The Process-Driven Approach Applied Globally: Methodology, Architectures & Strategy for a Competitive Digital Transformation of Societies

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Abstract

Digitization extends to all areas of people's lives and processes, including public administration and government technology (GovTech for short). However, there are various problems here, such as the inappropriate development of new application systems, that are to be solved efficiently by combining two aspects: methodical digitization according to the process-driven approach and the idea of an app store for processes. This simultaneously fuels a process competition to advance methodical process digitization in the EU. Furthermore, this study explains the target-oriented use of this "firing" within the EU and concludes with a proposal of a new 3-schema architecture standard for successful process digitization within the EU.

1 Introduction

The phenomenon of digitization basically relates to all conceivable economic, social, and labor-intensive processes and areas (also referred to as life processes) and makes it possible—through information technology processing and support—for values such as transparency and trust to be strengthened individually (Hesse et al., 2020; Klenk et al., 2020; Wewer, 2014). With special reference to the German administration and government technology (GovTech)—the connection of administration, state and technology—it represents a particularly great challenge, but holds all the greater potential if successfully implemented (Beck et al., 2017; Lasar, 2019; Schmid, 2019). According to a study by BCG, Germany currently ranks 29th out of 36 countries in terms of citizen satisfaction

with digital administrative services (Kleindiek et al., 2020). Politicians pretend to recognize the current situation and the potential and, therefore, demand more speed in the implementation of digital administrative projects and readjustment with regard to the currently lagging digitization in the administrative apparatus (Beck et al., 2017; Bundesministerium für Wirtschaft und Energie, 2021). This has been followed by various initiatives and meetings, such as the GovTech Summit (Handelsblatt), or other symposia that further raise awareness of the issue (Kersting & Graubner, 2020). In principle, however, some critical questions can be formulated in the area of "administration digitization": How can ideas be found that offer actual added value? What should exemplary digital administration even look like? Can the previous slow and lagging digitization simply pick up speed? How should appropriate solutions be developed and applied? At the outset, it thus seems sensible to work through the basic issues, including the state of digitization, the (political) will, and the way in which applications and solutions have been developed to date. Currently, Germany does not have its finger on the pulse of the times, as the basic functions of digital administration have hardly been implemented across the board, while other countries have already made significant progress, which is also confirmed by a global OECD comparison (OECD, 2020). Since an estimated 600 administrative services cannot be implemented in a hurry, an innovative look into the future is hardly possible, if at all (Kleindiek et al., 2020).

On the other hand, while the necessary technology and research are available (Kersting & Graubner, 2020), the organizational part (i.e., the leadership issue) does not seem to be extensively managed by politics. Furthermore, since the change processes that would be necessary within the administrations are not properly coordinated, these important IT decisions are decoupled and made independently of each other (Schwertsik, 2013). There may be pioneers in individual places (e.g., Sormas[*]), but in the broad mass such results are simply not used, or scaling is not possible (Beck et al., 2017; Heintze, 2020).

Lastly, the previous method of developing applications must be addressed. In previous approaches, companies have "simply" bought ready-made solutions for a specific problem and adapted them to their individual needs (i.e., customization), which means that the entire logic of the solution has been a black box that is simply used as it is. During the digital transformation, this approach is currently reaching its limits and is fueling further problems, including the lack of transparency and flexibility, elaborate customization options, a high cost factor, further solution purchases because not everything is covered (interface republic), constant updates, and endless migrations. This behavior leads to a landscape of many standard solutions with many interfaces, which consume so many resources just to maintain ongoing operations that innovation is almost unthinkable. These digital deficits and problems have been most obvious during the ongoing coronavirus pandemic, especially within the various administrative processes (e.g., contact person management, vaccination management, etc.) (Bundesministerium für Wirtschaft und Energie, 2021; Ebert, 2021; Kersting & Graubner, 2020). Now is precisely the time for the state to realize that it must not lose touch and must take responsibility for advancing the country technologically and economically, which means that GovTech in particular represents a huge field with great innovation potential. From an economic perspective, the next few decades may depend on how technology-leading and innovation-friendly a state is in its administration. For example, Estonia can certainly be counted as a pioneer, having taken this innovative path years ago and being ahead of many countries (Beck et al., 2017).

