issues and resistance to change (Alfarani, 2014), and information overload, such as those caused by numerous notifications (Weber et al., 2017).

This study will investigate how teachers use these SMDs in their daily lives and how they use them for infocommunication and PKM. However, it is recognized that there are teachers who do not use SMD (Hinojo-Lucena et al., 2021).

Infocommunication

Infocommunication, as a process, contributes to the individual's day-to-day life to the extent that he can combine his knowledge and informational, communicational, and technical skills in interaction with SMD and its applications to connect, receive, and share information and knowledge.

In the personal context, infocommunication emerges as a cross-cutting process that permeates various spheres of daily life, significantly influencing personal relationships, family dynamics, health and well-being, personal development, leisure, finances, social and community contribution, and spirituality.

Infocommunication plays an essential role in establishing and maintaining interpersonal connections. Digital tools, such as social networks, messaging apps, and collaborative platforms, redefine interpersonal relationships, creating a virtual environment conducive to constant interaction, regardless of geographic distance (Ellison, Lampe & Steinfield, 2009).

In addition, infocommunication is a key catalyst for accessing information and knowledge. Knowing how to navigate the internet, the skills to consult databases, and the proper use of applications in various sectors, such as health, education, finance, and leisure, enable constant updating and engagement (Daher Junior, Santos & Toutain, 2022). The rapid dissemination of news, the search for specific information, and participation in online communities are crucial elements in constructing individual and collective knowledge (Gouveia & Silva, 2020).

Table 1*App categories and examples*

Categories	App examples
Finance & Banking (Includes banking apps, financial management, investments, etc.)	Nubank, N26
Web browsers (Applications used to browse the internet.)	Chrome, Firefox
Image & Video Editing (For creating and editing visual content.)	Photoshop, CapCut
Word Processing & Office (Includes writing applications, spreadsheets, presentations, etc.)	Microsoft Word, Google Docs
E-mail Communication (Specific applications for e-mail management.)	Gmail, Outlook
Government Services (Applications related to government services and information.)	eGov, SNS24
Games (Gaming apps in a variety of categories.)	Fortnite, Candy Crush
Document Reading and Management (For reading e-books, PDFs, etc.)	Adobe Reader, Kindle
Messages & Calls (Includes text, audio, video, and calling messages.)	WhatsApp, Telegram
Search Engines (Applications used to search for information online.)	Google, Bing
Music Streaming (Online music services.)	Spotify, Apple Music
Navigation & Maps (GPS and route planning apps.)	Google Maps
Productivity Management (Organization and task management tools.)	Trello, Asana
Social Networks (Social media platforms.)	Facebook, Instagram
Health & Wellness (Apps related to physical and mental health.)	MyFitnessPal, Headspace
Security & Antivirus (Apps for device protection.)	Avast, Norton
Video Streaming (Video streaming services.)	Netflix, YouTube
Video conferencing (Tools for online meetings and conferences.)	Zoom, Microsoft Teams

In the field of health and well-being, infocommunication offers resources to monitor and promote an integrated approach to self-care, both as an analysis tool (Debetto & Saldanha, 2023), and through the use of digital platforms and apps related to mental and physical health (Ernsting et al., 2017). Added to this is the possibility of communication between doctor and patient (Lopes & Heimann, 2016).

In educational and personal development, infocommunication stands out through online platforms and educational apps, providing continuous learning opportunities from school age (Fonseca & Mealha, 2022). These tools contribute to developing skills and knowledge throughout life (Daher Junior & Borges, 2023). In the financial area, infocommunication enables the efficient management of personal finances through banking, budgeting, and investment applications, promoting financial education and facilitating financial decisions (Silva, Coelho, & Silva, 2020).

Infocommunication strengthens social contribution by facilitating participation in social causes and volunteering. In the environmental context, it plays a crucial role in promoting ecological awareness, facilitating access to information about sustainable practices, and connecting with communities (Oliveira et al., 2021).

Concerning leisure, infocommunication expands entertainment options, offering access to various digital activities, such as games, videos, music, and digital books (Bacha, Neto, & Schaun, 2013). Finally, in spirituality, infocommunication allows access to religious resources, guided meditations, and online communities focused on spiritual development. Infocommunication is an entry in the Encyclopedia of Conscientiology (Lopes, 2013).

Personal Knowledge Management

The practice of PKM exerts a substantial influence on individuals' daily lives and can be a valuable tool in various aspects of daily life. Like infocommunication, PKM can be relevant in personal relationships, family, health and well-being, education and personal development, leisure and recreation, finance, social and community contribution, spirituality, environment, and sustainability.

