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Rationalizing a Personalized Conceptualization for the Digital Transition and Sustainability of Knowledge Management Using the SVIDT Method

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Abstract: The objective of a current design science research (DSR) undertaking is responding to the call for a decentralizing Knowledge Management (KM) revolution by conceptualizing a Personal Knowledge Management (PKM) system. The rationale is rooted in today's accelerating information abundance and lack of adequate tools which signify—in the author's view—the presently emerging and most crucial barriers to individual and collective development. For validation, it employs prototyping and verifies its design decisions against DSR guidelines and KM-related methodologies and practices. For the latter purpose, this article employs the SVIDT methodology (Strengths, Vulnerability, and Intervention Assessment related to Digital Threats) by adopting a hindsight reverse-engineered logical perspective in order to present the line of reasoning from the proposed technologies back to the underlying motivations. Its focus is the sustainability of PKM systems, processes, and outcomes combined with SVIDT's concerns with goals and environments, actors and affiliations, strengths and weaknesses, threat and intervention scenarios, and synergies and strategies. In following the SVIDT's nine steps, the broad span of the Personal Knowledge Management (PKM) concept's "wicked" problem space is presented. The results reaffirm the DSR concept of theory effectiveness in terms of the system's utility and communication, and present the PKM concept and system as sustainable interventions to confront opportunity divides independent of space (e.g., developed/developing countries), time (e.g., study or career phase), discipline (e.g., natural or social science), or role (e.g., student, professional, or leader).

Keywords: knowledge management (KM); personal knowledge management (PKM); knowledge worker; knowledge society; opportunity divides; sustainability; digital revolution; digital ecosystems; affordances; adaptive capacity; SVIDT methodology

1. Brief Introduction of the SVIDT Methodology and Its Application in This PKM Context

The SVIDT (a method for Strengths, Vulnerability, and Intervention Assessment related to Digital Threats) provides a tool able of "thinking ahead about what has to be done" with regard to "strategy formation for constructing intervention scenarios that increase the resilience of coupled human–digital environment systems" [1] (pp. 19–20). It is based on a multilevel system–actor analysis, aiming to respond to potential digital threat scenarios with adequate interventions and intending to strengthen the adaptive capacity of actors as well as a human system's resilience. This forward-looking approach supports the digital transformation of companies. Its application in this article's context of Personal Knowledge Management (PKM), however, follows a different agenda.

Over the past five years, the objective of a Design Science Research (DSR) undertaking is to develop a Personal Knowledge Management (PKM) concept supported by a prototype. The complexities associated with such an undertaking constitute a "wicked" problem, characterized as ill-defined, incomplete, contradictory, and by changing requirements and complex interdependencies, where the

information needed to understand the challenges depends upon one's idea or concept for solving them [2].

Unfortunately, most management concepts and models "emanating from the academic discourse fall well short of organizational reality" and only few "are ever translated into software-based tools" [3]. To better ensure that research is relevant to stakeholders' needs and for audiences' fruitful consumption, O'Raghallaigh, Sammon, and Murphy advocate the notion of "Theory Effectiveness", which calls for theories to be incrementally and iteratively designed to be purposeful—both in terms of their utility (largely a matter of content) but also in their communication (largely a question of presentation) to an audience [4]. Accordingly, good DSR practice implies that relevant existing as well as emerging research findings, methodologies, and practices should be scrutinized to potentially integrate them for continuous thorough design evaluation and knowledge dissemination.

This article illustrates that the SVIDT methodology can play a role in supporting the utility and understanding of concepts and designs. The research objective, hence, is to

- further quality-assess/assure the PKM concept and design in terms of "Theory Effectiveness";
- illustrate that the SVIDT approach can support the utility/understanding of concepts/designs.

In this PKM System (PKMS) context, the SVIDT methodology was not applied for its forward-looking analysis and planning strengths, but has been tasked in retrospect, to reflect on and further validate the "Theory Effectiveness" in a reverse-engineered manner from the proposed PKMS solution back to the initial needs assessment. It is, however, presented in the forward manner, and involves (1) assessing and managing the *accelerating information abundance* for sustaining viability; (2) assembling threat scenarios to holistically assess the impacts on *knowledge workers' ecosystems*; (3) developing *PKMS-based intervention strategies* for coping with these threat scenarios; (4) addressing *vulnerabilities, knowledge and complexity*, *opportunity divides and equities*; and (5) aiding to *bridge the gaps* between conceptualization, technological means, reflective practice, and sustainable development.

A SVIDT strength is the support of transdisciplinarity processes which "relate or integrate problem-oriented interdisciplinary research with knowledge generated in a multi-stakeholder approach with the objective of developing socially robust orientations", including solutions for a sustainable and resilient relationship with, or transitioning of the digital environment [1,5]. Multi-stakeholders—in the PKMS context of this article—are represented by the feedback from peers, readers, attendees, and students via prior multi-disciplinary presentations and publications, as well as by the cited external sources which informed the design stages and publications in the form of empirical findings, reported practices, case studies, scenarios, theories, frameworks, and models.

The remainder of this paper is structured as follows. Next, (Section 2) the design research paradigm is briefly recapitulated, followed by (Section 3) introducing the current status of KM and the SVIDT's steps of (Section 4) goal formation and coupled system analysis; (Section 5) system analysis, strengths and weaknesses, threat and intervention scenarios; (Section 6) intervention scenarios; (Section 7) win–win strategies; (Section 8) sustainability assessment; and (Section 9) subsequent discussion.

Any "wicked" undertaking of this kind (the PKMS approach suggests nothing less than a paradigm shift supporting a decentralized KM revolution) cannot eliminate all complexity, but only try as best as possible to reduce it. Heisig's analysis of proposed KM success-critical context factors exemplifies this complexity, and resulted in four highly interdependent clusters where any change very likely has an impact on all clusters; an essential consideration to communicate and manage any change process effectively [6]. But, KM's abstract concepts also lack clearly delineated structures and "real world" referents, resulting in the extensive utilization of metaphors; regardless of whether they are used as a thinking device or to support dialogue and education, their potential "for communicating and stimulating creativity may be further enhanced when combined with visuals" [7]. Hence, Sections 4–9 have been summarized in and visualized as a high-level map (Figure 1). Its left column depicts the nine steps of the SVIDT method with the summarized arguments/findings and PKM-relevant conceptual structures (step 2 and bottom rows) on the right. All details are described in Sections 4–9.

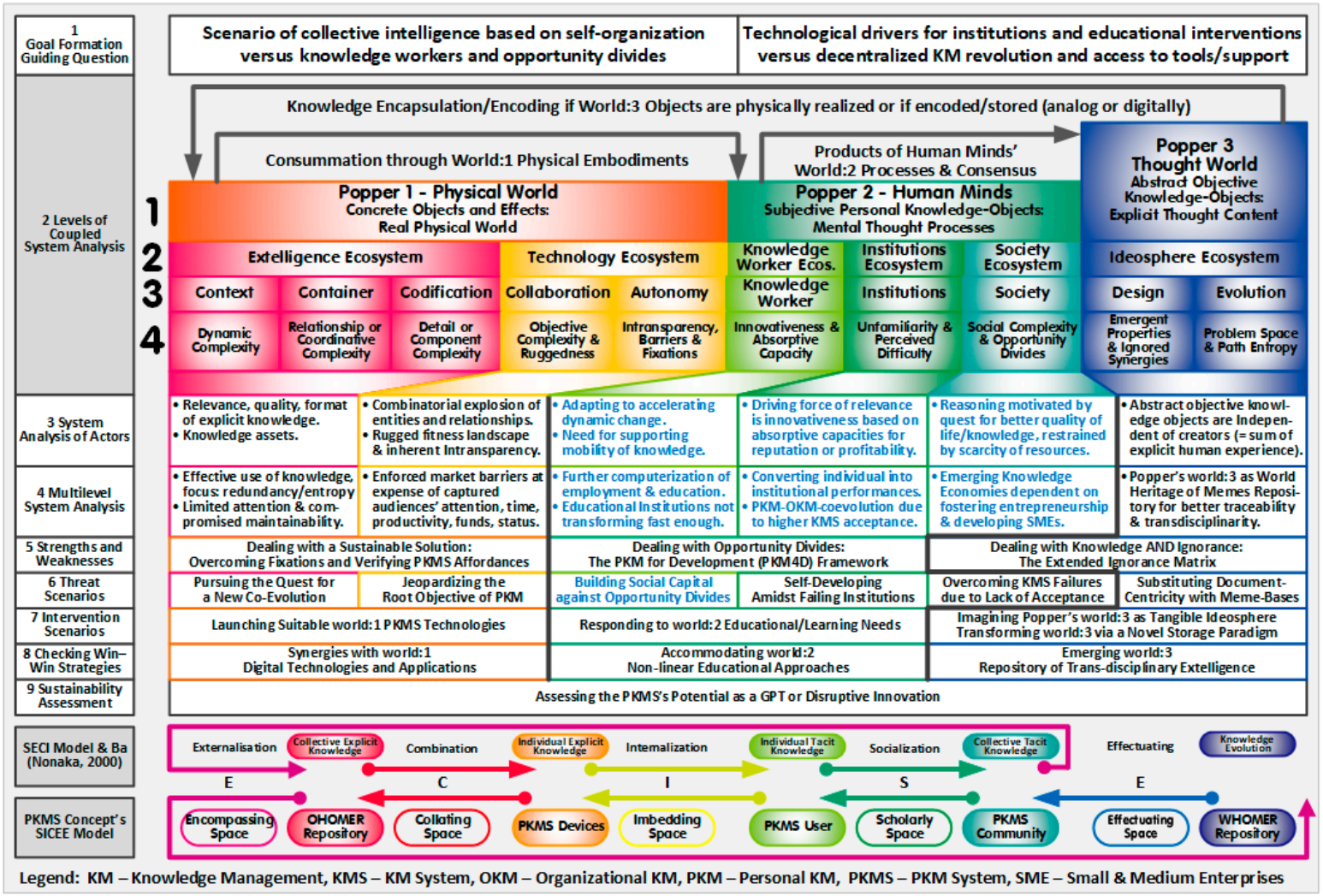

Figure 1. Overview of the Strengths, Vulnerability, and Intervention Assessment related to Digital Threats (SVIDT)-based PKM Argumentation.

2. The Research Paradigms Applied in the PKMS's Design Science Research Undertaking

Instead of justifying the research paradigm in an ad hoc and fragmented manner with each new paper, one prior article's objective has been to present the DSR-related PKM considerations comprehensively (design as an artefact as well as a search process) as evidence of their problem relevance and utility, research rigor and contribution, design evaluation, and publishability in Information Systems research outlets [8].

Hevner, March, Park, and Ram [9] motivate their DSR guidelines also as a reaction to the lack of impact of information systems research on business practices or organizational capabilities, and to the unsuitable presentations alluded to. Their aim is to supplement the reactive behavioral (natural) science paradigm with the proactive design science paradigm to provide a roadmap for conducting, and criteria for evaluating design science research in IT. In following this approach, the PKMS processes have been validated against some of the Informing Science's meta-approaches (a hierarchical framework with an emphasis on feedback loops) [10], and the envisaged PKMS affordances have been benchmarked against the needs of network communities (supporting communication, collaboration, and social knowledge sharing) [11]. This article—by utilizing the SVIDT's nine-stage line of reasoning—further contributes to this DSR objective in regard to the PKMS's theoretical underpinnings.

3. Introducing the Current Unsatisfactory and Unsustainable State of Knowledge Management

As societies and institutions struggle to stay relevant for assuring their prosperity, the conventional wisdom that their overall performance and viability result from innumerable small actions by individuals still applies: "Small personal 'nano-actions' combine with larger departmental actions that combine to create consolidated enterprise actions that result in the performance of the whole organization" and society. It follows that "the quality and extent of knowledge possessed by people—their competence—and structural intellectual capital assets available to them" determine the realized organizational and societal outcomes [12] (p. 235).

