Digital Legacy Management Systems: Theoretical, Systemic and User's Perspective

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Abstract: There are now relatively new systems and functionalities aimed at digital legacy management. In this paper, our objective is to analyze the domain of digital legacy management systems from three perspectives: the theoretical, the systemic and the users'. Due to the complexity of those systems, these perspectives were analyzed jointly and in an exploratory approach. Therefore, this article proposes the following classification of digital legacy management systems: dedicated systems and integrated systems. The innovative results from this study allow software developers to better understand important issues concerning the complex cultural practices in this domain, thus contributing to a rich discussion on those systems, their requirements and limits to their development.

1 INTRODUCTION

With the widespread popularity of the Internet starting in the mid-1990s, there has been exponential growth of people accessing the web and systems that store user data, and this poses challenges to its management. Among these challenges, we highlight: *what to do with the data of people who die?* This question led to the development of relatively new systems and functionalities to manage the challenges. In this context, there are several questions left unanswered and are intended to be discussed in this article.

In Brazil, one perceives that there is concern with the treatment of data in the event of death. Among the categories of challenges listed in 2012 in the GranDIHC-BR (Baranauskas et al., 2014), is the 'G4-Human Values', which included, among others, the challenge related to the theme "*Posthumous interaction and digital legacy after death*" (Maciel and Pereira, 2012b). In 2016, the GranDSI-BR were elaborated. One of the themes, "*The technological and human challenges of dealing with death in information systems*" (Maciel and Pereira, 2016), proposed a discussion on postmortem digital legacy, on solutions related to digital assets and on how web systems (cloud applications, digital memorials and social networks, for example) have been used and developed in light of these issues. In other communities, such as Software Engineering, there is also an opportunity to discuss this area. The sensitivity of this discussion should be highlighted, since taboos and beliefs about death also permeate the life of software engineers and can reflect on system design, as addressed by Maciel and Pereira (2012a). On the other hand, there is concern about the user data on networks (Braman et al., 2014; NYTimes, 2018). From the business viewpoint, there are different solutions in the market. Facebook (2020) and Google (2018) have implemented solutions in their systems functionalities that address digital legacy; furthermore, there are a few systems dedicated to digital legacy administration (Beyond, 2018). These systems generally store user data in Cloud Storage (Carroll and Romano, 2010; Hopkins, 2013) gen-

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erating, among other problems, concern about the legal requirements applied in the territories where the servers are located.

With the focus on literature, the development of these systems and the perception of users, this research seeks to investigate: *what are the functionalities and how do they serve users in managing legacies via software?* In order to provide answers, this article's goals was to analyze the proficiency of digital legacy management systems from three perspectives: theoretical, systemic and user. It was understood that, given the complexity of these systems, such perspectives should be unveiled together in an exploratory manner.

To this end, the literature on the subject was initially investigated from a **theoretical perspective**, especially work aimed at classifying such systems. More specific references are incorporated into the debate from other perspectives. From a **systemic perspective**, digital legacy management systems available on the market were analyzed and the authors saw the need to propose a typification for Digital Legacy Management Systems (DLMS): Dedicated Digital Legacy Management Systems (DDLMS) and Integrated Digital Legacy Management Systems (IDLMS). From these, a list of requirements is derived and discussed in the light of their engineering and other studies in the area. The starting point for these definitions was the existing literature on systems in the domain; however, no literature addresses the subject using this nomenclature. From the **users' perspective**, in order to understand how they behave and feel using such systems, information was collected through a survey. Among other points, the participants answered a questionnaire that encouraged reflection about digital legacy and the types of systems involved in the field. The innovative results of this research are useful to software designers for the abstraction of important issues and practices in this area, through the establishment of concepts linked to this complex domain.

The contributions of this paper are as follows:

- a review of the literature related to digital legacy systems
- the user perspective of using digital legacy systems
- a classification of digital legacy system considering the literature and survey findings
- a list of requirements for digital legacy management systems derived from literature review and survey findings

The theoretical and systemic perspective presents a survey of classifications and functionalities for DLMS as well as other related data sources (see Section 3) The user perspective brings the analysis of user's opinion on the subject (see Section 4). Section 5 presents and discusses the two main results of this survey: the differentiation between integrated and dedicated systems for digital legacy management, and the list of requirements for DLMS. Finally, Section 6 presents the final considerations related to this survey, including its limitations and future work.

2 RESEARCH METHODOLOGY

This research is exploratory, with contributions from a technical, technological and human nature point of view. Three perspectives of investigation were adopted in an integrated way: theoretical, systemic and user (see Fig. 1).

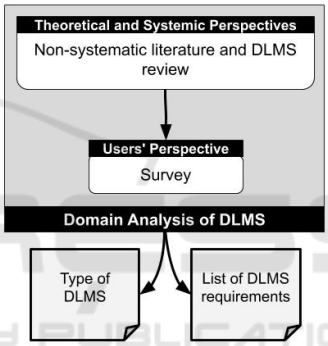

Figure 1: Research Phases.