In healthcare, PKM is useful for tracking data such as eating habits, physical activity, and sleep patterns. It promotes a proactive approach to personal well-being, makes storing and accessing health information easier, and enables informed decisions about treatments and prevention (Huang et al., 2016).

In turn, in education and personal development, PKM contributes to the organization and recovery of acquired knowledge, favouring continuous learning, monitoring educational and personal goals, and encouraging development and lifelong learning (Shahzad et al., 2023). Regarding personal finance, PKM can be used to manage personal budgets, record expenses, and analyze financial patterns. It can facilitate access to investment information, financial planning, and educational resources related to personal finance (Du, Qiu, & Xu, 2011).

PKM plays an essential role in social and environmental actions. It allows the monitoring of volunteer activities, promotes knowledge sharing in the community, and facilitates the implementation of sustainable practices in daily life (Podgórný, 2018).

In leisure, PKM expands the possibilities of organizing information about movies, books, music and other forms of entertainment, optimizing the time dedicated to leisure. It also contributes to discovering and exploring new hobbies and recreational activities (Bedford, 2012). Finally, PKM contributes to spiritual practices and offers a space to record spiritual thoughts, reflections and practices, promoting personal spiritual growth (Case & Gosling, 2016).

PKM can also be useful in personal and family relationships. Despite the scarcity of studies related to this utility, this practice could contribute to the management of family information and documentation and genealogical research, helping to reflect on significant interactions, contributing to more enriching relationships, and facilitating the exchange of relevant information between family members (cf. Krtalić et al., 2021).

Gaps in studies

However, despite the growing interest in SMD, there are still gaps in knowledge about how higher education faculty use these devices daily. As noted in the introduction to this study, the documents retrieved so far have focused mainly on the uses and benefits of SMD in teaching and learning

(Valencia-Arias et al., 2018). Although some studies focus on the teacher (Boude Figueredo & Sarmiento, 2017; Moreira et al., 2018), most studies focus on specific contexts, such as the use of SMD in the classroom or for specific learning purposes (Garcia et al., 2019; Ly, 2022), leaving gaps in knowledge about how these devices are used in the day-to-day life of teachers for infocommunication and PKM practices. This study aims to reduce the existing gaps in this area.

This study investigates the use of SMD by higher education teachers in Information Science in their day-to-day work, considering infocommunicational practices and PKM. The choice of professors in this area is related to the fact that the study's proponents are from this area and are interested in the personal improvement and practices of infocommunication and PKM.

As specific objectives, this work will:

- identify the most commonly used SMDs and app categories;
- analyze the frequency of use of both SMDs and app categories for personal purposes;
- identify how the categories of apps are used through the apps and how this use is carried out for the practices of infocommunication and PKM.

Methodology

The methodology adopted in this study aligns with the mixed methods paradigm, which is recognized for combining the strengths of qualitative methods (integrative literature review) with a questionnaire for a more complete understanding of the phenomena under analysis (Tashakkori & Teddlie, 2010). Based on this paradigm, the methodology of this study is structured as follows:

Integrative literature review: conducted between June and December 2023 in B-On, Google Scholar, ACM DL, Scopus, and Consensus with combinations of the terms "infocommunication," "personal knowledge management," "personal mobile devices," "smartphones," "tablets," "portable computers," and "smartwatches." The integrative review allows the synthesis of several studies and the creation of a comprehensive overview of the state of the art concerning this topic (Torraco, 2005).

Questionnaire: To complement the integrative literature review, a questionnaire was developed using Google's Forms platform, and it mostly consisted of closed questions. The questionnaire was designed to capture information on the prevalence and patterns of SMD use, PKM practices and infocommunication behaviour. Following the positivist approach, the questionnaire allowed for an objective data analysis. However, it is crucial to acknowledge that, due to the limited sample size, the generalization of results may be restricted. Nevertheless, this analysis still provides valuable

insights into the phenomenon being studied (Case & Given, 2016).

The data obtained through the questionnaire were processed using Excel PivotTables. Integrating this data with the integrative literature review allows for what Tashakkori and Teddlie (2010) call data triangulation, helping to reduce a single method's limitations. Furthermore, the combined approach offers a comprehensive view of teachers' uses of SMDs and their PKM practices, contributing to advancing knowledge in Information Science.