Wiig's term "People" equates—in this context—to knowledge workers (KWs). While Florida defines KWs as members of a "Creative Class" according to socioeconomic criteria and types of work [13], the article employs Gurteen's wider definition based on the virtue of responsibility: "Knowledge workers are those people who have taken responsibility for their work lives. They continually strive to understand the world about them and modify their work practices and behaviors to better meet their personal and organizational objectives." Being self-motivated, they "see the benefits of working differently for themselves". They take responsibility for their work and drive improvement [14].

However, while "the patterns of human interaction, communication, group formation, problem solving, negotiation, and conflict resolution are currently undergoing rapid changes" [15] (p. 2), KWs' social structures and discourse cultures can be positively affected (empowerment and enrichment) as well as negatively (vulnerabilities and threats), prompting the need—from a sustainability view—for thorough interrogations. But, the literature on resilience (defined as potential answers "going beyond survival to actually thrive, while still achieving one's core objectives, even in the face of adversity") focuses dominantly on organizational responses to dramatic change and disaster events, and lacks attention to social/cultural contexts of disadvantaged individuals and groups, to multi-dimensional perspectives, and to pro-active adaptation or re-invention of systems and practices [16] (pp. 536–539).

Williams et al. [17] (p. 742) suggest extending this current scope of resilience research to integrate more gradually emerging predicaments which accumulate over time before they unleash their disruptive potential, and define "resilience" as "the process by which an actor (i.e., individual, organization, or community) builds and uses its capability endowments to interact with the environment in a way that positively adjusts and maintains functioning prior to, during, and following adversity".

The motivation of the PKM project focuses on these neglected latter areas and provides a respective rationale of PKM Technologies for rectifying the unsatisfactory (and in the author's view unsustainable) status quo as previously portrayed in the contexts of knowledge workers' education and e-Learning [18], authorship and curation [19], and business activities [20,21]. A reminiscent glimpse at

five "standing-on-the-shoulders-of-giants" works demonstrates that today's KM predicaments have been a scholarly concern for quite some time, although they have not been given priority. Their brief introduction aims to set the stage for the following SVIDT-led deliberations:

- In 1945, Bush (then Director of Scientific Research under US President Truman) published an article "As we may think" [22] in which he imagined the "Memex", a hypothetical sort of mechanized private file/desk/library device acting as an enlarged intimate supplement to one's memory. Its aim was to enable an individual to store, recall, study, and share the "inherited knowledge of the ages" and to facilitate the addition of personal records, communications, annotations, contributions, as well as non-fading trails of one's individual interests, through the maze of materials available—all easily accessible and sharable with the "Memexes" of acquaintances. Bush's vision of the "Memex" has remained unfulfilled [23–25] but represents the as-close-as-it-gets ancestor of the PKM system proposed.
- In 1971, Simon stressed the need for managing our scarce personal attention. Instead of producing and transmitting more and more information, the focus should shift to how much it costs—in terms of scarce attention—to receive it: "In a knowledge-rich world, progress does not lie in the direction of reading information faster, writing it faster, and storing more of it. Progress lies in the direction of extracting and exploiting the patterns of the world—its redundancy—so that far less information needs to be read, written, or stored" [26].
- In 1995, Nonaka and Takeuchi published their "Theory of Organizational Dynamic Knowledge Creation" [27], one of the most widely cited KM theories. Its SECI Model (socialization, externalization, combination, internalization) addresses a major objective of Organizational KM (OKM) by aiming to make individuals' "tacit knowledge (gained only experientially and difficult to articulate, explain, share—as opposed to formal or explicit knowledge) explicit, so it can be measured, captured, stored, protected, shared and further utilized in a 'spiral' of knowledge creation" for the organizational benefit and independent of the availability of the initial knowers. Nonaka defines "Knowledge Creation" as "a continuous, self-transcending process through which one transcends the boundary of the old self into a new self by acquiring a new context, a new view of the world, and new knowledge". To guide this journey, the concept of "ba" is introduced as a context or place (physical or virtual) where knowledge is shared, created, interpreted, and utilized [28]. To energize these dynamic environments, recommendations focus on personal knowledge-related proficiencies, "mapping" one's personal knowledge assets, utilizing a knowledge vision, promoting interaction among the right mix of collaborators, and preserving enabling conditions, such as autonomy, creative chaos, redundancy, requisite variety, and love, care, trust, and commitment [28].
- In 2008, Pollard—as a response to the too many KM initiatives not delivering on their promises—suggests to "go back to the original premise and promise of KM and start again—but this time from the bottom up" by developing processes, programs, and tools to improve knowledge workers' effectiveness and sense-making, and by focusing on peer-to-peer content-sharing, expertise-finding, and connectivity, instead of top-down community-of-practice management and top-down centralized content acquisition and collection [29].
- In 2011, Nielsen demands more rapid iterative improvement by utilizing today's online realities for removing barriers that prevent potential contributors from engaging in a wider sharing and faster diffusion of their ideas and efforts [30]. As Bush sixty-six years earlier ("professionally our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for their purpose" [22]), Nielsen reminds us that the 17th century-established academic paper-based citation system is no longer suitable for today's reputation economy in science: "All that's needed for open science to succeed is for the sharing of scientific knowledge in new media to carry the same kind of cachet that papers do today. At that point the reputational reward of sharing knowledge in new ways will exceed the benefits of keeping that knowledge hidden" [30].

These five works exemplify a range of still unresolved issues as well as the "wickedness" of the interdependent problem spaces alluded to. It required consolidating the needs in an overarching conceptual framework and transparently structuring the process from analysis to solution. In the real-time project chronology, the approach taken has followed an iterative four-stage cycle, each with six iterative generic steps described in a prior article [8]. In line with DSR, the aim is to create an innovative IT artefact (that extends human and social capabilities and meets desired outcomes) by following thorough design processes: such a DSR artefact is complete and effective (utility) when it satisfies the requirements and constraints (functionality) of the problem it was meant to solve (performance) [9].

Although the PKMS approach aims for sustainably narrowing opportunity divides, it is substantially breaking with current paradigms and practices and, hence, rather qualifies as a disruptive than a sustaining technology. A related assessment has presented the PKMS as a potential General-Purpose Technology (GPT) [8]. GPTs, in general, are characterized as exerting strong and lasting impacts in their own industry (improvement), on technical change and productivity growth across a large number of uses and/or industries (pervasiveness), and on product and process innovation in a broad range of uses and/or application sectors (innovation spawning) [31].

With access to these prior articles assured, the remainder of this article embarks on the SVIDT's nine-stage approach, commencing with the guiding question(s) taken from a hindsight perspective. Although an initial "guiding question" was never explicitly articulated, it needs to be emphasized that the scope, depth, and boundaries of earlier project missions continuously expanded, with the insights gained in relation to the vaster potential of more integrated solutions.

4. Goal Formation and Coupled System Analysis (SVIDT's Steps 1 and 2)

4.1. Step 1—Goal Formation: The Importance of "Collective Intelligence" for Future Knowledge Societies

In "What the Digital Revolution Means for Us" [32], Helbing sees the only viable alternative as "creating resilient social and economic order by means of [guided] self-organization, self-regulation, and self-governance". As a result, "collective intelligence" combined with "suitable reputation systems" is expected to unleash "creativity, social capital and productive value" and to produce "desirable outcomes".

In pursuit of these aims, Levy envisages a "Decentralizing [KM] Revolution" scenario that gives more power and autonomy to individuals and self-organized groups. The technologies at the center of this development are decentralized PKM devices. Networked in continuous feedback loops of creative conversations, they are expected to facilitate the emergence of distributed processes of "collective intelligence" which in turn feed them. To facilitate the necessary change processes, Levy recognizes the sustainable growth of autonomous PKM capacities as one of the most important functions of education [33].

The current reality, however, is characterized by expanding opportunity divides which prevent individuals from accessing digital content, e-learning, e-skills development, knowledge, and innovation, all enveloped within the context of poverty or wealth [34].

From today's perspective, the guiding questions would have needed to address the notion of "collective intelligence" and the gap between its conceptual idea (as expressed above) and its practical realization (as proposed by the PKM concept and system to be developed). Such a task would, of course, need to take note of the state of art of the interdisciplinary KM discipline and technologies, as well as the plights of knowledge workers in the context of career development and opportunity divides. The guiding questions (Figure 1, step 1), thus, could have been summarized as follows:

- How this "collective intelligence" scenario translates into the realm of individual knowledge workers and how it can reconcile with the range of widening opportunity divides?
- Which technologies, educational interventions, and institutions will drive this revolution and how can access be assured to those currently disadvantaged and referred to in the first part?

The SVIDT allows for rationalizing the underlying design processes from the mere theoretical notion of "collective intelligence" up to what the current PKM solution provides. This ad hoc perspective not only adds a further level of PKMS design validation, but also one of transparency of the affordances offered—a vital prerequisite of any system's acceptance. This holistic SVIDT-supported approach, with its multidisciplinary web of sub-references, also contributes to the educational PKM-concept and its envisioned face-to-face and e-Learning courses. The many integrated KM tools and ideas allow for KM education in a transparent and coherent manner, including the rationale how and why some of the original methods had to be adjusted, extended, re-purposed, or merged.

4.2. Step 2—Coupled System Analysis: An Intertwined Playing Field with Soft Permeable Boundaries

The construction of the system model utilizes a popular triple-entity class heuristic, as exemplified in Table 1. The concretizations shown are based on a differentiation between physical and social entities, which engage in a fruitful co-evolution facilitated by a third entity as a catalyst, enabler, or driver. Alternatively (as in the second-last example in Table 1), one entity acts as an input and/or output transformed by a process (second) which is invigorated by an enabling environment (third), possibly comprising continuously recurring cycles (as in the case of the SECI model). The last example denotes where a once successful co-evolution (first) is approaching its natural limits (second), indicating a time when only innovative interventions (third) can spur further growth by initiating new kinds of co-evolutions (as to be detailed later).

Table 1. Frameworks of triple-coevolving entities focusing on physical, social, and enabling aspects.

Authors	Physical Entities	Social Entities	Catalysts/Enablers/Drivers
Popper (1972, 1978) [35,36]	*Three Worlds' Model*		
	World1: Concrete objects and effects: Real physical world.	*World2*: Subjective personal knowledge objects: Mental thought processes.	*World3*: Abstract objective knowledge objects: Explicit thought content
Kameoka & Wierzbicki (2005) [37]	*Vision for new era of knowledge civilization as triple coevolving design space*		
	Digital integration & convergence (technological).	Cyber-personal systems geared towards autonomy & collaboration, supported by educational reforms (social).	Shifting perceptions of the world by particularizing its ideosphere (concepts & drivers).
Beinhocker (2006) [38]	*Economic evolution as the result of coevolution across three design spaces*		
	Physical Technologies as "Designs and Processes for transforming Matter, Energy, and Information in Ways that are useful for Human Purposes".	Social Technologies as "Designs, Processes, and Rules that Humans use to organize themselves".	Plans for melding these "Technologies together under a strategy" and for "operationally expressing the resulting designs in the economic world".
Nakamori (2011) [39]	*Knowledge Science—Modeling tasks of the knowledge creation process*		
	To use information technology, systems science, & management of technology & knowledge to support creating knowledge & technology (for technological innovation).	To reform social systems and people's minds to make effective use of advances in knowledge and technology (to create social innovation)	To nurture leaders [and/or strengthen drivers] who [/which] can accomplish the first and second tasks and construct a better knowledge-based society (to nurture innovators).
Nonaka, Takeuchi, Toyama & Konno (1995, 2000) [27,28]	*Nonaka's SECI model and concept of "Ba"*		
	Input or output, here Knowledge Types (k.): Individual tacit k. Collective tacit k. Collective explicit k. Individual explicit k.	Transformation, here Knowledge Processes: By internalization By socialization By externalization By combination	Invigoration, here "Ba" or enabling spaces Exercising "Ba" Originating "Ba" Dialoguing "Ba" Systemizing "Ba"
Schmitt (2014) [8]	*Schmitt's co-evolutionary drivers of human development*		
	On-going economic co-evolution as portrayed by Beinhocker [B04]	Accumulation of unsustainabilities over time leads to stagnation	Innovation as general-purpose technology (GPT) overcomes deadlock

Integrating Popper's Three Worlds Notion [35,36] as the top level of the PKM meta-system allows making relevant causes and effects transparent, as will be pointed out. These worlds (Figure 1,

step 2, level 1) host six Digital Ecosystems (DE) (level 2) to accommodate ten consecutive "zones of engagement" (level 3). Although these meta-components are highly interdependent (as exemplified by the arrows connecting the three level 1 worlds), each has distinctive characteristics (as exemplified by their dominant complexities in need to be dealt with (level 4)).