The **literature review** stage (**theoretical perspective**) was performed in a non-systematic way. For the selection of the theoretical references, a free survey was available in digital libraries of a specific database in this field, which was developed by the project (DAVI, 2020), was carried out. Many of the selected works performed the **tool analysis** (**systemic perspective**). These works considered several tools such as Eter9 (2020), Afternote (2020) and Safebeyond (2020), Facebook (2020), Instagram (2018) and Google (2018).

Finally, the user perspective was assessed through a survey. The study opted for the construction and electronic distribution of a questionnaire in order to reach a larger number of answers, considering the exploratory proposal. The data collection focused on users' experiences and opinions regarding digital legacy management systems (DDLMS and IDLMS). The questionnaire[1] was applied in two moments.

[1]The questionnaraire is available at https://lavi.ic.ufmt.br/davi/en/artefatos/

First, with the students of the subject Special Topics in Software Engineering at University X. In the subject, the students developed a redesign project for an DLMS. The project gave them an understanding of what digital legacy management tools are, but it was believed that they already had knowledge about the subject before answering the questionnaire and therefore they compose the first group of subjects in this survey. In this first stage, 47 responses were obtained in 12 days.

In a second stage, the questionnaire was shared on social networks (Facebook and Twitter) and was sent by e-mail to research groups, with 133 responses recorded in a 7-day application period. In total, 180 answers were obtained. The data were treated in order to detect inconsistencies. At the end, out of the 180 answers, nine were discarded because the participants only answered one part, which left 171 questions. Table 1. presents the numbers obtained in the survey.

Table 1: Survey Numbers.

Data Collection Phase	Number of Responses
Students	47
Public in General	133
Total (before data treatment)	**180**
Total (after data treatment)	**171**

Then, for the purpose of anonymity, the participants of the first stage were identified as *UAn* and those in the second stage as *Un*, where*n* is a unique number and each unit represents a different participant in that stage.

Although the collection was carried out at different times, the data was analyzed together, but noting differences between the two sets. Below, the three perspectives for the study of this domain are presented, following the methodology explained above. The following sections present the results obtained in each of the phases of this research (DAVI - Dados Além da Vida/Data beyond Life) (DAVI, 2020), which has approval from the Ethics Committee on Research with Human Beings of UFMT.

3 THEORETICAL AND SYSTEMIC PERSPECTIVES

While alive, an individual produces information associated with the online or digital world, such as social network profiles (Facebook, Twitter etc.), e-mails, databases, images, sounds, videos, passwords to access digital assets and services and several others. All this production is defined by Edwards and Harbinja (2013) as *digital assets*. Once this individual dies, he leaves a *digital legacy* that deserves special attention as it belongs to the field of intimacy of the holder (Leal, 2018; Beppu and Maciel, 2020). For Carrol and Romano (2010), *"a digital legacy is the sum of the digital assets that you leave to others"*. In this sense, concerns arise as to where and how this data is left, how it is passed on, how it can be managed, how the systems can support users in these tasks, among others.

Gulotta et al. (2014) also states that "the creation of a digital legacy is a complex process, and the rapid growth of technology is increasingly intersecting with it in profound ways." In addition to that, Pfister (2017) highlights that "digital legacy is fragmented over devices, storage locations, and storage providers."

Based on researches such as Odom et al. (2012) and Carroll and Romano (2010), Pfister (2017) agrees that "The term digital legacy is used quite vaguely in prior work and shall, in this work here, also imply that every information item digitally created and curated by an individual has the potential to become a digital heirloom given the right kind of socially-constructed circumstances once an individual passed away."

In this context it is important to have Digital Legacy Management Systems (DLMS), because they aim to help the user define what happens with his legacy after death. This non-systematic literature review identified four approaches to studying DLMS: (1) studying the functionalities of an DLMS, (2) discussing aspects related to the data handling of a DLMS, (3) services offered by a DLMS, and finally, (4) the behavior of users and developers towards DLMS. The following sections present the SGDLs considering these four approaches.

3.1 DLMS Functionalities

Ueda et al. (2018) analyzed eleven digital legacy systems, listed a series of functionalities and detailed more complex functions of some of these services, typifying the systems and functionalities in: inheritance management, memorial, communicators and online immortality.

Gullota et al. (2016), analyzed the contents and functionalities of 75 digital legacy systems and classified the DLMS in four categories, as follows:

1. **Systems Designed Primarily for Personal Use:** they are designed to assist the user who wishes to plan the events arising from his future death. Systems of this category generally provide functionalities for the administration of their users' data, as well as functionalities for the disclosure

of their latest wishes, the sending of messages to pre-configured people, and the management of information and possessions that will be inherited by the pre-defined heirs.