The participants were selected through the collection of public emails from professors in Information Science in Portugal and Brazil. Forty emails were sent on December 26, and a reinforcement was sent to these contacts on January 3. The questionnaire was available to be answered until January 6, inclusive. The email encouraged teachers to share the questionnaire with at least one colleague in the field.

Findings

The analysis results on the retrieved data were divided into demography, the daily use of SMD and apps, infocommunication, and the practice of PKM.

Demography

We received 12 responses, of which ten were considered valid. The remaining two were provided by professors who declared that they did not belong to the area of Information Science or related areas. Of the ten valid answers, six teachers are from Brazil, while four are from Portugal. Regarding gender, six are women, three are men, and one chose not to disclose this information. Regarding academic degrees, seven professors have a Ph.D., 2 have a master's degree, and one preferred not to reveal his or her educational level.

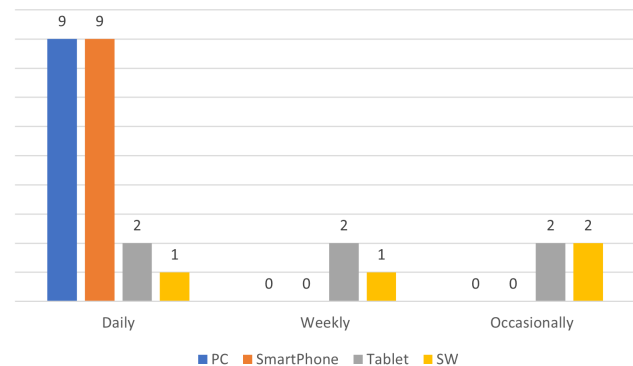
Regarding the age group of the teachers, we observed the following distribution: between 24 and 35 years old, we have one teacher; between 36 and 45 years old, two teachers; between 46 and 55 years old, five teachers; and between 56 and 65 years old, two teachers. Regarding the length of professional experience, three professors stated that they had between 5 and 15 years of experience, two less than five years, two between 16 and 25 years, and two between 26 and 35 years, while one professor chose not to disclose his or her professional experience.

Daily SMD and app usage

One of the first questions of the investigation was to determine the frequency of SMD use. As shown in the graph in Figure 1, the PC and the SmartPhone are the most used SMDs daily by nine teachers. Two teachers use the tablet daily, weekly, and occasionally; one teacher uses the SW daily, weekly, and occasionally by two teachers.

Figure 1

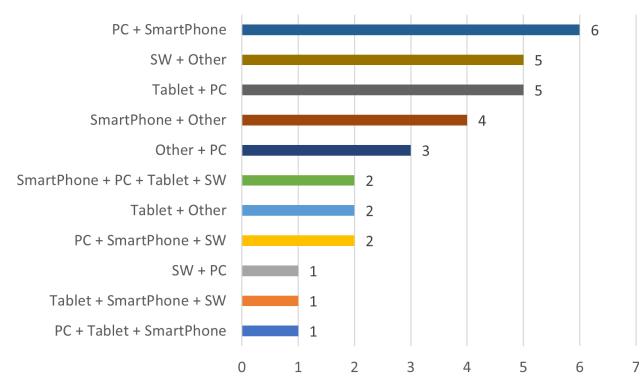
Frequency of SMD use



On the other hand, the teachers were asked if they needed to use an SMD ecology simultaneously. The answers provided by the teachers allowed us to learn about the PC and SmartPhone ecology practised by six teachers, followed by the Tablet and PC ecology used by five teachers. Another five professors reported using SW ecology and "Other" (this other was disregarded because these were technologies not included in Firtman's (2010) definitions. Smartphone and "Other" were mentioned by four teachers, and PC and "Other" were mentioned by three teachers. The graph in Figure 2 illustrates all the ecologies reported by the teachers.