In the near future in various countries, there will also be an increase in the use of alternative products, which already represents corresponding competition. As this use expands, major innovations will no longer come from a company's own ranks, but rather from "hyperscalers" like Google, for example, that play and will continue to play a particularly noteworthy role here (Beck et al., 2017; Huff et al., 2021). The question is not whether Germany will succeed in principle in advancing the digitization of administration, but rather when it will be achieved, whether the phase of self-determination will then still be possible, and whether the nation will be determined (i.e., digitized) by the hyperscalers

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[*] A "real-time" software solution for epidemic and outbreak surveillance (https://sormas.org/)

mentioned above. The latest technologies are also available in Germany, and, thanks to the pandemic, they have become the focus of debate and application analysis (Beck et al., 2017). In order to achieve real common and generic progress in this regard, each participant must not build its own system, so as not to become an "interface republic" as Angela Merkel calls it (Bundesregierung, 2021); there is need for a standard, which can or even must be set by politics.

This article offers a way for the methodical digitization of the administrative apparatus and the global Process App Store for the comparison and development of digital processes to advance digitization in the administration cleanly and unerringly. The article concludes with an outlook on a standard to be developed that is of interest to the EU and its methodological digitization. This approach is not limited to countries or industries; rather, it can be applied to the EU if not worldwide.

2 Methodical process digitization

Before the actual approach of methodical process digitization can be discussed, a brief explanation of various basic elements is required. In a first approach, the big picture must be understood, which globally prompts a solution in the sense of the "Digital World Control Architecture." In Figure 1, this architecture is presented. Basically, it is sufficient to understand that the digital world is characterized by process-driven interactive application systems developed according to the process-driven approach (Stiehl, 2014), which is linked to the analog world . At the same time, the digital world is having a direct impact through its technologies, such as cloud computing (Repschläger et al., 2010), AI, and security, on the analog world and its (life) processes (Ortner, 2005) by simultaneously controlling them and monitoring their execution.
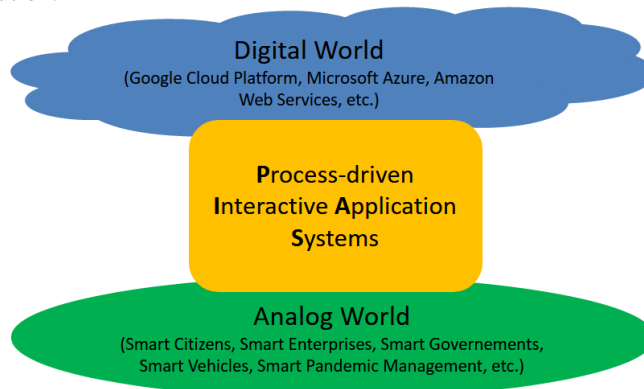

Figure 1 Global process-driven approach (PDA)

2.1 Aspect of language criticism

In order for successful digitization or digital transformation to occur, it is necessary to clarify what digitization means from a critical language perspective. In principle, the ability to digitize must become a basic skill, just as reading and writing are based on pen and paper. In addition, it should be understood that a computer responds to language unlike a human. This makes it clear that digitization, which forms the basis for human–technology interaction, has nothing to do with morals or the like and can be implemented free of any ideology (Ortner, 2005). The bottom line is that the foundations of digitization (H. Wedekind et al., 2004) thus represent a new formation for the disciplined use of language. To ensure this disciplined use, the uniform use of terms and words is required; indeed, a glossary can ensure standardization and common understanding. Finally, it is important to emphasize that groups cannot

oppose digitization just because it is being used by other countries, such as China or the USA, to better control world events (Ortner, 1993, 2005).

Digitization is, from the perspective of both technology and people, a new kind of education (Hartmut Wedekind & Ortner, 2004) meant to teach the disciplined use of language, and it should be provided to every person, no matter their ideology, from an early age.

2.2   Process centricity

One elementary cornerstone of methodical process digitization is process centricity and the associated view of placing a process at the center of application system development (Stiehl, 2014). This illustrates a paradigm shift in the history of interactive application system development since about the mid-1990s. Starting with structured programming by Edsger Dijkstra (Dijkstra, 1976) about data centering by means of databases according to Ted Codd (Codd Ted Edgar, 1970), this development shifted to object-oriented programming and then to today's necessary process orientation/centricity, in which a clear transition from software focus to entire application systems with human-supported processes and actions takes place (Stiehl, 2014). The need for such a shift in thinking is obvious because, as Edward Deming said, "you don't know what you are doing unless you are able to describe as a process what you are doing" (Stiehl, 2014). Apart from computer science perspectives, such as the data and technology aspects, this process centricity includes other sciences. In particular, both the human-oriented (e.g., biology, sociology, and psychology) and the rule- and knowledge-oriented (logic, mathematics, linguistics, and language research from the human point of view) aspects of language use are included and play an independent and non-negligible role (Stiehl, 2014).