Popper's Three Worlds differentiate today's reality into three distinct spheres: *world:1* comprises the concrete objects and their relationships and effects in the real physical world; *world:2* refers to the results of the mental human thought processes in the form of subjective personal knowledge objects; and *world:3* represents the thought content made explicit in the form of abstract objective knowledge objects which express the products of *world*:2 mental processes.

Conceptual Digital Ecosystem Frameworks support the cross-pollination of ideas, concepts, and understanding between different classes of ecosystems [40]. From Gibson's ecological point of view, "the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill", as exemplified by "the terrain, shelters, water, fire, objects, tools, other animals, and human displays" [41]. Correspondingly, the affordances of Digital Ecosystems differ in what they offer to their inhabitants (agents). Thus, the six DEs defined in the PKM context have been demarcated and defined based on a modified set of key properties, behaviors, and structures [8]. Each represents distinctive landscapes of knowledge creation and learning able to accommodate all relevant actors and framing agents. Moreover, currently unfulfilled needs (as summarized in the guiding question) have been transparently mapped to show how PKMS's structures and processes interact within this conceptual meta-system and provide for the required adequate affordances [11].

The SVIDT's steps 3 to 8 are to be described according to each of the worlds (as indicated by the divider lines in Figure 1). Although highly interdependent horizontally, the separation places the SVIDT reasoning in a closer textual proximity and reduces cross-references:

- Step 3 focuses on analyzing the main actors operating in and affecting the diverse environments of the six DEs including drivers and rationales. They are summarized in Tables 2–4.
- Step 4 looks at the DEs' multilevel multi-agent relationships at the center of the complex, diverse, transdisciplinary, "wicked" problem spaces, including implications and/or synergies.
- Step 5 identifies strengths, weaknesses, dependencies, and different fields of action at present and in the foreseeable future.
- Step 6 is concerned with assessing digital threat scenarios, their negative impacts, and potential countermeasures and interventions.

Table 2. PKM's three Human Minds-related Digital Ecosystems (*World:2*) (Figure 1, step 2, level 3).

The *Knowledge Worker Ecosystem* provides a space for individual *world:2* minds engaged in leisurely and professional practices or labor markets. Motivated by earnings, reputations, or career prospects, developing one's attitudes, skills, and expertise is vital for advancing into *world:1* desired work positions shaped by qualification frameworks and professional cultures. The key is to overcome *Unfamiliarity* and *Perceived Difficulties* by acquiring task-specific knowledge and by adapting to the accelerating dynamics of organizational, commercial, social, and legal innovations.
The *Society Ecosystem* is the habitat of the individual's *world:2* mind interacting with other *world:2* minds (acquaintances and contacts) through their *world:1* bodies and senses, resulting in the *world:2* personal subjective tacit knowledge which might be explicable by its host through *world:1* concrete explicit knowledge objects via their *world:3* abstract objective process stage. Primarily, the mind's reasoning is motivated by a quest for a better quality of life or knowledge, restrained, however, by resource scarcities as well as ethical considerations, laws, and regulations imposed to care for the *world:2* diverse communities and/or the *world:1* environment. Leadership and interacting for the common good require addressing *Social Complexity* and *Opportunity Divides*.
The *Institutions Ecosystem* is an extension providing a space for *world:2* professionals and their stakeholders to form *institutions* (defined as "snapshots of a subset of the ideational field that persevere while the network itself continues to fluctuate" [42]) with organizational intelligence and memories operating in particular cultural, public, and economic sectors. The driving force of relevance and competitiveness is *Innovativeness* based on *Absorptive Capacities* to successfully exploit, explore, and advance one's portfolio of interests, leading to reputation and/or profitability.

5. System Analysis, Strengths and Weaknesses, Threat and Intervention Scenarios (Steps 3 to 6)

5.1. Popper's World 2: Human Minds, Subjective Personal Knowledge Objects, Mental Thought Processes

In summarizing the analysis of actors and rationales of *world:2* with its six DEs (Figure 1, step 3), Table 2 provides the basis for the following multilevel analysis of relationships and implications (Figure 1, step 4):

- To compete successfully in today's turbulent times, individual *Knowledge Workers* are advised to nurture their *intellectual, social, and emotional capitals* by building depth and by putting in the time and resources to create a *body of knowledge and skills*—not only in one single but multiple areas [43]. The obstacles they face, though, are not only lacking support and widening opportunity divides, but also the severe prospects pointed out in *scenarios of future education* [44] and the *computerization of employment* [45,46], all while our *Higher Education Institutions* are often still stuck in the previous century [47].
- The emerging *Knowledge Societies* are deeply affected by the scenarios and divides referred to. Efforts to stimulate *job creation* and *economic growth* and to develop *Entrepreneurship* are crucial. In taking note of the disruptive forces and the substantial changes ahead for broad-based innovation agendas, a rethinking of the *Triple Helix Model* of University–Industry–Government Relations has led to the analytical construct of *Triple Helix Systems* (*THS*). The revised approach particularizes innovation sources and development paths in more detail and different contexts [48]. Hence, an article has assessed the PKMS benefits for entrepreneurs and SMEs [49].
- *Institutions* strive to convert *individual into institutional performances*. While the PKMS concept sheds centralized institutional approaches in favor of individual sovereignty and personal applications, it should not be seen as detrimental to *Organizational KM*, but rather as an option for a fruitful co-evolution [20]. Based on mutually beneficial interests of PKM–OKM users in collectively harvesting prior accumulated knowledge subsets and on a common ground of methodologies [20,21], PKMSs are expected "to strengthen the *absorptive capacity*, *ambidexterity*, and resulting *dynamic capability of organizations* considerably, not at the expense of disinterested employees, but as a means to motivate them by serving their [very] self-interests" [21].

To address the inherent dependencies, vulnerabilities, and potential actions (step 5), a PKM for Development (PKM4D) framework has been devised inspired by two prior works: Maslow's extended Hierarchy of Needs [50] and an ICT4D Framework for Human Development [51]. It provides a preliminary commonsense heuristic (in need of being empirically confirmed with the PKMS's future application testing) in form of an integrative motivational scaffold matching the ambitions of the users the PKMS serves. It adds transparency to the assessment of interventions (as exemplified by appraising the PKMS) in the individual, organizational, and societal capacity development contexts of opportunity divides and knowledge societies.

The PKM4D Framework allows for prioritizing the needs of knowledge workers (by following the principles of the Herzberg's Two Factor Theory [52] and Kano Model [53]) and "raises awareness, helps to self-reflect, to channel one's ambitions, and to set one's personal targets" [54]. Since it has been detailed in a prior paper [54], its key features are briefly summarized (Figure 2):

- The twelve PKM4D Criteria form six pairs, each related to the six ecosystems (right).
- The criteria (Exciters & Delighters) represent higher development states to which an individual should be able to aspire, and promise higher levels of satisfaction if these states are reached.
- Their counterparts (Inhibitors & Demotivators) indicate negative consequences if such progress is denied (by the continuing lack of support and appropriate tools), resulting in increasing levels of frustration with detrimental effects on individuals and their surroundings.
- The same applies on the aggregate societal level of the various opportunity divides currently discussed (e.g., access, digital, learning, knowledge, innovation).

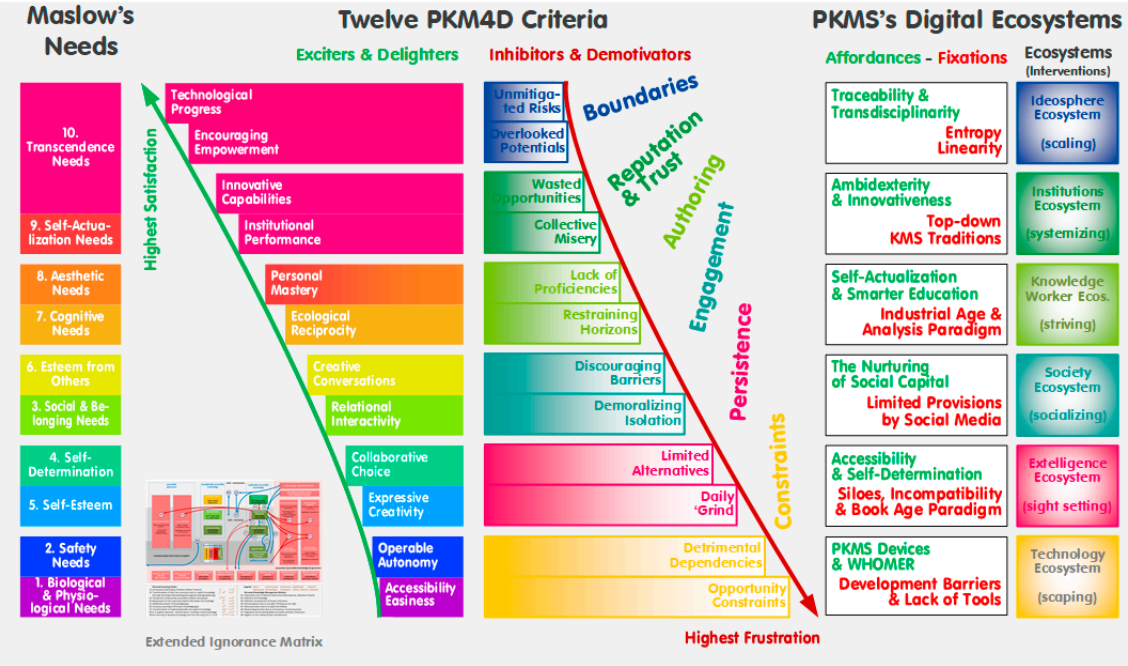

Figure 2. Personal Knowledge Management for Development (PKM4D) Framework: Affordances & Fixations challenging Pioneering Personal Knowledge Management Path Development.