2. **Mourning Support Systems:** these are designed for people who are in mourning or who have an interest in remembering information about someone who has already passed away. They are typically used by people who have met the deceased in life. This category is composed of websites and applications where users create a memorial for the deceased.
3. **Systems That Cater to 'memories' and Share Information about Ancestors or People Who Died in a Distant Past:** they include tree systems and share similar objectives with the first and second category. Some users use these systems to understand their own lives, or prepare for death. Similarly to the second category, these systems are designed for people in life to reflect on people who have died. In addition, they provide the functionality to connect information about the user's ancestors.
4. **Systems that Promote Public Reflection and Debate on Significant Events and Experiences:** they aim at public reflection and debate, such as war or major disasters. This category uses elements from others, but is distinct because it is designed to collect and store information regarding a broad theme, not specifically an individual or family.

The next section presents the LMSs considering the data that they store.

3.2 Data Management in DMLS

Bahri et al. (2015) propose a conceptual framework based on a review of studies in the field (Brubaker et al., 2014; Schiffman, 2003; Hopkins, 2013; Micklitz et al., 2013) with a view to data management related to digital legacy in the context of social networks. From this perspective, the process of defining the fate of the digital legacy is the central point. To this end, the authors categorize the data contemplated by the framework as follows: a) donation data: b) legacy data, c) intellectual property data, and d) destructible data: data which the user wishes to be destroyed after his death.

In the first stage of the framework the user distinguishes the categories of data he/she possesses and selects who will be his/her heirs, the institutions that will receive his/her data and the people who will authenticate his/her death when it occurs. The second stage consists of the framework's performance after the identification of the user's death. The framework deletes all destructible data, selected in the first stage, and performs the delivery of legacy data, intellectual property and donation to people and institutions previously defined.

The next section presents studies that discuss the DLMS from the perspective of the services they offer.

3.3 DLMS Services

Ohman and Floridi (2017) also discuss DLMS services in the commercial context and coined the term Digital Afterlife Industry (DAI) to characterize services and products offered as a result of the death of an online user, which can be monetized by the industry. The DAI is defined by three criteria:

1. **Production:** to be classified as an industry, some form of goods or services must be produced, therefore the DAI refers to production activities, this distinguishes it from activities without any productive result, such as unregistered mourning.
2. **Commercialism:** companies operating with DAI generate goods, services or experiences (such as bereavement and death) with the objective of obtaining profit, thus producing commodities (Marx, 1887). This excludes non-profit activities, such as religious communities; memorial sites written by users; and charity, which fall outside the production criteria.
3. **Online Use of Digital Human Remains:** DAI can act on any information left by the deceased online, such as: a) commercialization of physical funerals and off-line digital services, such as the alteration of the photo of a tombstone or the cremation of the deceased; b) projects of biological immortality that increase the durability of the organic body; and c) business of digital assets that do not involve human beings or animals.

In this study, Ohman and Floridi (2017) selected 57 companies from three resources: a list provided by the *Digital Afterlife Blog* (2018), a list used in the Oliveira studies (2016) and the 50 applications found in Google search using the string *"Digital Afterlife Service"*. Ohman and Floridi noticed that the selected systems offer a set of services to achieve their main goal. They analyzed the systems from the perspective of the services offered, detecting 72 services related to the digital legacy. Ohman and Floridi classified these 72 services into 14 *"generic groups"*, later grouped into four *"service types"*:

1. **Information Management Services:** help the user with the administration of digital assets in

case of death or the administration of data from a deceased third party.

2. **Posthumous Messaging Services:** provide the delivery of messages to their recipients after detection of the user's death.
3. **Online Memorial Services:** provide an online space for a deceased or a group for the deceased to be remembered/commoned. In the literature, uses of memorials linked to social networks (de Campos et al., 2017), specific for this purpose (Maciel et al., 2019) and/or linked to physical spaces (Maciel et al., 2017) are recorded.
4. **Life Recreation Services:** they use personal data to generate new content replicating the behavior of the deceased, from the perspective of digital immortality (Galvão and Maciel, 2017).

Another important issue to be explored in the context of DLMSs is the behavior of users and developers towards the challenges imposed on this type of system. The next section aims to present authors who have discussed the DLMSs from this perspective.

3.4 User and Developer Behavior in Relation to DLMS

The same research by Gullota et al. (2016) cited in Section 3.1 also discusses how the analyzed systems engage users to feed their data into these same systems, taking as assumptions *"the possible uncertainties of life and death"*, *"the desire to contribute to the next generations"* and the ability of digital systems to protect the personal life of users, that is, death-oriented practices in the system. It was noted that systems need other types of death-oriented practices, since narratives that engage ordinary users may not engage all users. In this same context, Maciel (2011) analyzed, through a questionnaire, the perception of 83 software engineers about aspects related to DLMS. In particular, the author analyzed the destination of digital assets on the social web and highlights a list of requirements for the deployment of volition in Social Web applications. In another study with the same data, Maciel (2012a) identifies taboos and beliefs that engineers have in digital legacy management.