With the help of Business Process Model and Notation (BPMN) 2.0, an executable 2-level modeling language for processes (level 1: business processes at the level of the process-controlled application; level 2: integration processes for calling the IT services required in the business processes) and the application of a process engine (Juric, 2008; Schäffer et al., 2021), an environment is provided for executing this language, which makes the processes interactively executable from the point of view of IT and from the point of view of people and their knowledge (Allweyer, 2016). The requirements for the development of so-called "process-driven interactive application systems" (Figure 1) are thus all fulfilled (Stiehl, 2014).

Process-driven applications. Taking a deeper look at process-controlled applications, it should be mentioned that they represent the closest link between future activities of people (i.e., the analog world) and the digital world because the digital world initiates and monitors the analog world via process-driven applications. A good example of this is autonomous driving, which is currently being frequently discussed worldwide. In the context of GovTech, the users of these process-controlled applications are the citizens themselves, the government and administrations, and other companies. Since digitization is in itself a method of processing and, if necessary, controlling described circumstances by means of IT systems, this leads to IT support for directed sequences of activities (processes) in the analog world. Thus, we can speak of process control, which takes place through the execution of digital descriptions (i.e., process-driven applications) by IT systems. The process-driven application in turn controls the analog world and its external events—for instance, human life processes in all situations—through operation on an IT system. Software can therefore be used not only to process digital data but also to control processes in the analog world (Rauscher & Stiehl, 2008; Stiehl, 2014). Process-driven applications can also be implemented according to current process models, such as Scrum, because various steps are required, such as modeling, requirements engineering, configuration of IT services, and actual use by users. Furthermore, all phases can be conducted repeatedly in sprints.
Pioneer in this new engineering field is (Stiehl, 2014), which can be classified as a concluding innovative textbook in the field of the development of such process-driven interactive application

systems. Specifically, the associated architecture of process-driven applications (Process-drive-Approach Architecture, Figure 2), explained below, is also the focus of this topic.

2.3 Process-driven approach architecture

As described in the introduction, a change is also required with regard to the current way in which applications are developed in order to escape the constant purchase of black boxes in the form of standard solutions. For this, it is imperative that an alternative approach be introduced and stringently applied that makes it possible to standardize processes, enable individual integrations, reduce interfaces, and build a flexible and robust, as well as process-oriented, architecture. The process-driven approach in general, as a project management and implementation methodology, and the process-driven architecture in particular represent exactly such an alternative. The approach no longer involves buying standard software, but rather standardization at the domain-oriented process level, which leads to a completely new architecture for applications based, for example, on executable BPMN process models. In short, the domain-oriented and integrative processes are pulled out of the black boxes and made "visible" by BPMN. From now on, these externally "visible" processes are referred to as business processes, which are later used as part of process-driven applications. These specialized processes (e.g., the passport management process, shown in Figure 3) are now modeled in BPMN in such a way that they are completely independent of the real system landscape found in companies and administrations. Only with the help of an additional integration layer, the Service Contract Implementation Layer (SCIL), are the respective business processes connected to the various technical systems of the companies or administrations, with the SCIL taking over the coordination of external information sources and systems. The service contract is also located between the business processes and the SCIL, and it expresses the external services (e.g., IT services) required by the business processes in the form of interface descriptions. These services are then realized through concrete SCIL implementations. In this way, business processes are separated from the respective system landscapes. A business process can thus be run unchanged in a wide variety of environments; only the SCIL has to be adapted in accordance with the system landscape found (Stiehl, 2014). Using this approach, it is also possible to reduce legacy costs. Since the SCIL stands like a protective shield in front of the business processes, the system landscape can be successively restructured or even dismantled below the SCIL. For example, the processes that are invisible in standard solutions could be detached from them and become part of a process-driven application in the form of explicit BPMN models. Through this mechanism, the architecture allows the responsible IT departments to tidy up their system landscape, consolidate systems, and even dismantle them. Figure 2 below shows such an architecture.
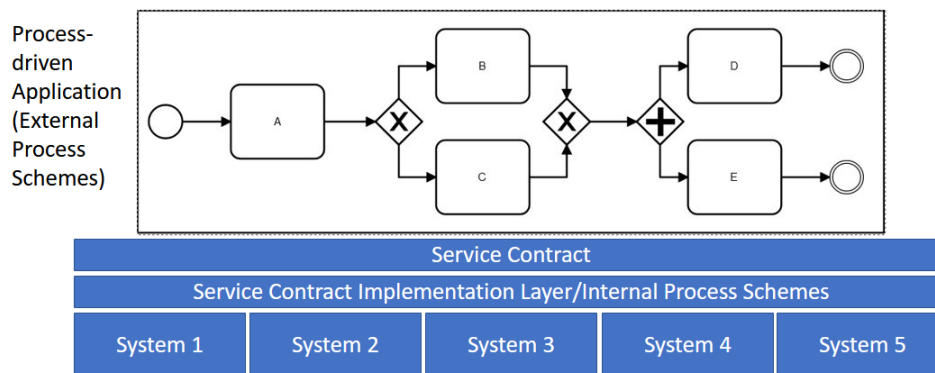