The PKM4D Framework also helped identifying the following threat scenarios (Figure 1, step 6):

- Forming ties for sharing ideas and creativity "is the backbone for producing and sustaining a society that values individual freedoms" [51]. In this endeavor, Social Capital represents the "sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" [55]. Since finding and keeping these regenerative relationships are a key competence (for individuals and organizations alike), an individual's social capital has to be crafted and nurtured in conscious ways [43], ranging from maintaining and classifying contacts and their talents, to utilizing them for facilitating actual conversations or collaborations, towards expediting wider intercultural and interdisciplinary discourses [54].
- However, social media tools and providers are criticized with regard to exclusion (of people without access or account), design control (features imposed on members), content ownership (exploitation of information voluntarily shared by members), and collaborative support (restrictive communication/cooperation-oriented functionalities) [56]. As Levy emphasizes, the need for a personal discipline for collection, filtering, and creative connection (among data, among people, and between people and data flows) [33], being prohibited from or incapable of engaging in these wider discourses or being prevented from accessing or leaving knowledge-linked services will prevent the narrowing of Opportunity Divides.
- Today's Creative Class favors "individuality, self-expression, and openness to difference" over "the homogeneity, conformity, and 'fitting in'" that defined the previous industrial age [13]. But, the continuing fragmentation of work and extelligence is limiting the time and concentration needed for self-actualization [50]). Those, who successfully reconcile the ensuing conflicts have numerous options on where, how, and for whom they will put their portable and mobile knowledge to work, provided they prepare themselves appropriately.
- However, Higher Education Institutions (tasked with stimulating long-term economic growth by producing talented, creative, and capable graduates, as well as inventive, pioneering, high-impact research and entrepreneurial spin-offs) are not only failing them due to cost

increases, administrative bloat, and questionable impact [57,58], but also by preparing students in disciplinary siloes for the linear, definite, specialized and predictable career paths of the past [47], by conducting academic research based pre-dominantly on "analysis" instead of "evaluation" and "design/synthesis" [59], and by contributing management concepts and models which "fall well short of organizational reality" and lack "Theory Effectiveness" [4].

- A recent meta-study has just confirmed the "*nano-actions*" notion by observing the strongest association between creativity and innovation, not at the team, but at the individual level [60]. The findings acknowledge the need of knowledge workers to acquire a thorough understanding of how value can be added to knowledge assets as well as intangible services. Hence, strengthening their sovereignty and personal utility is not a contradiction, but a viable strategy for improving *Institutional Performance*, as detailed with regard to traditional top-down "KM System Generations" [20], "Ambidextrous Organizations", and Earl's "Seven KM Schools" [21].

5.2. Popper's World 3: Thought World, Abstract Objective Knowledge Objects, Explicit Thought Content

Table 3 summarizes the analysis of the ideosphere (Figure 1, step 3) to precede this multilevel perspective (Figure 1, step 4). Following a wider definition, the *Ideosphere Ecosystem* can be viewed as an invisible but intelligible metaphysical sphere of ideas and ideation, where we engage in the creation of our world [61]. It not only incorporates Popper's *world:3* abstract explicit thought content, but also the *habitat of memes*, a concept initially introduced by Dawkins [62], but then further developed by a variety of authors under the banner of "*Memetics*" which views ideas and concepts as "Living Organisms", capable of reproduction and evolution in this Ideosphere. In further exploring this metaphor, a prior paper concluded: "If memes and their inbuilt ideas are able to flourish in a virtual 'Ideosphere' as their habitat of operation", systems "aiming at supporting individual capacity and repertoire for innovation, sharing and collaboration are well advised to utilize the very same space and resources and to form a *digital [explicit and concrete] counterpart* of this 'Ideosphere'" [10].

Table 3. PKM's Thought World-related Digital Ecosystem (*World:3*) (Figure 1, step 2, level 3).

The *Ideosphere Ecosystem* connects the *world:2* minds with their *world:3* abstract objective knowledge objects. For Popper [35], only formulated thoughts can be shared and criticized. As abstract objective *world:3* objects, these thoughts stand on their own, are independent of their creators, and should be judged on their own merit. In their abstract totality, the *world:3* objects account for the entire accumulated explicit human know-how and experience represented by task-specific *Problem Spaces* as understood by individual *world:2* minds. Each problem space might present a series of transitions (alternative paths to a solution) characterized by varying levels of uncertainties, constraints, or irreversibilities (*Path Entropy*) [63]. Developing complex solutions have to deal with positive or negative *Emergent Properties* or suffer from *Ignored Synergies*. However, to elicit impact on *world:1* physical objects and/or other *world:2* minds, the abstract *world:3* objects have to be resourcefully combined and physically embodied or realized in concrete *world:1* objects.

Meme-based repositories, hence, form elementary parts in the PKMS concept. Traditional OKM systems are based on document-centric databases whose features and flaws have been elaborated on in the contexts of the world of paper, PDFs, and the web. Their outdated paradigms are compromising the quest for interdisciplinarity, better traceability, and non-linearity [19].

The key causes (Figure 1, step 5) contributing to the opportunity divides discussed incorporate the external lack of support and tools, as well as personal ignorance (including deficient self-awareness). Unfortunately, people who are unskilled in many social and intellectual domains "suffer a dual burden: Not only do these people reach erroneous conclusions and make unfortunate choices, but their incompetence robs them of the metacognitive ability to realize it". "Not ignorance, but ignorance of ignorance, is the death of knowledge" [64] (p. 30).

In this step's context, "the issue regarding chance-[or threat-]discovery is not the presence of the chance [or threat], its availability [or relevance] to the agent who is looking for [or affected by] it, but the unnoticed yet quality [or impact] that makes it so valuable [or disruptive]" [65] (p. 333).

Any constructive reaction to a causing event or trend requires becoming fully aware of it in order to appropriately modify one's decision-making, priorities, and/or behavior, a process which draws on one's knowledge as well as one's ignorance. A well-known surrounding or domain ("within the limits of the agent's cognitive environment" and interests) might just require a specific known "unknown" to be grasped ("via selective abductive inference"), while an unfamiliar setting or space entails an "enlargement of the entireness of [an agent's] knowledge field" determined by the dimension and deepness of his/her ignorance ("via creative or trans-paradigmatic abduction") [65] (pp. 336, 339).

These notions of abduction have underpinned the significance of extending the "Ignorance Matrix" [66,67] to provide agents with a fitting classification system to address the concerns, and with it, some means to overcome them based on the learning cycles and the associated wastes depicted (thumbprint shown in Figure 2, bottom-left, as reference to original visual ([10] Figure 6).

The threat scenarios (Figure 1, step 6) are concerned with substituting the current "Document-Centricity" with "Meme-based Repositories" in order to better tackle ignorance and acquire knowledge. "One of the ideals of social [and personal] knowledge management is its de-compartmentalization, exchangeability and commensurability" [33], but it necessitates reducing entropy, complexities, and incompetence as well as removing barriers, including those preventing a wider sharing and faster diffusion of knowledge for more rapid iterative improvement [30]. It also requires motivating those who can make the crucial difference and make up the critical mass to benefit from network effects.

On the one hand, this necessitates self-transcendence, which seeks to further a cause beyond the self and involves helping others to achieve self-actualization by acknowledging responsible leadership and integrity in the process. On the other hand, it requires a convincing narrative or "story". The conceptual scheme of the "meme" meme not only offers such an interesting story, it also simplifies the task of rationalizing the substitution of traditional document-centricity with digitally embedded structural references. However, one also has to be aware of related shortcomings and criticisms:

- While theory creation and validation constitute research objectives in the search for truth and forethought, conceptual schemes provide an alternative, but instead of representing truth they are foremost "evaluated based upon their usefulness to a client". To be useful, a scheme needs to be interesting (meaning it conveys something novel to the client), simple enough (to be communicated effectively), and aware of its own limitations [68].
- While an adapted "meme" notion has been enthusiastically adopted in the web (commonly applied "to describe the propagation of content items such as jokes, rumors, videos, or websites from one person to others via the Internet", it is a highly controversial issue in social sciences and humanities [69]. As applied in the PKMS context, it closely resembles its original "memetic" context (by offering a conceptual scheme seeking for usefulness rather than truth) [11].

5.3. Popper's World 1: Real Physical World, Concrete Objects, and Effects

The system analysis of the "Physical World" summarized in Table 4 (Figure 1, step 3) makes a distinction between the objects (technologies) and their information (extelligence), aiming to expose significant multilevel concerns regarding current KM paradigms and practices (Figure 1, step 4).

Table 4. PKM's two Physical World-related Digital Ecosystems (*World:1*) (Figure 1, step 2, level 3).

The *Extelligence Ecosystem* embodies the interactions of *world:2* minds with the content of *world:1* explicit knowledge containers (e.g., books or digital files) as characterized by subject categories within the documented world record available. Extelligence is selected on its relevance (e.g., learning, record keeping, or entertainment value) and the quality, standards, and/or formats of its data, information, or knowledge components. Accessing or authoring extelligence has to deal with *Objective Complexity*, which can be further broken down into *Detail/Component, Relationship/Coordinative, and Dynamic Complexity* [10], a differentiation which closely aligns to the PKMS's digital re-use methodologies adopted (changing codification, container, or context) and the creation of *knowledge assets* (defined "as nonphysical claims to future value or benefits" [70].

Table 4. *Cont.*

The *Technologies Ecosystem* offers *world:1* artefacts characterized by their technical domain or area to satisfy the needs and wants of *world:2* minds. With rising populations and higher innovation rates, the number of entities to be confronted with grows, and their potential relationships are subjected to a combinatorial explosion. Accelerating change also renders the acquired know-who-how-why-where-when-with-abouts logged in personal and organizational knowledge repositories more rapidly obsolete than ever before. The associated *Objective Complexity* forces individuals and institutions to keep their knowledge a jour, despite the *Ruggedness* of the design fitness landscape, which represents the combinatorial potential of objects and information available for selection. Closely related is the inherent *Intransparency* to overcome for unearthing additional viable options and for filtering out unfit ones.

Human civilization has not only thrived on improved memory and communication technologies, but recent advances in *world:1* Information and Communication Technologies (ICT) and their widespread affordability are also accompanied by an insatiable urge of *world:2* minds to use them for the purposes intended [71].

As a result, the familiar problem of information scarcity (few sources/channels, high associated costs) has recently been replaced by a never-before experienced ever-increasing attention-consuming information abundance. But, while "we have many powerful applications for locating vast amounts of digital information, we lack effective tools for selecting, structuring, personalizing, and making sense of the digital resources available to us" [25]. A prior paper has analyzed the broader significance of this sorry state [11], so only some of the identified findings will be briefly highlighted:

- The *Extelligence Ecosystem* focuses on adding to and making effective use of the available *world's explicit knowledge and information*, characterized by the accelerating information growth. A prior article argues that this abundance does not only comprise novel knowledge (as projected in a *UN-Scenario of Knowledge Mass Production over Time* [72]), but also rising shares of duplicated original content (redundancies), partial (fragmentations) or erroneous (inconsistencies) replications or deletions, non-disclosure or subsequent erasure of sources (untraceabilities), unsuitable alterations (corruptions), or lack of curation and maintenance (decay) which are not filtered out by search engines, and thus, pointlessly divert our *attention* from dealing with more pertinent issues [8]. When faced with a comparable problem of compromised integrity and unmaintainable redundancy, earlier flat file databases were replaced with the normalized table structures of the relational database design approach [73].
- The *Technologies Ecosystem* lacks, as just alluded to, adequate tools for knowledge workers despite the promising, seven decades old vision of Bush's "Memex" [22]. Novel technological systems and their components usually evolve based on their *utility and fitness*, resulting in sustaining (incremental improvements), disruptive innovations (substitutions), or failure [8]. But, the development of today's most popular technologies supporting communities "is left in the hand of few big players while the research community is just observing and reporting on their usage in different contexts" and how this state is "stifling the development of real alternatives" [56]. As a result, affordances to collaborate across engagement spaces suffer from *providers* enforcing inflexible exit, entry, and data format and export barriers, at the expense of their *captured audiences*' attention, time, productivity, funds, and status.