Pereira et al. (2019) analyzed how the public understood and how they used a DLMS by reporting the emotional cost of death-related technologies to both the user of a DLMS and the heir. They focused on the perception of young adults, from 18 to 24 years old, about these systems. This age group was chosen because they are the "main" potential users of this type of system. The researchers used the semiotic inspection method and the DiLeMa framework proposed by Pereira et al. (2017), composed of six dimensions: 1) Interlocutors, 2) Definition of Inheritance, 3) Assignment of Functions, 4) User Status, 5) Availability of Inheritance and 6) Security Mechanisms. The first dimension refers to the **interlocutors**, those who assume functions in the DLMS. In the second dimension (**definition of the inheritance**), the collection that will be inherited (the digital legacy), how it is obtained and the associations of this collection with the heirs are defined. The third dimension deals with how the **assignment of functions takes place**. The fourth dimension, **user status**, deals with when the actions defined by the user must be initiated. The user can assume two statuses: active or inactive. The change of status occurs through triggers, which can be a notification to the system by the trusted contact or the inactivity time of the user. After this time, the system sends notifications to the trusted contacts, who must confirm or deny the death of the user. The way to **make the legacy available** is handled in the fifth dimension. Finally, the sixth dimension deals with **security mechanisms**: authentication of the interlocutors and data security.

Considering the four approaches to the study of DLMS presented here, in general, the authors deal with systems to **support mourning and the rites of death** (Gulotta et al., 2016; Öhman and Floridi, 2017), **inheritance management and transfer of assets** (Gulotta et al., 2016; Öhman and Floridi, 2017; Ueda et al., 2018; Bahri et al., 2015; Maciel, 2011; Pereira and Prates, 2017), **digital memorials** (Gulotta et al., 2016; Öhman and Floridi, 2017; Ueda et al., 2018; Maciel, 2011), **posthumous messages or communicators** (Öhman and Floridi, 2017; Maciel et al., 2015; Ueda et al., 2018) and **digital immortality** (Galvão and Maciel, 2017; Gulotta et al., 2016; Öhman and Floridi, 2017; Ueda et al., 2018). Many of these systems are dealt with by providing services in an interconnected and overlapping way, which makes their analysis difficult. The centrality of legacy management in heritage management, asset transfer systems and in digital memorials, which can incorporate solutions for others, is noteworthy.

Finally, it should be emphasized that there is no definition in academic literature that contemplates the DLMS from the perspective of the primary objective of the systems that will offer this service, that is, if the focus is on the management of the legacy, or if they are functionalities embedded in a system that has other purposes. Such perspectives broaden the scope of these systems, respectively called dedicated and integrated in this research.

4 USERS PERSPECTIVE

This section aims to present the results of the survey conducted with 171 users, as presented in Section 2. An initial discussion of these data was briefly published in (Yamauchi et al., 2018).

In relation to the **survey respondents' profile**, 29.8% were between 26 and 30 years old; 26.9% were between 21 and 25 years old; 18.7% were between 31 and 40 years old; 18.1% were between 40 and 60 years old; and 4.1% were between 17 and 20 years old. Of these, 57.7% were identified as belonging to the male gender; 42.1%, female; and 0.6, as non-binary. In general, the participants had a good education level: 62% had university degrees; 34.5% incomplete university degree; and 2.9% had only a high school degree. All participants claimed to use some form of social media: 97.07% used Facebook; 80.70%, Youtube; 70.76%, Instagram; 36.5%, Google+; 26.9%, Pinterest; 16.95%, Snapchat; and 9.94%, Twitter. Regarding foreign languages, 60.81% answered that they were fluent in English.

The **knowledge about digital legacy** was gauged through a discursive question. Considering the answers given, the idea is derived that digital legacy is any data that is left stored in some digital system and may persist or not after the user's death. Furthermore, participants understand the relationship between digital assets and legacies, but without distinguishing the different types of assets and what they are used for. Of the 171 participants, 29.9% answered that they had prior knowledge about DLMS; 70.8% did not. For those who answered the latter, the questionnaire was finalized. The upcoming survey questions addressed specific aspects of the DLMS, which are discussed in the following sections.

Transfer of Inheritance. One of the objectives of these systems is the transfer of digital heritage. Therefore, the users were asked to notify their will as to the destination of the legacy itself, with a list of options. Of the respondents, 34% preferred the assignment of a guardian; 18%, the assignment of an heir who would have complete access to all accounts; 22%, the exclusion of accounts, but with data transfer to the heir; 12%, the total exclusion of accounts; 10%, the exclusion of some pre-selected accounts, leaving the responsibility for others to an heir; 2%, the exclusion of the account, but leaving only the data that was selected while alive; and 2% gave another option. In the latter case, the U87 participant answered "*I would like for it to be possible to group the information and classify it into categories or tags, and so the systems can allow you to choose what data you want to share while you are alive, or omit data that you don't want anyone to see*". It should be noted that the majority of the users opted for the exclusion of the account, with or without transfer of goods. This data corroborates Gach's (2019) research on users' preference for account exclusion.