Figure 2 Process-driven application architecture

In summary, the result is now that both the specialist processes and the completely new innovation processes hover over the IT landscape of the company or administration. Thanks to the integration layer,

work can now begin on the technical systems—that is, they can be rebuilt or replaced in order to reduce the interfaces in this way. Work on the technical structure is thus easily possible, with simultaneous innovation at the (business) process level (Stiehl, 2014). In Figure 3, an exemplary process from the administrative environment is shown for better understanding, using exactly this architecture. In terms of content, the digital badge application is modeled in simplified form according to the process-driven approach. The upper process, which represents a domain-specific specialized process, models the digital application for an ID card. Meanwhile, the lower level represents the concrete implementation of the service contract. This process is a good illustration of the transition between the domain-specific process and SCIL. Already in the "Persist documents" step of the business process, any other systems could be connected in the SCIL—depending on where the business process is used—if, for example, the data has to be stored in several systems because the system landscape of the citizens' registration office has grown considerably due to the history. There is also a transition between the business process and SCIL in the "Initiate identification of the citizen" step of the business process. From the perspective of the business process, it is only important that the citizen is identified, but not how this identification takes place from a technical perspective (e.g., Post-Ident, Video-Ident, etc.). Functionality is technologically independent and is the basic prerequisite for the Process App Store, which will be explained later. The business process always determines which data flows from the business process to the SCIL and vice versa; interfaces from existing systems must not play any role in the formulation of the service contract.
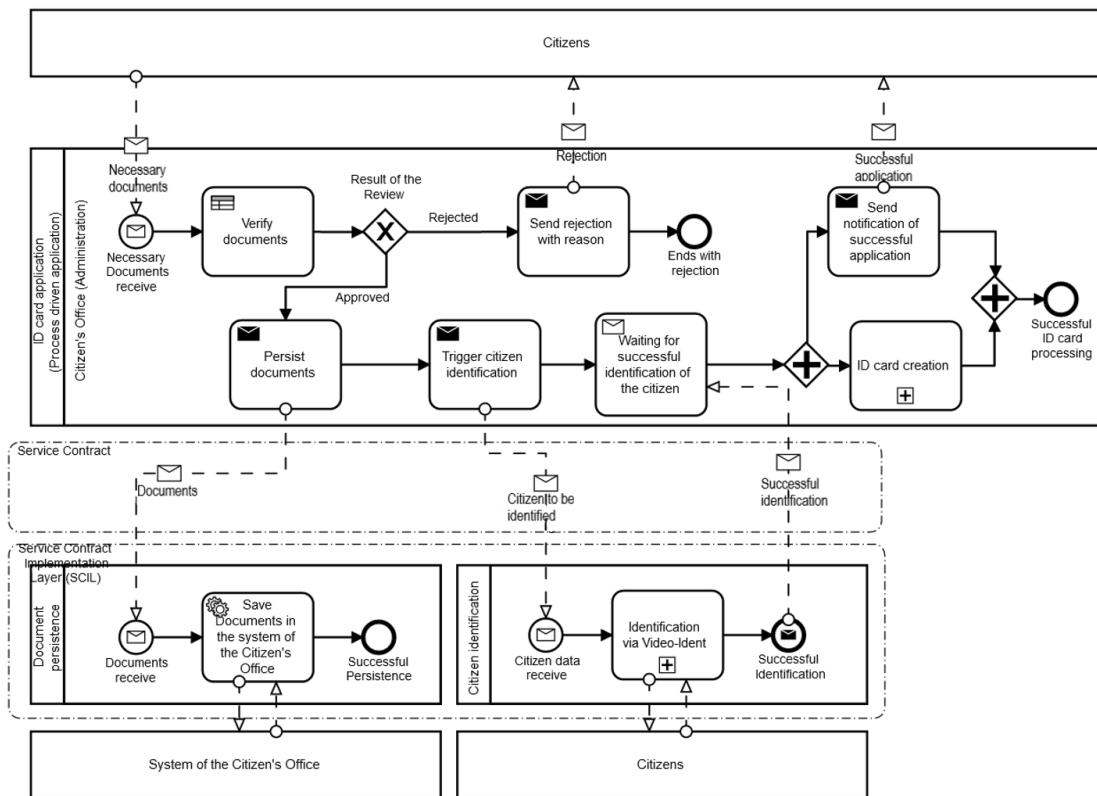