The search for weaknesses and dependencies (Figure 1, step 5), hence, turned to former network-and-affordance-related publications probing communication and community-building [74], as well as collaboration and social knowledge sharing [56]. Focusing on the envisaged PKMS beneficiaries and the affordances to be bestowed on them, a recent article investigates the common and differing narratives of the two publications in relation to the PKMS objectives. It resulted in the repurposing, restructuring, and extension of the affordances frames previously discussed since the wider scope of the PKM concept, and system was only partially covered [11]. These revised affordances provide adequate criteria for judging how an individual's status is weakened under the

current technological options and constraints, and how it can be considerably strengthened if properly assimilated by the design decisions for the proposed prospective PKMS devices. The digital threat scenarios are rooted in the continuation of the current status quo (Figure 1, step 6):

- While sustaining human life means meeting certain physiological needs, sustaining peoples' life as "Digerati" [75] means assuring their participation in a knowledge society and their access to information and knowledge via effective and affordable artefacts with an emphasis on individuals' *Expressive Creativity* and *Collaborative Choice*. It ranges from assisting people with their learning and reflection, to developing and articulating their own ideas based on their individual knowledge, background, and situation, towards guiding the self-determination of their lives and careers and their self-choosing of personal and professional acquaintances [54]. The popular social networking sites "do not offer these affordances" because the means to facilitate socialization among their members "are primarily based on a quantitative and merely communication-oriented notion of it. From the technological point of view, their persistence is, on the one hand, guaranteed by the provider, once a critical mass of members has been reached; on the other hand, just for this reason, the technological persistence is fully outside the community space of control" [56].
- Besides, the current outdated book-age paradigm ensures entropy is rampant, while silos of information and knowledge continue to be created due to proprietary content and incompatible digital formats or semantic ontologies [33]. Digital repositories are fortified by "Walled Garden" apps and platforms, counteracting an open and connective web and ignoring the pleads for a "New Era of Networked Science" [30]. If these trends are allowed to go on, the root objective of PKM (defined as "the desire to make citizens highly knowledgeable" to "function competently and effectively in their daily lives, as part of the workforce and as public citizens" [12] (p. 230)) will be further jeopardized.
- In the wider context of extelligence, the narrative concerning conceivable impacts is even bleaker. The progress of civilization is based on changes by humans in pursuit of affordances. A prior paper [8] divides this progress (in analogy to the in Table 1 listed heuristics) into five successive co-evolutions. At each transitional stage, civilization had been running into constraints which could only be overcome by an even more powerful co-evolution triggered by the emergence/invention of capacitating technologies (Table 5). Due to its own transformational muscle, the digital revolution has again reached a stage of severe constraints, and triggered an urgent need to address today's digital, innovation, and opportunity divides [34,75].
- The actual agenda, however, is still driven, for the time being, by the priorities of the "Industrial Internet (of Things)" (also termed the "4th Industrial Revolution") which is incorporating networked sensors, software, and machine-processable knowledge into goods and machines resulting in the self-organizational capability of complex value chains. These developments are unlikely to ease this situation, but are further inflating the information abundance alluded to.

Table 5. Past and envisaged co-evolutions at six civilization stages with evolving knowledge types.

Physical Entities & Storage Facilities	Social Entities	Enablers or Drivers	Emerging Types of Knowledge
Genes (DNA) (units of heredity)	Neo-Cortex Human (single brain)	Ever more creative Memes	• embodied • embrained
Transitional General Purpose Technologies: Learning & Imitation, Language			
Physical Technologies (tools, habitats)	Social Technologies (collaborating brains)	Ever more complex Plans	• encapsulated • encultured
Transitional General Purpose Technologies: Writing & Printing, Institutional Memory			
Analog Storage Devices (paper, libraries)	Collective Intelligence (institutional brain)	Accumulating Analog Extelligence	• encoded • organizational

Table 5. *Cont.*

Physical Entities & Storage Facilities	Social Entities	Enablers or Drivers	Emerging Types of Knowledge
Transitional General Purpose Technologies: Digitalization, ICT Affordances			
Digital Storage Devices (hard drives, databases)	Connectivity (web communities)	Accumulating Digital Extelligence	• digitalized • networked
Transitional General Purpose Technologies: Cloud Computing, Industrial Internet			
Cloud-based Memory (server-client, no-SQL)	Cyber-Physical Systems (internet of things)	Accumulating Cloud Extelligence & Big Data	• enclouded • value chained
Transitional General Purpose Technologies: Personal & Shared KM Devices, Smart Education			
WHOMER Repositories ()	*Autonomous PKM Capacities*	*Decentralizing KM Revolution*	• unified • knowcationed

So, while all these still ongoing co-evolutions are continually adding to our knowledge base, more and more memes are generated, copied, varied, selected, and interpreted (some entirely by machines without human intervention). How much longer or how many more of them will we be able to comprehend with the very attention our finite cognitive capabilities are able to master?

6. Intervention Scenarios: Triple Response for a Sustainable Holistic Solution (SVIDT's Step 7)

The findings of the SVIDT's steps 3 to 6 (differentiated according to Popper's three worlds) blend into a complex, diverse, and "wicked" problem space, presenting considerable challenges. They highlight the need for a transdisciplinary solution able to holistically address these issues for the benefit of the actors and framing agents across all the PKM's digital ecosystems. To increase the credibility and validity of the arguments, as well as the awareness of knowledge workers concerning their precarious situation, the system model adopted with its three worlds (step 2) allows for applying a triangulation approach, closely aligned to the six digital ecosystems with their ten zones of engagement, as well as to the affordances and PKM4D frameworks established. The investigation confirms the fragility and unsustainability of the current status, and points to a range of affordances in need of being conferred and a number of fixations in need of being overcome.

In pursuit of the next co-evolution, the PKMS concept and system development considers the overabundance of information and lack of adequate support as the presently emerging most crucial barrier to individual and collective development—at least until direct access to the Internet through brain implants will allow us to have "the entirety of the world's information as just one of our thoughts" [76,77]. The approach chosen to find it (in the manifestation of the PKMS concept) is aiming to radically change the status quo by pursuing a bottom-up approach, starting with knowledge workers (*world:2*) and memes (*world:1* and *world:3*) as the common smallest denominators of interest.

Having specified six probable threat scenarios with their potential negative outcomes, this task (Figure 1, step 7) involves responding to their vulnerabilities after assessing possible interventions to reduce the degree, severity, and sensitivity of exposure, and to increase the adaptive capacity with regard to comprehensible viable countermeasures [1]. The proposed PKMS technologies are, thus, positioned as positive remedies trying to diffuse the negative culprits as represented by the currently dominating digital technologies and the mounting information load triggered by them.

Many of these remedies are based on the PKMS affordances offered and the KM methodologies integrated, but the most powerful game changer promises to be the paradigm shift from the current document-centric storage practices and application systems towards *meme-based repositories and devices*. This alternative approach features as the first of three intervention scenarios for adaptive capacity improvements, to be followed by the PKMS devices with their centralized knowledge base, and the (in-)formative force of the educational dimension of the PKM concept.

6.1. PKMS-Specific Intervention Scenario 1a: Imagining Popper's World:3 as a Tangible Ideosphere

Popper's "*world:3* represents the thought content made explicit in the form of abstract objective knowledge objects" (Section 4.2). What might escape readers' attention due to its philosophical lingo conceals, in fact, the very reason of our rising information load. Thankfully, O'Raghallaigh, Sammon, and Murphy [4] have provided the metaphors of "big-T and small-T Theories" (in this section the terms "*big-TK*" and "*small-TK*" are used to incorporate knowledge) to shed more light on this crucial aspect of Popper's notion based on the shared view that "theories" (as well as knowledge, concepts, ideas, etc.) have an existence separate from the subjective understanding of individuals. Accordingly, mental processes of a scholar's non-linear *world:2* thinking lead to subjective tacit non-linguistic *world:2* knowledge, while their "objectified" inherent semi-linear thought content results in the objective linguistically formulated abstract *world:3* knowledge [36] (see Section 4.2).

In the PKMS concept, the latter, in unison, represents the accumulated human extelligence, the virtual ideosphere as the habitat of memes, and also the "*big-TK*" just introduced. Unfortunately, as an abstract *world:3*, it is only a non-physical imaginary virtual construct and neither commonly accessible nor directly interrogatable. The "*big-TK*" is, yet, absolutely crucial in holistically representing aspects of a reality, while "it is only through effective dissemination (via '*small-TK*' in form of as *world:1* physical or digital objects) that the ('*big-TK*') move from being objects of private interest to objects of community interest" [4] (p. 122), offering an understanding of the respective reality able of being reviewed for its quality, impact, and further development. This transition is marred by disconnects and overlaps causing gaps and increases in entropy:

- A "*big-TK*" is likely to need several subsets of "*small-TKs*" (e.g., *world:1* research papers, conference presentations, chapters, reports, or prototypes) due to, for example, page restrictions, diverse target audiences, confidentiality considerations, project progress updates, error retractions, sponsoring agreements, and partial or extended re-publications.
- Various already published "*big-TK*" elements might have to be repeated (essentials), restated (further development), amended (reviewers' feedback), reformatted (publisher standards), or dropped (rejected novel or re-submitted proposals), resulting in a variety of inconsistencies.
- Much of the historic content cited might have been referenced many times before (by oneself or other authors' standing on the shoulders of the same giants). Much of what one presents, might be (fully, partially, or incorrectly) copied or cited (paper-based or digitally) by people or technical means. In parallel, academic output is mounting with growing higher education enrolments and more demanding publish-or-perish practices.
- Any digital content does not necessarily stay unchanged as previously ensured by the physics of paper (making the web vulnerable as a storage device). As the traditional physical filters and curating authorities lose their grip, one can now also witness that "every idiotic idea [is] put forward seriously and [that] every serious idea [is] treated idiotically" [78].
- The challenges of fabrications, fakes, and deceit have even further intensified owing to the need for an ability to recognize "Post-Truths" (just named 2016 word of the year by Oxford Dictionaries) defined as "relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief" [79].

These five points constitute the major contributions to the "entropic" and "unsustainable" redundancies, fragmentations, inconsistencies, replications, deletions, untraceabilities, corruptions, and decay alluded to (Section 5.3 Extelligence Ecosystem). Their unproductive and discouraging consequences could be avoided just by transforming the current abstract inaccessible non-interrogatable *world:3* into a tangible accessible interrogatable "WHOMER" repository which does represent one of the outcomes aimed for by the PKMS concept and system.

6.2. PKMS-Specific Intervention Scenario 1b: Transforming World:3 by Alternative Storage Paradigms

Despite all the digital age advances, current citation and reputation systems continue to be document-centric, and are failing to benefit from technological opportunities [19]. "Instead of digitally embedding and reusing parts of digital documents via structural references", digital documents are still over-simplistically modelled "as monolithic blocks of linear content with a lack of structural semantics", "unnecessarily replicating content via copy and paste operations" [80]. The concept of memes offers an alternative:

- A meme represents a basic building block of knowledge and the smallest entity to be referenced and stored with its meta-data. It should ideally be captured in a quasi-atomic state (understandable alone by itself without piggybacking irrelevant or potentially redundant information), so it can be classified multi-dimensionally for easy retrieval and repurposed at any later stage with other memes to create knowledge assets.
- As "living organisms", memes have to survive by enduring in a medium they occupy and the medium itself has to persevere. Currently, they either need to be encoded in inanimate durable *world:1* vectors (such as buildings, machines, products, software, storage devices, books, great art, or major myths) spreading at times unchanged for millennia, or to succeed in competing for a living host's *world:2* limited attention span (such as people, teams, corporations, or economies) to be memorized (*internalization**) until forgotten, codified (*externalization**) in further *world:1* objects or spread by the spoken word to other hosts' *world:2* brains (*socialization**) with the potential to mutate into new variants or form symbiotic relationships (*combination**) with other memes (*memeplexes*) to mutually support each other's fitness and to replicate together (*-marked terms refer to comparable SECI Model stages [27,28] and Figure 1, second-last row).
- In the above context, the PKMS affords a meme a further potent path for continued existence, while the concept of memes enables the PKMS to escape the dilemmas of document-centricity:
    - *Granularity*: Rather than as "monolithic block", any document is configured as a sequence of basic information units (memes) with bi-directional relationships between them (predecessor or successor and internal links to footnotes, glossaries, figures, tables, keywords, and citations).
    - *Guidance:* External bi-directional references can be linked directly to a document's meme rather than to its container (e.g., book, file, or page).
    - *Evolution:* Bi-directional links also connect versions of a meme due to changes in time, space, detail, relevance, or validity and closely related additions like, for example, annotations, peer comments, or forward feeding information about a meme's obsoleteness and authenticity.
    - *Validation:* Since the stored relationships form an interdependent web, any ancestor meme whose repute changes to outdated or untrue, is enabled via the curation services to "inform" its dependent memes as well as current and potential users of its changed undesirable status.