Guardians. Regarding the use of guardian mechanisms (data administrators) (Brubaker et al., 2014) of digital assets, the majority of participants (54%) are comfortable with the use of this mechanism; 36% do not feel comfortable; and 10% fit in like others. Participant UA3 has another response: "*I don't think the idea of a guardian is legal. Because you might choose a guardian who doesn't want to manage your account. So I think you should delete the accounts and just keep the information, which is similar to what happens in real life. Because when the person dies she stops performing activities*". The participant UA13 believes that "*there is no need to assign a guardian and the system should only ensure that all posts are deleted permanently*".

For digital legacy management systems to be effective, users must determine their will while alive (Maciel, 2011), as well as define their heirs, according to the systems' rules. In the questionnaire it was asked if all preconfigured settings in the digital will should be obeyed. The study found that 86.0% of the respondents believe that it should. Participant UA3 emphasizes that "*wills must abide by current law*". Participants UA3, UA6 and U58 stressed that wills often cannot be fulfilled. Participant UA32 stresses that the will must always be updated, since the user's will always changes. The participant suggests techniques such as machine learning (Britannica, 2018) or some kind of "judge" to evaluate whether the will recorded in the digital will should be complied with or disregarded. Prates, Rosson and De Souza (2015) report a set of challenges that, if met by the systems, will ensure the anticipation of user interaction, providing higher volition (Maciel, 2011) at the time the users configure their digital legacy.

Digital Will. Another issue addressed in the survey was whether participants consider that the digital will has the same relevance as a physical will and, in case there was any conflict between the two, which one should be prioritized. Of the total number of respondents, 84% think that the digital will has the same importance as the physical will.

Respondents were also asked whether the digital will and the written on paper (physical) have the same validity. Of the respondents, 54% believe that the last written will is valid; 24% opted for the physical and

12% gave no response. Participant UA38 replied that "*It depends on the origin of the digital document, and security considerations should be validated*", while participant UA44 replied: "*The physical one! Who guarantees that the user was not hacked and his will was changed?*". Therefore, there are concerns that the will may be improperly changed by third parties; for the digital will to be valid, the system must provide security mechanisms and authentication of users (Pereira and Prates, 2017).

Data in SGLD. Online systems use globally distributed databases, i.e. the data of a given user may be stored in a different country than the country of residence. Users were asked whether they feel comfortable having their data stored in other jurisdiction, empyazing that databases are subject to the laws of the countries where they are located. The survey showed that 64% of respondents felt comfortable with this, but 36% did not.

The form of data management is, in the vast majority of systems, described in the terms of use and privacy policies of the systems. In this context, participants were asked if they read the terms related to digital legacies. Answers were 52% they do not, 44% read sometimes and only 4% read such documents. Oliveira et al. (2016) highlight that"*the lack of knowledge on the part of participants about the terms of use of the services*" and Yamauchi et al. (2016) point out the difficulty of understanding these texts, as they are long and have a very technical vocabulary.

The participants were also asked how they felt about the ownership of their data: 84% affirm that the data are from the users themselves; 8%, from the companies that hold the data; 4%, from the public; and 4%, others. However, in terms of use, this is not always the understanding about the ownership of digital assets.

Types of DLMS. In another question, participants were asked what DLMSs are, presenting the proposal of two subgroups: the dedicated (DDLMS) and the integrated (IDLMS). About the DDLMS, 66% answered that they knew what it was; 26%, that they did not know; and 6%, that they only knew about it after the Special Topics in Software Engineering classes. In another question, the IDLMSs were contextualized, giving as an example *Google Inactive Accounts* (2018), and it was questioned if the participants had knowledge about this functionality in the Google systems: 58% answered that they knew about it; 40%, that they didn't know; and 2%, that they only knew about it after attending the course. In the open question at the end of the questionnaire, some highlighted the importance of dealing with the subject in the course and through the survey conducted. This reinforces the importance of literacy in relation to this subject (Maciel and Pereira, 2012a).

The questionnaire asked participants what their preference would be regarding the two types of system (DDLMS and IDLMS) to configure their digital legacy. 44% answered that they would use integrated systems; 40% would use dedicated systems; 12% could not answer; and 2% were not interested in configuring their digital legacy. Participant UA27 states that "*it would be ideal for all online systems to have tools for the administration of the digital legacy, enabling a better configuration of the data that will be inherited in the future*".

5 DISCUSSION

This section aims to present and discuss the two main results of this research: the classification of the DLMSs into two types (Section 5.1 and a list of requirements for DLMSs, both results derived from the literature review, the study of DLMS and the survey conducted in this research.

5.1 Types of DLMS

Considering the works and concepts related to Digital Legacy Management Systems (DLMS) presented in Section 3, it is possible to classify them into two types: Integrated Digital Legacy Management Systems (IDLMS) and Dedicated Digital Legacy Management Systems (DDLMS).

The main difference between DDLMS and IDLMS is that IDLMS do not have the management of the digital legacy as one of their main objectives. These systems only incorporate functionalities related to the digital legacy to supply other needs. Therefore, they are systems that continue to exist even if the digital legacy functionalities are removed. We analyzed functionalities integrated into Facebook (2020), Instagram (2018) and Google Inactive Accounts (2018). In general, they are functionalities that are pre-configured in life by the user and executed after the detection of inactivity or death. Some involve the transfer of user data to third parties, the transfer of an account, the transformation of a profile into a memorial, or the deletion of their respective data/accounts.