Figure 3 Sub-process for digital badge application according to PDA

Another advantage resulting from this approach or architecture is the transfer of the business processes to other companies or administrations. This means that any specialized process can be rolled out in any company or administration since the process, as described, only has to be coordinated with

the new IT environment via an individual integration layer. Thus, standardized processes with individual integrations are available, meaning that nothing stands in the way of scaling across the board. In addition, a new perspective is created on the processes, which are made explicit and executable by means of BPMN. All in all, this architecture (Stiehl, 2014) is very powerful and robust compared to the previous programming of processes. At the same time, it is significantly more time-efficient, both in the initial development of process applications and in the no less important maintenance and adaptation to new circumstances. It is precisely these properties that can secure the lead in digital transformations.

3 Process App Store

Today, an app store is primarily understood to be one of the digital sales platforms (Hein et al., 2020) for application software from Apple or Google. Such a store is characterized by the fact that practically any software or IT service can be uploaded in the form of apps on almost any conceivable topic. Other users can ultimately access the huge number of apps on this marketplace and, depending on their requirements, find a corresponding app in the catalog or repository (Martin et al., 2017; Winter, 2017). Strictly speaking, an app store is nothing more than a repository system for software. The advantages of such digital stores are obvious: any user with Internet access can install new apps that are needed quickly and easily at any time and from anywhere. At the same time, each store has an integrated rating system, which fuels the corresponding competition for the best app in the subject area. This allows the user to choose from a large number of apps covering a similar range of functions and topics. Based on the different rating metrics (e.g., comments, star ratings, and download numbers) that result from the interaction of other users with the apps, the user can see which app will be the best for them (Clement et al., 2019; Jung et al., 2012).

Now that the basic requirements for app stores have been clarified, the idea of an app store for processes—that is, a process app store—is presented. All the advantages and features of an app store mentioned above apply to a process app store. Instead of apps, it should be possible to upload corresponding (best practice) processes. Such a process app store can be based on the general-purpose architecture (Repschläger et al., 2010) shown in Figure 4 below.
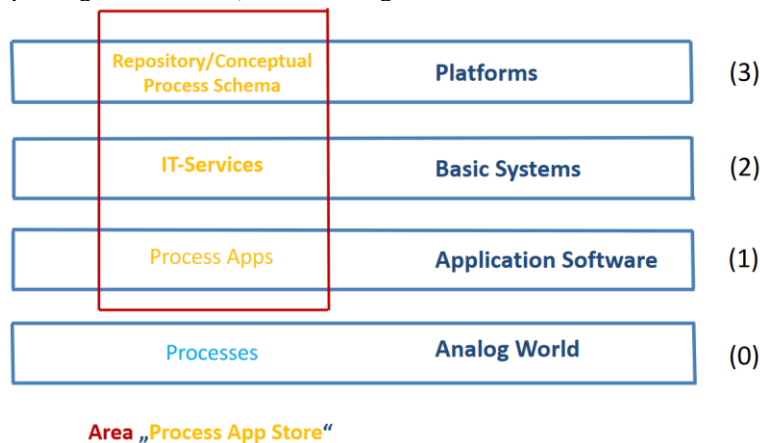

Figure 4 General purpose architecture (Ortner, 2005) and the Process App Store

What is special is that this Process App Store can also be built on the basis of the previously described process-driven approach since only the process-driven approach provides for the clean separation between the technicality and the SCIL for adaptation to the respective system landscape of the deploying company or administration. For this reason alone, such a construct can function. The

business processes of the process-driven applications, including the service contracts, are then to be uploaded to such a Process App Store. Exemplary processes that could be apps of such a Process App Store can be seen in Figure 5.