This bi-directional structural referencing has been termed "*Associative Indexing*" [22]. The resulting meme-based PKMS repository as a directly interrogatable representation of the "*big-TK*" is able to contain so much more shared detail than its published "*small-TK*" incarnations, so that "the inheritance from the master becomes, not only his additions to the world's record, but for his disciples the entire scaffolding by which they were erected" [22]. Based on a distributed network of PKMS devices engaged in "*Creative Conversations*" [33], cloud-based facilities would be tasked with curating the voluntary contributions by the PKMS community ensuring that identical memes shared were to be merged while preserving all their unique relationships (termed "*Associative Integrity*") for providing accessible accumulating collective extelligence with superior metrices and services but without the currently experienced redundancies.

6.3. PKMS-Specific Intervention Scenario 2: Launching Suitable World:1 PKMS Technologies

The idea for a PKMS originated in the late 1990s, and an early prototype has been used personally for career support as a management consultant, scholar, professor, and academic manager. Recent advances in development, database, and hosting platforms have provided a viable opportunity for innovation and for developing PKMS applications serving and educating a wider audience and for presenting knowledge workers with affordances and support services currently not catered for, as, for example, the "Six Vital PKMS Provisions" (Figure 3).

The name chosen, "Knowcations", is meant as a reference to our knowledge and know-how as well as to the locations/spaces or vocations/abilities vital to further our careers and expertise. The overall aim of the PKMS is to promote an innovative "next-generation" Knowledge Management (KM) technology based on a design of decentralized PKMS devices (trademarked Knowcations® (Ulrich Schmitt, Gaborone, Botswana)) to be backed by a cloud-based "World Heritage of Memes Repository" (WHOMER™) for:

- Managing/growing the intellectual, social, and emotional capitals of individuals;
- Supporting their creative authorship throughout their academic and professional careers anywhere—and as contributors and beneficiaries of organizational and societal performance, educational services, and the world's collective extelligence;
- Fostering Creative Conversations among teams, organizations, and communities for mutual benefit and competitive advantage via network and cloud technologies.

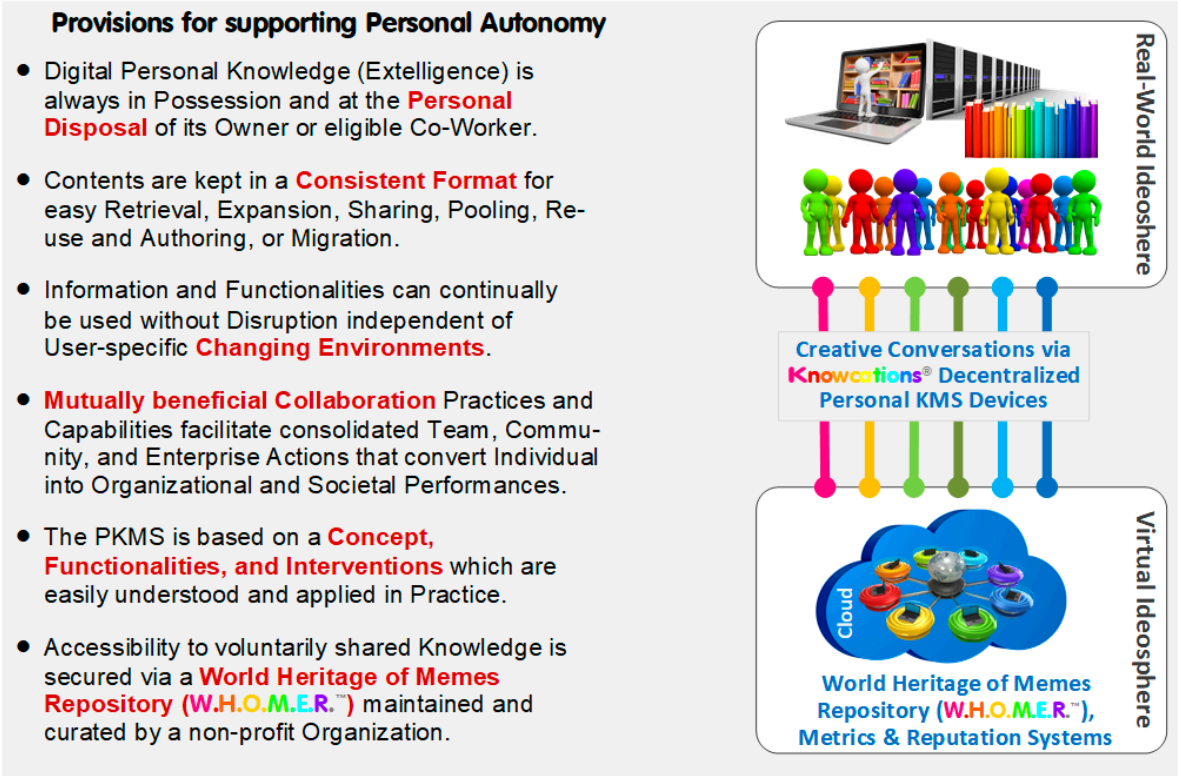

Figure 3. Six Vital PKMS Provisions informing PKM System Design and Development.

6.4. PKMS-Specific Intervention Scenario 3: Responding to World:2 Educational/Learning Needs

The PKMS enables its user to recall, sequence, and combine stored memes and memeplexes with his/her own new meme creations for integration in any type of authoring and sharing activity he/she would like to pursue. The user obtains the means to retain and build upon knowledge acquired to

sustain personal growth, to create knowledge assets, and to facilitate productive contributions and collaborations between fellow learners and/or professional acquaintances.

This concept—in essence—enables self-reflecting monologues of its user over life-long learning periods of educational, professional, social and private activity, and experience. In these conversations with self, the knowledge under review is biographically self-determined, and presents itself as a former state of personal extelligence captured in external extensions of the individual knower's mental storage capacity. Thus, in a personalized setting, the Utopian idea mentioned by Wilson [81] converts into a workable scenario where individuals are indeed autonomous in the development of their expertise, and where they can determine how that expertise will be used or exchanged with people, communities, or organizations close to them [20]. They are also able to take their Personal KMS with them as they move from one project or responsibility to the next.

The PKMS concept's educational agenda, however, extends further. The transdiscipline of KM hosts an ill-structured mishmash of complementing as well as conflicting interdisciplinary methodologies, and its implemented practices and technologies too often struggle to achieve their stakeholders' objectives, due to diverse scholarly contributions, repetitive polemic discourses, and misguided organizational KM system generations. Accordingly, the PKM design process has been forced "to unearth feasible solutions in regard to the many methodologies advocated by scholars and practitioners. Fortuitously, what might have appeared initially as difficult to reconcile or at odds (e.g., KM's objectives, philosophies, and methods) has been integrated into sub-systems serving an overarching system architecture" [8], covering a few hundred renowned KM models and methods.

All PKMS publications with their cited references already form part (in their meme-based representations) of the prototype's knowledge repository and—as Bush put it—represent "an extensive mesh of associative multidisciplinary trails already built-in of alternative pathways" [22] which will also be utilized for the planned PKM coursework as pointed out in Section 4.1. The ambition is to align the PKMS's innovative features and educational philosophies to an established Learning Management System (LMS) for benefitting creative authorship as well as novel learning and collaboration experiences [18].

7. Win–Win Strategies: Transdisciplinarity, Traceability, and Non-Linearity (SVIDT's Step 8)

The three intervention scenarios presented not only complement each other, but also holistically address all three worlds and digital ecosystems. They are a departure from the present assimilation strategies followed by individuals and institutions for trying to cope with ever-rising levels of information loads. Successfully tackling this challenge requires shifting the perspective from a priori assessment to a posteriori management, and necessitates overcoming outdated paradigms by combining a decentralizing KM revolution with innovative digital responses (Figure 1, step 8).

As these PKMS interventions aim at rectifying the unsatisfactory and unsustainable status quo, prior publications have highlighted appealing outcomes for stakeholders engaged in the areas of education and e-Learning [18], authorship and curation [19], and business [20,21]. To add a new perspective, this section combines some of the intersecting sources of these benefits as three "digital prospects".

7.1. Multi-Win Digital Prospect 1: Emerging World:3 Repository of Transdisciplinary Extelligence

The PKMS merges distinctive knowledge objects/assets of diverse disciplines into a single unified knowledge base curated by the cloud-based "World Heritage of Memes Repository" (WHOMER™). As this knowledge base with a growing PKMS community evolves, it fully supports Bernstein's notion of transdisciplinarity, which "generally rejects the separation and distribution of topics and scholarly approaches into disciplinary 'silos'" and rather focuses on work "that creatively re-imagines the disciplines and the possibilities for combining them", resulting in challenging "the entire framework of disciplinary thinking" and in seeking "to assemble new approaches from scratch, using materials from existing scholarly disciplines for new purposes" [82] (pp. 6–7).

Faced with the insularity and limitations, distorted priorities, and interdisciplinary gaps resulting from the current segmented disciplinary knowledge, he recommends developing an approach to knowledge "that transcends the limitations of disciplinary perspectives altogether by viewing the study of knowledge as a transdisciplinary undertaking", by making "connections visible between various wings of knowledge research", and by involving "work in both academic and nonacademic settings" in order to tackle today's "wicked" problems more creatively and comprehensively [83] (pp. 242, 250).

7.2. Multi-Win Digital Prospect 2: Synergies with World:1 Digital Technologies and Applications

The PKMS concept views knowledge assets and their containers as being made up of relationships between memes in the same manner industrial supply chains rely on technical interrelatedness by connecting discrete parts, ingredients, and labor to their final products and services. The latter forms the backbone of modern manufacturing, and stands for the ability to trace the history, application, or location of an entity by creating an as-built genealogy across diverse value chains and sources. In PKMS terms, memes correspond to entities, knowledge assets to as-built genealogies, value chains to authorship and classifications, and sources to output of any discipline.

These synergies add further force to a PKM-OKM coevolution via affordances invigorating digital scholarship and curation and via transdisciplinarity, allowing for flexible knowledge capturing and traceability. However, compared to the physical entities referenced in modern enterprise resource and supply change management systems, knowledge represented by memeplexes or knowledge assets is neither reduced when consumed nor lessened when transferred.

A prior article has examined these and other particular knowledge traceability aspects further [19], an undertaking which has repurposed Pinheiro's excellent introduction of requirement traceability in order to fit the context of the Personal Knowledge Management concept [84].