IDLMSs, in the context of the DiLeMa framework (Pereira and Prates, 2017) (described in section 3.4), can assume some strategies due to their specificities. For example, in dimension 2, it is foreseen that a file

is already contained in the system (so it is not required to upload this file, only for complementary additions) and the feeding process (Gulotta et al., 2016) is fostered by the nature of the system, as in a social network that is used and fed by the user. In dimension 5, the heir may be obliged to create an account in the system in order to then have access to the collection. Another option is for the system to provide a way to download the legacy stored and destined to that heir (Maciel, 2011).

The DDLMSs are developed with one of the primary objectives being to manage the digital legacy of its users. Therefore, they incorporate some of the above mentioned functionalities related to the digital legacy, depending on the focus and needs of the service. However, by removing the digital legacy management functionalities, the system would be totally uncharacterized, as it would lose a primary function. Of the so-called DDLMS, the functionalities of Eter9 (2020), Afternote (2020) and Safebeyond (2020) were analyzed. These systems hold or store the data sent by the user and execute, after his/her death, the wills configured in life. It is interesting to note that these systems can also incorporate services not exclusively related to the digital legacy, such as funeral wishes, for example.

In the context of DiLeMa, in dimension 2, DDLMSs do not previously hold the user's legacy. For this purpose, these systems can allow users to store the information necessary to access the collection in another system or provide the DDLMS some level to the external system. Furthermore, they can request the user to send their legacy items to be hosted in the DDLMS. Regarding dimension 5, the DDLMSs could send the heir a link and instructions how to download the legacy collection, request that they create an account in the system to then access or, depending on the types of legacy items, could send the data through the email platform.

Dedicated system services include digital inheritance and desire management systems; posthumous messaging systems; online memorial systems; life recreation systems; grief support systems; systems that provide the ability to remember and share information about one's ancestors or people who died in the distant past; and systems that promote public reflection and debate about significant events and experiences.

5.2 DLMS's Requirements

The distinctions between these two types of systemic possibilities were made, based on the analysis of the functionalities of the analytical tools, and requirements were elicited, which can be modeled in IDLMS or DDLMS, depending on the primary objective of the system. Some requirements conflict, especially because they depend on the primary objective of the application: to be a dedicated system for legacy management, or to do it in an integrated way with systems with other objectives. In any case, they are complex solutions that have found specific studies in the literature.

In general, digital legacy management systems have different target audiences: users, heirs, guardians, curators, lawyers, trusted contacts, service provider company's, etc. In terms of digital assets, all files in text, image, documents, audio, etc. that may be of interest to the user are considered in the context of these requirements[2]. This section aims to discuss each of the listed requirements, considering five main categories: (1) registration, (2) death detection, (3) legacy administration, (4) bereavement support, and (5) security and other usage rules. The following sections deal with each of them.

Req. Group 1: Registration. First of all, it is important that the parties interested in the process implemented by an DLMS are properly registered in the system, which is the reason for requirements 1 to 3. Maciel, Pereira and Sztern (2017) point out that it is relevant to consider the temporality of the contact information, since human relations and contact data change over time. For this, the system must be in constant contact with the heir (requirement 42). In addition, the system can foresee the possibility of the user dying as well as his heir (requirement 43). For this purpose, the systems can make use of trustees, guardians and/or lawyers to pass on "digital assets", as expressed in requirements 3 and 10. Brubaker et al. (2014) define that stewards are people who act as data and account administrators after the user's death, and meet the wishes established by the user in life, such as being continuously present online in social media. Some digital legacy management systems use the guardian mechanism to activate the triggers regarding the detection of death and the accurate delivery of user data.

Req. Group 2: Death Detection. Another fundamental functionality is expressed in requirement 32, the detection of death by the system. There is the possibility of this occurring automatically, by text mining, for example, as occurs in social networks that transform profiles of deceased users into memorials

[2]The requirement list is available at https://lavi.ic.ufmt.br/davi/en/artefatos/

(Viana et al., 2017). However, in other systems, such as *Google Inactive Accounts* (2018), contacts are registered in the system so that it can check the user's status with third parties (Maciel et al., 2015; Maciel, 2011; Maciel and Pereira, 2016).

Req. Group 3: Legacy Administration. Legacy management on dedicated systems would require interconnection with other systems to facilitate data management, interfering in terms of use and privacy policies specified by the companies providing the services and policies of each country, as proposed in the requirements. Some authors have dedicated themselves to outline this discussion in different contexts (Yamauchi et al., 2016; Edwards and Harbinja, 2013; Viana et al., 2017). In particular, there is a concern that users do not give due value to such documents, often leaving them unread (Yamauchi et al., 2016).