Reporting	Change of residence	Information on civil register	Registration certificate	...	
Lost & Found	Lost and found management	...			
Passport system	Passport application	Request ID card	EID card for EU citizens	Declaration of loss	...
Certification	Certification Management	...			
Business	Business registration	Permit Management	...		
Finance	Tax management	External audit	Determination management	...	
...	...				

Figure 5 Process App Store repository (Excerpt conceptual process diagram)

Interested companies or, in our case, administrations can download the processes from the store and, thus, implement them quickly and easily. Only the SCIL has to be implemented according to the above description in line with the existing system landscape. Another possibility would be for the "Process Apps" to be hosted centrally by a service provider and activated in the data center without having to be downloaded by the administration. For this, only one thing is necessary: the administrations once again only have to implement the SCIL according to the requirements of the service contract (part of the PDA). Thus, a process, thanks to the flexible PDA architecture, can be made to run in the most diverse environments. Administrations do not have to buy processes as applications, as it is conceivable to pay for them according to use (i.e., pay-per-use)—say, only a few cents per process instance (process execution). This would have the advantage of a low barrier to entry and a high level of acceptance.

4   Using the Process App Store in the EU

After describing the implementation of such a process app store and its benefits, the question now arises as to how such a special app store can contribute to the digital transformation of the EU. This can be based on the familiar application of an app store from Google or Apple, as described above. In other words, member states could simply upload the processes, which are digitized according to the process-driven methodology, to the Process App Store. Thus, in the best case, several processes exist for one topic area, such as passport administration. This step alone can already create a certain transparency, since the BPMN modeling of the specialized processes reveals which processes run where (i.e., in which member state) and in which way. As in an app store, where apps are compared and compete with each other, this now also applies to the processes. Processes will thus become comparable, and the best processes will prevail. Another key advantage is that each process will be immediately available to all participating member states and can be used accordingly. The ranking of the processes can be performed by the member states themselves, or top EU authorities can make their own recommendations. This can even go so far that a new standard for the application of digital processes can be developed by the EU. In addition, further regulations, such as entry criteria or rejection criteria for individual process areas, can be established. This would create a basis on which future process innovations could be rolled out

at will. The more frequently that such a Process App Store is used in the EU, the faster a new and completely digitized EU can emerge (Huff et al., 2021). Figure 6 is intended to illustrate this idea graphically.
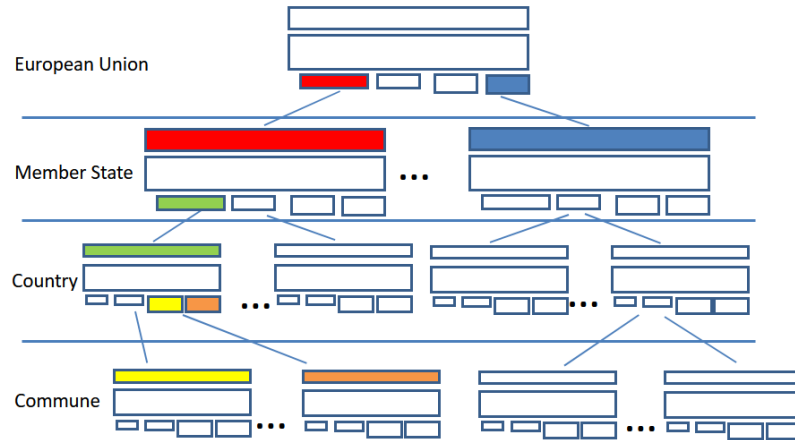

Figure 6 New EU—fully digitized (Huff et al., 2021)

In order to approach this digitization in a structured manner, the top-down and bottom-up principles should also be applied (Huff et al., 2021). The EU should therefore assume the role of coordinator at the top and organize the Process App Store, for example. On the other hand, the individual countries could develop bottom-up digital solutions for individual processes if necessary and suitable processes are not already included, which can then be loaded into the Process App Store and used by others.