7.3. Multi-Win Digital Prospect 3: Accommodating World:2 Non-Linear Educational Approaches

The continuing fixation on the outdated book-age paradigm, as noted by Mintzberg, still compels us to provide linear accounts of a nonlinear world [85]. One way to compensate has been the extensive use of visualizations (including a poster mapping the PKMS in a three-dimensional Information-Space [86]). A further alternative arises from the way the PKMSs' publications are "retained in the knowledge base in a format with all reference links kept intact and [with] instant access to the underlying information-rich contributing memes, their sources and alternate [subsequent] uses" [86]. While any knowledge asset can be displayed in its linear structure based on its wholly stored memes and relationships, its stored virtual copy also provides access to each of its memes' multi-dimensional and transdisciplinary neighborhoods, ready to be re-utilized for learning, curation, and authorship.

Additionally, the anticipated synergies between the PKMS and Learning Management System (LMS) (Section 6.4) "are geared towards reinforcing compliance with graduates' attributes and qualification frameworks, strengthening capacity with re-usable/re-purposable dynamic relational knowledge artefacts, and fostering curation and cultivation based on better knowledge traceability, retention, creation, and metrics" [18]. Any meme re-purposed in a LMS module allows for the use of its PKMS stored as-built-and-utilized genealogy for further interrogations once the hardcoded connectivity in the LMS is exhausted. The current activities, in regard to the KM e-learning course design also test the delivery of the LMS learning units and exercises in non-linear fashion, so that course participants are given suitable choices of where to start and how to proceed, including options to leap into an entirely different course world for a transdisciplinary learning experience in case a LMS unit and/or test is shared across these courses, due to its multi-disciplinary relevance.

8. Sustainability Assessment: PKMS as a GPT or Disruptive Innovation (SVIDT's Step 9)

The success of a digital innovation of this nature depends on its suitability for and its acceptability by a sufficient number of users, while the wider benefits suggested further rely on network effects. The suitability (Figure 1, step 9) is a function of the PKM4D and GPT criteria met [8,53] and the PKMS affordances offered [11], while individuals' interest follows stages of Appreciation Models [8,87].

Adding to these pull-effects of a prospective user base are push-effects by potential stakeholder groups (e.g., companies, universities, or triple-helix spaces) eager to benefit from the appealing outcomes mentioned by encouraging their staff, students, or members to use PKM technologies.

The last row of Table 1 referred to the importance of General-Purpose Technologies (GPT) [8] as driver of human development. One of the GPT criteria addresses "*Network Effects*", which apply to goods whose value increases at a geometric rate as more people possess and use them [88]. This effect is also likely to be triggered by a growing PKMS user community disrupting the current providers of attention-consuming inferior services focusing on captured audiences. The barriers established by these actors have prevented Personal Knowledge Management approaches, so far, but are likely to be swept away if PKMSs are catching the attention of an expanding user base.

9. Discussion

9.1. Assessing the Role of the SVIDT Methodology for "Theory Effectiveness" in DSR Projects

This article reiterates the point of prior publications that the current paradigms and technologies in the wider KM field are responsible for a range of barriers and shortcomings that are no longer viable and sustainable. Substantial support has been cited in this and prior articles from other renowned authors who made similar observations. Their diverse concerns, however, have neither been systematically combined and investigated, nor have they yielded adequate methodological and technological responses.

But, as demonstrated, notions of information abundance and redundancies, management of attention and human capital, innovation agendas and opportunity divides, social networking and technologies are highly interdependent, while intersecting with even more concepts, structures, and practices. Problem spaces of this "wicked" nature require a holistic transdisciplinary approach and comprehensive complex solutions. Structuring the project workflows and output, as well as the related documentation and communication, is vital for promoting understanding and acceptance.

The PKM design science research project presented fits this category, and resolved that new approaches and technologies are needed to provide essential affordances and overcome the fixations and impasses detected. The "theory effectiveness" of this undertaking has been detailed in prior publications following chronological [8], functional [10,11], and technical [18,86] pathways.

This article's rationale adopts a logical approach by utilizing the SVIDT methodology. Accordingly, the PKMS configuration—as it currently stands—has been adopted as the fixed outcome of the SVIDT process and the holistic design approach has been "reverse-engineered" from hindsight according to the nine SVIDT steps allowing to omit the numerous iterations and revisions which characterize any complex design project.

The SVIDT's system-theoretical step-wise approach has afforded an ideal basis for focusing on the sustainability of systems, processes, and outcomes, by presenting the broad span of the relevant problem space before narrowing in on the rationale of design decisions taken with its envisaged benefits (as also mapped in Figure 1). As result of its non-traditional ad hoc utilization, a flow of forthright reasoning emerges, which defies the chronological reality (by only touching on issues deemed relevant) but provides a transparent comprehensible reductionist solid source for investigation. Accordingly, this article provides a distinctive space relating to all prior and future publications. It provides validation in line with DSR guidelines, clarity in the envisaged PKM, OKM, and educational context, and will assist—as a primary reference—to streamline further publications.

9.2. PKM as a Sustainable Intervention to the Digital Threat of a Continuation of the Status Quo

The article commenced by referencing five concerns of renowned scholars which all have been addressed by the proposed PKM functionalities. In the same way, the notions summarized in the second paragraph of the previous section are responded to. Due to the "reverse-engineered" manner of the SVIDT's utilization, all shortcomings and unsustainabilities referred to in the text are, in fact, positively affected by the advocated PKM remedies and affordances.

In supplementing the win-win strategies and assessments elaborated on (Figure 1, Sections 7 and 8), this discussion uses the PKMS components and guiding concepts depicted (bottom two rows of Figure 1 labelled "SECI Model & Ba" and "SICEE Model") to specifically focus on sustainability.

The chart indicates that each of the ten zones of engagements discussed corresponds to specific functionalities which are presented as distinct components (depicted as labels or rounded rectangles). The eight left components of the upper row are closely aligned to Nonaka's knowledge categories and concept of "ba" with its SECI workflow (Section 3). The two left components offer a PKMS-related extension of Nonaka's model due to the meme-based repositories and curation services and effect a reversed SICEE workflow (shown in the bottom row; these flows have been further detailed in Boisot's three-dimensional Information Space [86]). The PKMS's SICEE anticlockwise workflow is closely aligned to the clockwise SICE+ cycle, further evidence of the proposed concept's integrative nature with established methodologies and its potential for a fruitful PKM-OKM co-evolution

In the same way, certain complexities are dominating each zone of engagement (Figure 1, step 2, level 4), particular guiding concepts are ruling the ten PKMS components, contributing profoundly to the notion of sustainability:

- *Opportunity Divides* (Section 4.1) are addressed by offering affordable PKMS devices and access to its repositories in line with personal development objectives (PKM4D Framework Figure 2) and independent of space (e.g., developed/developing countries), time (e.g., study or career phase), discipline (e.g., natural or social science), or role (e.g., student, professional, or leader).
- The repositories are continuously being build-up nurtured by the *Creative Conversations* (Section 4.1) of the PKMS User Community, based on the sharing of memes and their relationships. The emerging web of the unified knowledge base is curated to reduce entropy (Section 5.2), to ensure *Associative Integrity* (Section 6.2), to promote *Transdisciplinarity* (Section 7.1) and *Traceability* (Section 7.2), resulting ultimately in transforming Popper's abstract inaccessible non-interrogatable *World:3* (Section 5.2) into a tangible accessible interrogatable comprehensive "World Heritage of Memes Repository" (Section 6.1), which supports authors to achieve *"Theory Effectiveness"* (Section 5.1) by their contributions' utility and communication.
- These advances are not only critical for emerging knowledge societies and for the prospects of storing and accessing knowledge. For the individual PKMS user, they provide the means to engage in *Cumulative Synthesis* (Section 6.4: self-reflecting monologues), a methodology suggested by Usher which convincingly couples the activities of researchers and entrepreneurs [89,90]. For institutional and societal spheres, the consolidation of these "nano-actions" (Section 3) in the PKMS repository supports the notion of *Emergent Innovation* [91] (Section 5.1: Triple Helix Systems). For an educated society, the PKMS memes and relationships captured are repurposed for the benefit of the PKM e-learning agenda as part of an established Learning Management System (LMS) [7] (Sections 6.4 and 7.3). The memes are shared with the attendees for effective learning retention and *Non-Linearity* surfaces as a defining feature of the e-learning structures and learning cycles. These latter advances further promote *Design Science and Design Thinking* for benefitting the logics and logistics of new knowledge formation in general, and for the digital asset production and creative value creation, in particular.

Future research and publications are under review or planned concerning the synergies between SICEE and SECI+ workflows as well as the link between PKMS and Personal Learning Environments, the semantic web, transdisciplinarity, and disruptive innovation. After completing the test phase of

the prototype, its transformation into a viable PKMS device application and a cloud-based WHOMER server based on a rapid development platform and a noSQL-database is estimated to take 12 months.

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References

1. Scholz, R.W. Digital Threat and Vulnerability Management: The SVIDT Method. *Sustainability* **2017**, *9*, 554. [CrossRef]
2. Rylander, A. Design thinking as knowledge work: Epistemological foundations and practical implications. *Des. Manag. J.* **2009**, *4*, 7–19. [CrossRef]
3. O'Raghallaigh, P.; Sammon, D.; Murphy, C. Towards an ontology of innovation models—A conceptual framework. In Proceedings of the European Conference on Information Systems Proceedings (ECIS), Helsinki, Finland, 9–11 June 2011; p. 156.
4. O'Raghallaigh, P.; Sammon, D.; Murphy, C. The design of effective theory. *Syst. Signs Actions* **2011**, *5*, 117–132.
5. Scholz, R.W.; Steiner, G. The real type and the ideal type of transdisciplinary processes. Part II—What constraints and obstacles do we meet in practice? *Sustain. Sci.* **2015**, *10*, 653–671. [CrossRef]
6. Heisig, P. Harmonisation of knowledge management—Comparing 160 KM frameworks around the globe. *J. Knowl. Manag.* **2009**, *13*, 4–31. [CrossRef]
7. Andriessen, D.; Kliphuis, E.; McKenzie, J.; Van Winkelen, C. Pictures of knowledge management, developing a method for analysing knowledge metaphors in visuals. *Electron. J. Knowl. Manag.* **2009**, *7*, 405–415.
8. Schmitt, U. Design science research for personal knowledge management system development—Revisited. *Informing Sci. Int. J. Emerg. Transdiscipl. (InformingSciJ)* **2016**, *19*, 345–379. [CrossRef]
9. Hevner, A.; March, S.; Park, J.; Ram, S. Design science research in information systems. *MIS Q.* **2004**, *28*, 75–105. [CrossRef]
10. Schmitt, U. Putting personal knowledge management under the macroscope of informing science. *Int. J. Emerg. Transdiscipl. (InformingSciJ)* **2015**, *18*, 145–175. [CrossRef]
11. Schmitt, U. Devising enabling spaces and affordances for personal knowledge management system design. *Informing Sci. Int. J. Emerg. Transdiscipl. (InformingSciJ)* **2017**, *20*, 63–82. [CrossRef]
12. Wiig, K.M. The importance of personal knowledge management in the knowledge society. In *Personal Knowledge Management*; Pauleen, D.J., Gorman, G.E., Eds.; Gower: Farnham, UK, 2011; pp. 229–262.
13. Florida, R. *The Rise of the Creative Class—Revisited*; Basic Books: New York, NY, USA, 2012.
14. Gurteen, D. Taking Responsibility. *Inside Knowledge*, 2006, Volume 10. Available online: https://www.scribd.com/document/3517535/The-Gurteen-perspective-Taking-responsibility (accessed on 29 September 2016).
15. Scholz, R.W. Sustainable Digital Environments: What Major Challenges Is Humankind Facing? *Sustainability* **2016**, *8*, 726. [CrossRef]
16. Quendler, E. Organisational Resilience—Building Business Value in a changing World. In Proceedings of the DIEM, Dubrovnik International Economic Meeting, Dubrovnik, Hrvatska, 1–3 October 2015; Volume 2, pp. 534–553.
17. Williams, T.A.; Gruber, D.A.; Sutcliffe, K.M.; Shepherd, D.A.; Zhao, E.Y. Organizational Response to Adversity: Fusing Crisis Management and Resilience Research Streams. *Acad. Manag. Ann.* **2017**, *11*, 733–769. [CrossRef]
18. Schmitt, U.; Saade, R.G. Taking on opportunity divides via smart educational and personal knowledge management technologies. In Proceedings of the 12th International Conference on e-Learning (ICEL), Orlando, FL, USA, 1–2 June 2017; pp. 188–196. Available online: http://www.academic-bookshop.com/ourshop/prod_6217523-ICEL-2017-Proceedings-of-the-12th-International-Conference-on-e-Learning.html (accessed on 9 March 2018).
19. Schmitt, U. Towards a 'world heritage of memes repository' for tracing ideas, tailoring knowledge assets and tackling opportunity divides: Supporting a novel personal knowledge management concept. *Int. J. Technol. Knowl. Soc. Annu. Rev.* **2015**, *10*, 25–44. [CrossRef]