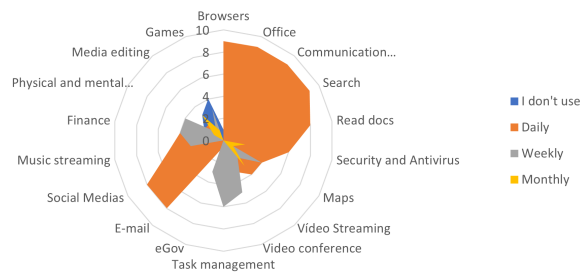
Figure 2

Ecology of SMD used by teachers

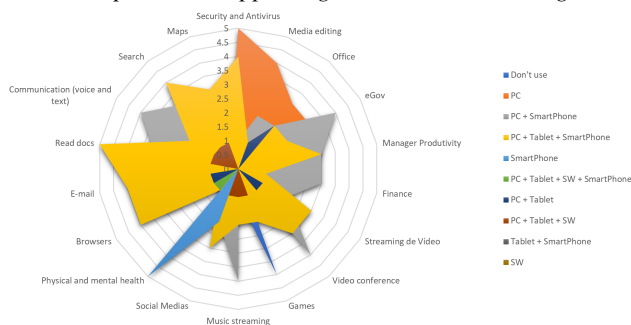


Another question asked how often teachers used each of the app categories. The answers revealed that nine teachers use browsers, office packages, text and voice communication apps, and search apps daily; eight teachers use document readers, social media, and e-mail daily. The graph in Figure 3 shows how often other app categories are used.

On the other hand, the study investigated which SMD ecologies teachers used for each category of app. PC, Tablet and Smartphone ecology proved to be the most used by teach-

Figure 3*Frequency of app category usage*

ers in categories such as reading and documents (5 teachers), Browsers, search and security and antivirus (4 teachers). The graph in Figure 4 shows other app categories and SMD ecologies.

Figure 4*Relationship between app categories and SMD ecologies*

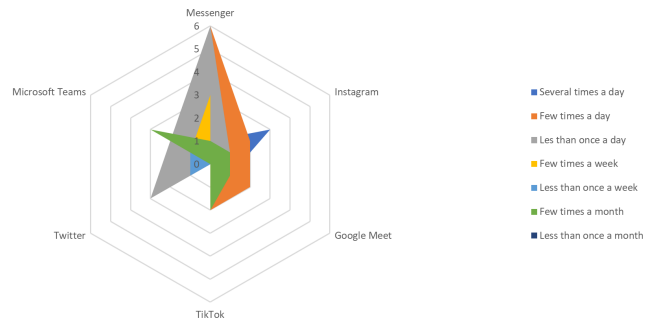
Up to the present moment, it has been possible to know the SMDs most used by teachers, the frequency of their use, their ecology of use, the most used app categories, their frequency of use and with which SMDs these apps were used. From this point on, the questionnaire was used to determine how the professors used the SMD when focusing on infocommunication and/or PKM.

Infocommunication

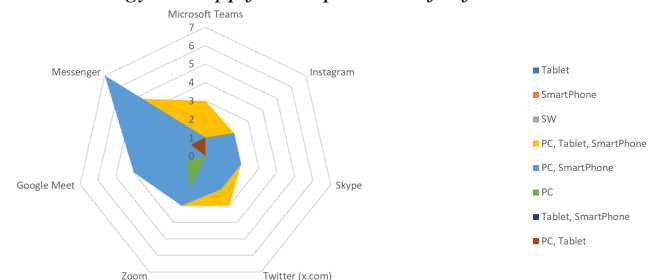
This time, thinking about the practice of infocommunication, the teachers were asked to answer a set of questions.

The first question asked teachers to indicate the frequency of use of a communication app. Most of the responses indicate that they use Messenger a few times or at least once a day (6 teachers). In turn, three teachers use Instagram several times a day. The graph in Figure 5 shows the apps most frequently used and the frequency of use reported by teachers.

Also, within the infocommunication, teachers were asked to relate the ecology of devices they use with the categories

Figure 5*Frequency of use of the most suitable communication apps*

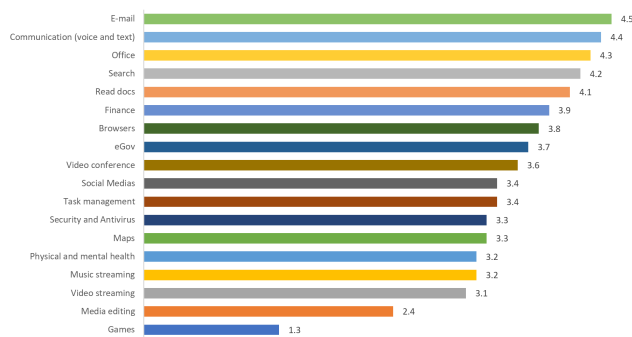
of apps related to communication, PC and SmartPhone ecology was the most mentioned, and the most used app was Messenger, as shown in Figure 6.