5 3-schema architecture standard for processes

The 3-schema architecture standard for processes (Figure 7) is based on the 3-schema architecture for data (ANSI/SPARC architecture) from 1975 (Härder & Rahm, 2001). It represents an integration model for developing and executing process-driven application systems (i.e., Process Apps) on a global scale. The conceptual process schema, like the catalog in a physical library, represents the conceptually consistent access to all process-driven applications (i.e., Process Apps) stored in the App Store. Therefore, it can also be seen as a kind of Process Apps Glossary or Process Apps Dictionary. The Process Apps that can be downloaded from the App Store are represented with their conceptual design (External Process Schemas) and with the IT-side implementation (Internal Process Schemas). The conceptual process schema (Process Glossary) can be understood as neutral (process neutrality) with respect to the external process schemas that can be conceptually derived from it and as independent (process independence) with respect to the internal process schemas. The process terms from the technical design are included in the conceptual process schema (Process Glossary) in their most general form, so that the specific terminology of the external process schemas can be derived from it. Moreover, the technical terms of the internal process schemas (implementation details of the Process Apps) do not even have to appear in the conceptual process schema. The conceptual process schema is a kind of search tool, a Process Apps taxonomy (Figure 5), for solution-seeking users. The 3-schema architecture for processes could thus provide an orientation, and even a norm or standard, for all Process App Stores to be built on the business side (External Process Schemata, Purposes) with the conceptual integrative effect. The globally traded Process Apps would be conceptually and consistently related and semantically or intentionally connected in such a conceptual process schema, as well as available for potential users, independent of technical details (Internal Process Schemata, Means).

This can only occur if all manufacturers of process apps agree on such a 3-schema architecture standard for their app stores, or if a global app store is immediately established according to this 3-schema architecture standard for processes (Figure 7) as a platform worldwide.
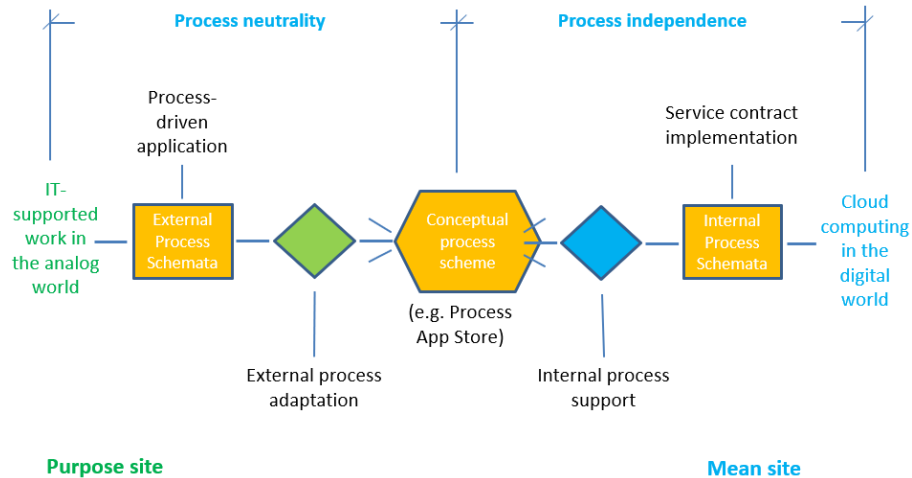

Figure 7 Proposal: 3-scheme architecture standard for processes

6 Summary and outlook

By combining the ideas of methodical process digitization according to the process-driven approach explained at the beginning, the idea of a Process App Store, and the proposal of a 3-schema architecture standard for processes, it has been possible to create a basis that, contrary to the problems mentioned at the beginning, leads to standardized processes with individual integrations and has the potential to change administration in the EU in a methodically disruptive way. The result is digital transformation by means of methodical process digitization through the development and execution environment for interactive application systems (Process App Store), which itself is also both language critical and process driven. By applying the presented process-driven approach and the clear separation between business processes and the technical integration layer, any innovations to the business process are possible while simultaneously working independently and smoothly on the system landscape. At the same time, a digital process platform is created in which all participating institutions can easily load the best and most efficient processes—selected by means of a process glossary—into their own structure; then, only the technical integration layer needs to be adapted. The rating system, originally known from the app stores, creates a competition for the best process, which also strongly promotes process innovation. At the end of the day, every administration can thus simply integrate and use the best processes, which can take the next step toward a completely new, digitized EU. Moreover, new tasks for top EU authorities may also emerge here, such as recommendations on ideal processes or the establishment of a new democracy-proof EU process standard.

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