Regarding the transfer of goods through the system, two conflicting requirements are proposed, 13 and 14. Requirement 13 advocates the transfer of the password to third parties, which generally occurs in DDLMS while in requirement 14, there is the transfer of account management to third parties, as occurs in integrated systems (such as some social networks (de Campos et al., 2017)), in a less invasive way. In both, the application must take care of the express in requirement 44, the authentication of the interlocutors and data security (Pereira and Prates, 2017). It should be noted that these requirements, like the others, have a strong impact on what is expressed in the terms of use and privacy policies (Eter9, 2020; Afternote, 2020).

Another option in the systems, especially the integrated ones, is the possibility of deleting the account, contemplated in requirement 12. According to Gach studies (Gach, 2019), with specific members of the public, the most popular preference is for the post-summary profiles is deletion of data. If, on the one hand, this satisfies the user's desire to take his/her data off the network, on the other hand it eliminates the possibility of posthumous interaction (Maciel and Pereira, 2012a,b). Thus, aspects of the application that deserve to be treated, such as those related to bereavement, for which requirements 33 and 34 have been proposed, are no longer valid. This has an impact on the bereaved who remain in the system and could find in these profiles a relief for their pain. With the elimination of the account, systems with Artificial Intelligence, which could perform posts on behalf of the user (requirement 23), would not be met.

Req. Group 4: Grief Support. Regarding bereavement support, other functionalities need to be dealt with in the application, especially integrated ones, since the "presence" of the user's post-summary data affects people in mourning. Thus, cultural issues affecting the deceased, such as religious and those related to sports symbols (Ueda et al., 2019), can be addressed, a fact for which we have requirement 34. It is also possible that an heir to the account inserts information related to the death of the user, changing elements of the interface and inserting data such as date of death and epigraph (Ueda et al., 2019), or, as in requirement 45, inserting data useful for access to physical spaces. This depends on the powers that the account administrator has, as in requirement 14.

One aspect that has gained space and can be used with data from integrated or dedicated systems is the transformation of data into digital art, contemplated in requirement 30. According to Gach (2019, it is important to design the system to give the experience of digital death a ritualistic aspect. In this proposal two key aspects of a user's data are used: the use of data as art and the use of data as an individual (personal).

In addition, there is an aspect dedicated to using data for digital immortality (Galvão and Maciel, 2017). Generating memorials is a way to immortalize the subject, however it is also possible to use the data for chatbot conversations or to generate avatars (Galvão and Maciel, 2017), which is why requirements such as 28 and 29 were proposed. On the other hand, the recreation of life by software results in many reflections, including the ethical limits of data use (requirement 31), and the support to bereavement of those who will interact with such data (requirement 34).

Another possibility for these systems is the registration of posthumous messages, which has fostered the development of specific applications (Maciel and Pereira, 2012b). The requirements of 20 to 22 aim to deal with this possibility. Pereira et al. (2017) performed the analysis of two posthumous message systems, If I die (2020) and the Se eu morrer primeiro (Unknown, 2020), under the perspectives of semiotic engineering, recommendations for volitional requirements (Maciel, 2011) and challenges to the anticipation of interaction (Prates et al., 2015).

Req. Group 5: Security and Other Rules of Use. The authors noticed four important aspects in the context of these systems: indication and access to trusted contacts; possibility of editing posthumous messages by the user herself ; possibility of different media in generating the content to be sent as posthumous messages; and use of reminders and notices to users and trusted contacts. On the other hand, these systems can be used to pass passwords or to send unwanted mes-

sages, thus generating new problems. In general, few of the requirements listed in this section are present in integrated systems, especially because they are social networks or e-mail managers, photos, etc., i.e. they meet the primary objectives of the application. As an example, requirement 24 (profile transformation into a memorial).

Moreover, many features are in specific areas and are not known to the general public. Although they are important for these systems, it is believed that this occurs due to the emotional cost of operating these functionalities, as highlighted by Pereira et al. (2017; 2019), especially because they are linked to the taboos of death (Maciel and Pereira, 2012a). Thus, some systems, such as Facebook, attempting to reduce the contact of users with experiences that can be painful (NYTimes, 2019), not sending reminders of the birthday of a family member who passed away, if the profile becomes a memorial, for example. However, if the system makes the possibility of legacy management more transparent to users, this can allow an anticipation of interaction (Prates et al., 2015), according to requirement 40.

In order to get around problems that affect usability and that allow users to be informed about the system's functionalities, applications, whether integrated or dedicated, must provide information that helps in their use, which is why requirements such as numbers 6 to 9 and 36 are proposed. Requirement 9, in particular, more useful for integrated systems, aims to engage users in what is called "*memento mori*" (from Latin, "remember that you will die") (Maciel and Pereira, 2012a).

Another very important issue is the fact that many passwords are stored in web browsers, interfering with requirements such as 44, which deals with security and data authentication.

6 FINAL CONSIDERATIONS

This article discusses digital legacy management systems from the theoretical, systemic and user perspectives. It is believed that the adoption of such perspectives was fundamental for the presentation of the subject, given the complexity of systems in this field, surrounded by taboos, beliefs, legislation, ethical, human and technological challenges.