Figure 6*SMD ecology and app for the practice of infocommunication***Personal Knowledge Management**

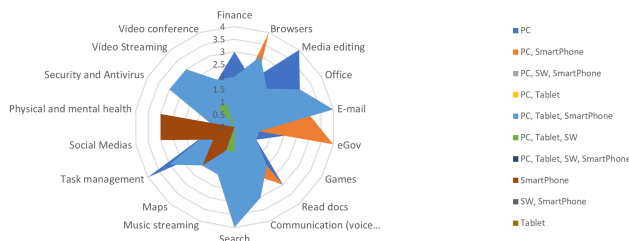
Other questions were elaborated to understand how SMD and its apps contributed to PKM. The first question questioned the importance of each category of app for the practice of PKM. This importance was illustrated with a scale from 1 to 5, where 1 meant "not very important" and 5 meant "very important."

The responses show that the highest amounts, from 4 to 5, were given to e-mail, voice and text communication, Office packages, and search and document reading apps. The graph in Figure 7 shows the other app categories and the importance given to each of them. The lowest scores were between 1 and 3 for game and media editing apps.

Also, within PKM, teachers were invited to mention, within the category of app and SMD ecologies, the most useful relationships for the practice of PKM in their day-to-day lives. The most reported SMD ecology was composed of PC, Tablet and SmartPhone. This ecology is used for the e-mail and search app (4 teachers). Four teachers also mentioned using only the PC for media editing and task management

Figure 7*The importance given to app categories for PKM*

apps. Four teachers also mentioned the PC and SmartPhone categories for using browsers and the eGov app. Other SMD ecologies and app categories can be seen in the graph in Figure 8.

Figure 8*The relationship of PKM in the ecology of SMD and app use*

The responses reveal that teachers significantly depend on digital technologies for PKM. E-mail, communication apps, Office suites, search, and document reading applications are considered highly important, while gaming and media editing apps are deemed less relevant. The combination of PC, Tablet, and Smartphone emerges as the most useful device ecology, particularly for e-mail and search. In contrast, the PC alone is preferred for media editing and task management. The combination of PC and Smartphone is valued for browsers and e-government applications. These conclusions highlight the importance of tools facilitating communication and information access and the efficient integration of multiple devices to support teachers' PKM.

Conclusion

This study revealed the SMD and app frequently used by higher education teachers in Information Science and how these teachers used this ecology for infocommunication and PKM. It was observed that smartphones and PCs are the most used SMDs, and simultaneous use is the most used ecology.

On the other hand, apps related to browsers, Office suites, text and voice communication and search are used daily.

Regarding the relationship between SMD and app ecologies, the ecology composed of PC, tablets and smartphones for the use of document reading apps is the relationship most mentioned by teachers.

Regarding infocommunication, Messenger was the most mentioned app for this practice and PC and Smartphone ecology is the most referred to use this app. On the other hand, for PKM, the most mentioned apps were e-mail, voice and text communication apps, Office suites, and search and document reader. Concerning ecologies, the one composed of PC, tablet, and smartphone was the most mentioned, and the teachers were mostly employed in using e-mail apps and search engines.

Thus, PC and Smartphone ecologies are frequently mentioned in infocommunication and PKM practices. Despite the meticulousness employed in conducting this study, it is imperative to recognize some deficiencies that may influence the interpretation of the results and guide future investigations. The main limitation refers to the sample size (N). Despite efforts to contact professors in Information Science, only 12 responses were obtained, and only ten could be analyzed. This limitation restricted a more in-depth knowledge of relating demographic characteristics (age, education, and professional experience) to using devices and applications.

The length of the questionnaire may have impacted adherence, suggesting the need for future research to focus on specific areas, such as utilization, infocommunication, or PKM. A deficiency in constructing a specific question was also identified, especially in the inquiry about using a device ecology. The absence of options to indicate the non-use of certain devices may have led to misinterpretations. In addition, the lack of an option that allowed for isolated use of a device may have compromised the accuracy of the responses.

Recognizing these limitations is crucial to guiding methodological adjustments in future research, ensuring a more comprehensive and accurate approach to analyzing academic staff responses about using devices and applications.

An important consideration for future research is whether SMD users prefer using the ecologies of these devices or prefer a single device that meets all needs. The same can be investigated for apps, such as whether they prefer using different apps for different activities or a super app that allows multiple practices.

Finally, the results of this study are anticipated to enrich the understanding of the use of SMD and its apps, contributing to the development of a generic descriptive model of infocommunicational behaviour and Personal Knowledge Management (PKM). This model can then be applied in different contexts.

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