From a **theoretical perspective**, the main contribution is the literature review. We found some studies in the literature that are concerned with classifying these types of systems in different ways. However, few of them focus on the users' perspective on the processes adopted in digital legacy management systems. From a **systemic point of view**, the main contribution is the understanding of main systems already available. We brought a discussion between IDLMS and DDLMS by analysing some systems and comparing them to the literature, a set of requirements was proposed and discussed. In this way, it is expected to assist software engineers in the development of systems in this field. It is not a trivial area and to have knowledge of the subject from a different perspectives is fundamental. Solutions that seem simple and have been offered in the market could be better designed in the feasibility study stage of the system. From the **users' perspective**, the main contribution was understand the needs and thoughts related to digital legacy subject. The questionnaire helped the respondents understand the challenges in dealing with digital legacy. In general, they still didn't have an opinion about legacy management possibilities. However, many of the respondents showed concern about the issue.

Regarding the two types of systems specified in this work, there appeared to be **advantages in using dedicated digital legacy management systems**. Due to the centralization of the deceased person's data, there is greater control in the transference of the digital inheritance, thus allowing the execution of more complex functions and a better will, thought out in the set of assets as a whole. A good example is Safebeyond (2020), which provides the functionality to deliver data from an event predetermined by the user (with death being detected by the system or notified by a third party). The occurrence of this event disengages the sending of the information and data that will be inherited.

On the other hand, **dedicated systems** have the **disadvantage** of being difficult to manage by a company, and needs this company to survive throughout generations, because the company has considerable responsibility over third parties' digital assets and the transfer of the data. Perhaps for this reason we still have few systems of this size, some of which have been discontinued or are under maintenance, such as Eter9 (2020), analyzed in this research. In Brazil, there is this gap for innovation.

Integrated systems have different **advantages** compared to dedicated systems, thanks to the premise that they do not have as primary objective only service related to digital legacies. Users who use this type of system feed it, in an organic way, with data that will become their legacy. Thus, they do not need to perform a large data transfer to a dedicated system if they are later interested in the issues related to the digital legacy. It is only necessary to configure the system for this service. In addition, in inte-

grated systems there may be users who are not interested in configuring their digital legacy or who feel uncomfortable being prompted by the system with issues related to their death/digital legacy. However, there may be users who are interested in configuring their legacy, but do not know of the existence of such features and/or settings. Therefore, it is necessary to make users aware of this issue and provide solutions for their needs. Solutions in the field of artificial intelligence can be adopted aiming at systems increasingly adapted to each user and their contexts, thus being able to make more assertive decisions and exempting the user from exposure to these possible uncomfortable situations.

The **list of requirements**[3] presented as a result of this research has addressed several problems detected in the literature, for example the factor that the currently available DLMSs do not clearly discern the nature of the data. This categorization needs to be offered by the systems and configured by the users while alive, which is not simple. Thus, the system could better manage the legacy of users, for example, by discerning sensitive data from others, such as destructible data Bahri et al. (2015). Furthermore, the user could define the end of his data based on categories.

It is also important to point out that digital assets are expanding, leading to an appreciation of the digital legacy, which is a complex, dynamic and present issue on a daily basis, meeting the demand of the market, which is increasingly concerned with issues related to user data and sensitive contexts such as death.

6.1 Limitations and Future Works

During the research, it was noticed that many of the participants at the first stage had no knowledge of what a digital legacy was, even while using systems that had digital legacy services incorporated into them, such as the possibility of transforming their profiles into digital memorials (de Campos et al., 2017) or data transfer after death. In addition, another perceived issue was that not all users wanted to choose the destination of their data when they die. As a limitation of this research phase and consequent future proposal, there is the need to discuss the subject after a more complete exposure than DLMS by forming a study with a more specialized focus group.

The treatment of the digital legacy is perceived as advantageous from the perspective of integrated systems and dedicated systems. Current systems tend to have different architectures, configurations and behaviors from when the literature began to investigate issues related to the subject. Today, integrated systems tend to have an expansible and modular set of functionalities, so they can maintain their primary objective, but incorporate services related to the digital legacy.

By analyzing from the perspective coined in this work, we can perceive the different nuances of these systems, as well as the users' perception of digital legacy. However, in future studies, it is necessary to expand the requirements and separate the analyses according to the two types of systems. Another important issue to be better delimited is the meaning of digital assets, its concepts and the limits of what is inheritable according to succession law (Maciel et al., 2015) or to affection.

As for the limitations of the study with questionnaires, one of them was the age range and academic background of the respondents, despite efforts to reach a larger audience. It is believed that the survey can evolve to reach participants from other areas, the labor market and the elderly, for example. In addition, the quantity and complexity of the questions in the second stage caused fatigue to the participants, something verified during the validation of the questionnaire. It has not yet been possible to investigate in greater depth the feelings and perceptions of these users in relation to DLMS and IDLMS, which is being launched for the future. Also, it is important to modify the questionnaire to bring data in a quantitative way.

[3]Available at:https://lavi.ic.ufmt.br/davi/en/artefatos/

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