20. Schmitt, U. Quo Vadis, knowledge management: A regeneration or a revolution in the making? *J. Inf. Knowl. Manag. (JIKM)* **2015**. [CrossRef]
21. Schmitt, U. Tools for exploration and exploitation capability: Towards a co-evolution of organizational and personal knowledge management systems. *Int. J. Knowl. Cult. Chang. Manag. Annu. Rev.* **2016**, *15*, 23–47. [CrossRef]
22. Bush, V. As we may think. *The Atlantic Monthly*, 1 July 1945; Volume 176, 101–108.
23. Davies, S. Still building the Memex. *Commun. ACM* **2011**, *53*, 80–88. [CrossRef]
24. Osis, K.; Gaindspenkis, J. Modular personal knowledge management system and mobile technology cross-platform solution towards learning environment support. In Proceedings of the Annual International Conference on Virtual and Augmented Reality in Education (VARE), Valmiera, Latvia, 18 March 2011; pp. 114–124.
25. Kahle, D. Designing open educational technology. In *Opening up Education*; Iiyoshi, T., Kumar, M.S.V., Eds.; MIT Press: Cambridge, MA, USA, 2009; pp. 27–46.
26. Simon, H.A. Designing organizations for an information-rich world. In *Computers, Communication, and the Public Interest*; Greenberger, M., Ed.; Johns Hopkins Press: Baltimore, MD, USA, 1971.
27. Nonaka, I.; Takeuchi, H. *The Knowledge-Creating Company*; Oxford University Press: Oxford, UK, 1995.
28. Nonaka, I.; Toyama, R.; Konno, N. SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Plan.* **2000**, *33*, 5–34. [CrossRef]
29. Pollard, D. PKM: A bottom-up approach to knowledge management. In *Knowledge Management in Practice: Connections and Context*; Srikantaiah, T., Koenig, M., Eds.; Information Today: Medford, NJ, USA, 2008; pp. 95–109.
30. Nielsen, M. *Reinventing Discovery—The New Era of Networked Science*; Princeton University Press: Princeton, NJ, USA, 2011.
31. Cantner, U.; Vannuccini, S. A new view of general purpose technologies. In *Jena Economic Research Papers*; No. 2012,054; Leibniz Information Centre for Economics: Jena, Germany, 2012. Available online: http://hdl.handle.net/10419/70135 (accessed on 9 March 2018).
32. Helbing, D. What the digital revolution means for us. In *Thinking Ahead-Essays on Big Data, Digital Revolution, and Participatory Market Society*; Springer: Berlin, Germany, 2015; pp. 177–187.
33. Levy, P. *The Semantic Sphere 1*; Wiley: Croyden, UK, 2011.
34. Giebel, M. Digital Divide, Knowledge and Innovations. *J. Inf. Inf. Technol. Organ.* **2013**, *8*, 1–24.
35. Popper, K. *Objective Knowledge—An Evolutionary Approach*; Oxford University Press: Oxford, UK, 1972.
36. Popper, K. *Three Worlds. The Tanner Lecture on Human Values*; University of Michigan: Ann Arbor, MI, USA, 1978; pp. 143–167.
37. Kameoka, A.; Wierzbicki, P.A. A Vision of New Era of Knowledge Civilization. In Proceedings of the 1st World Congress of IFSR, Kobe, Japan, 14–17 November 2005.
38. Beinhocker, E.D. *The Origin of Wealth*; Harvard Business Press: Boston, MA, USA, 2006.
39. Nakamori, Y. Knowledge Science—Modeling the Knowledge Creation Process. In Proceedings of the 55th Annual Meeting of the ISSS 2011, Hull, UK, 17–22 July 2011.
40. Briscoe, G. Complex adaptive digital ecosystems. In Proceedings of the International Conference on Management of Emergent Digital EcoSystems, Bangkok, Thailand, 26 October 2010; ACM: New York, NY, USA, 2010; pp. 39–46.
41. Gibson, J.J. *The Ecological Approach to Visual Perception*; Lawrence Erlbaum Associates Inc.: Hillsdale, NJ, USA, 1979.
42. Kanengisser, D. How ideas change and how they change institutions: A memetic theoretical framework. Presented at the 2014 Annual Meeting of the American Political Science Association, Washington, DC, USA, 28–31 August 2014.
43. Gratton, L. *The Shift—The Future of Work Is Already Here*; HarperCollins: London, UK, 2011.
44. Blass, E.; Hayward, P. Innovation in higher education: Will there be a role for 'the academe/university' in 2025? *Eur. J. Futures Res.* **2014**, *2*, 1–9. [CrossRef]
45. Bowles, J. *The Computerisation of European Jobs—Who Will Win and Who Will Lose from the Impact of New Technology onto Old Areas of Employment?* Bruegel: Brussels, Belgium, 17 July 2014. Available online: http://www.bruegel.org/nc/blog/detail/article/1394-the-computerisation-of-european-jobs/ (accessed on 9 March 2018).

46. Frey, C.B.; Osborne, M.A. *The Future of Employment: How Susceptible Are Jobs to Computerisation?* Oxford Martin: Oxford, UK, 2013.
47. Davidson, C.N. So last century. *Times Higher Education*, 28 April 2011.
48. Ranga, M.; Etzkowitz, H. Triple Helix systems: An analytical framework for innovation policy and practice in the Knowledge Society. *Ind. High. Educ.* **2013**, *27*, 237–262. [CrossRef]
49. Schmitt, U. Supporting the Sustainable Growth of SMEs with Content- and Collaboration-based Personal Knowledge Management Systems. *J. Entrep. Innov. Emerg. Econ. (JEIEE)* **2018**, *4*, 1–21. [CrossRef]
50. Koltko-Rivera, M.E. Rediscovering the later version of Maslow's hierarchy of needs: Self-transcendence and opportunities for theory, research, and unification. *Rev. Gen. Psychol.* **2006**, *10*, 302. [CrossRef]
51. Johri, A.; Pal, J. Capable and convivial design (CCD): A framework for designing ICT for human development. *Inform. Technol. Dev.* **2012**, *18*, 61–75. [CrossRef]
52. Herzberg, F. One more time: How do you motivate employees? *Harvard Business Review*, September–October 1987, pp. 109–120. Available online: https://pdfs.semanticscholar.org/ca2a/a2ae02ac5b738b55b12b7324fac59571b1c1.pdf (accessed on 9 March 2018).
53. Kano, N.; Seraku, N.; Takahashi, F.; Tsuji, S. Attractive quality and must be quality. *Quality* **1984**, *14*, 39–48.
54. Schmitt, U. Personal knowledge management for development (PKM4D) framework and its application for people empowerment. *Procedia Comput. Sci.* **2016**, *99*, 64–78. [CrossRef]
55. Bourdieu, P.; Wacquant, L.J.D. *An Invitation to Reflexive Sociology*; University of Chicago Press: Chicago, IL, USA, 1992.
56. Cabitza, F.; Simone, C.; Cornetta, D. Sensitizing concepts for the next community-oriented technologies: Shifting focus from social networking to convivial artifacts. *J. Commun. Inform.* **2015**, *11*. Available online: http://www.ci-journal.net/index.php/ciej/article/view/1155 (accessed on 9 March 2018).
57. Economist. Higher education—Not what it used to be. *Economist*, 1 December 2012.
58. Economist. Online college courses. Outsourcing education. *Economist*, 27 May 2013.
59. Darwazeh, A.N. A Rationale for Revising Bloom's [Revised] Taxonomy. Available online: http://www.tresystems.com/proceedings/documents/2016_lasvegas_volume2.pdf#page=49 (accessed on 9 March 2018).
60. Sarooghi, H.; Libaers, D.; Burkemper, A. Examining the relationship between creativity and innovation: A meta-analysis of organizational, cultural, and environmental factors. *J. Bus. Ventur.* **2015**, *30*, 714–731. [CrossRef]
61. Sandberg, A. Memetics. 2000. Available online: http://www.aleph.se/Trans/Cultural/Memetics/ (accessed on 9 March 2018).
62. Dawkins, R. *The Selfish Gene (30th Anniversary Edition)*; Oxford University Press: Oxford, UK, 2006.
63. Gill, T.G.; Murphy, W. Task complexity and design science. In Proceedings of the 9th International Conference on Education and Information Systems, Technologies and Applications (EISTA), Orlando, FL, USA, 19–22 July 2011.
64. Kruger, J.; Dunning, D. Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Psychology* **2009**, *1*, 30–46. [CrossRef]
65. Magnani, L.; Arfini, S.; Bertolotti, T. An argument for ignorance-based chance discovery. *Int. J. Adv. Intell. Paradig.* **2016**, *8*, 327–342. [CrossRef]
66. Kerwin, A. None too solid medical ignorance. *Sci. Commun.* **1993**, *15*, 166–185.
67. Armour, P.G. The five orders of ignorance. *Commun. ACM* **2000**, *43*, 17–20. [CrossRef]
68. Gill, T.G. When what is useful is not necessarily true: The underappreciated conceptual scheme. *Informing Sci. Int. J. Emerg. Transdiscipl.* **2011**, *14*, 1–32. [CrossRef]
69. Shifman, L. Memes in a digital world: Reconciling with a conceptual troublemaker. *J. Comput. Med. Commun.* **2013**, *18*, 362–377. [CrossRef]
70. Dalkir, K. *Knowledge Management in Theory and Practice*; Butterworth-Heinemann: Burlington, MA, USA, 2005.
71. Hughes, J. *On the Origin of Tepees*; Free Press: Oxford, UK, 2011.
72. United Nations. *Understanding Knowledge Societies*; United Nations Publications: New York, NY, USA, 2005.
73. Date, C.J. *An Introduction to Database Systems*; Pearson Education India: Delhi, India, 2006.
74. Mynatt, E.D.; O'Day, V.L.; Adler, A.; Ito, M. Network communities: Something old, something new, something borrowed. *Comput. Support. Coop. Work (CSCW)* **1998**, *7*, 123–156. [CrossRef]
75. Drori, G.S. Globalization and Technology Divides: Bifurcation of Policy between the "Digital Divide" and the "Innovation Divide". *Sociol. Inq.* **2010**, *80*, 63–91. [CrossRef]

76. Stibel, J.M. *Wired for Thought*; Harvard Business Press: Boston, MA, USA, 2009.
77. Shelf, D. Playboy Interview: Google Guys [Sergey Brin and Larry Page]. *Playboy*, September 2004.
78. Weinberger, D. *Too Big to Know*; Basic Books: New York, NY, USA, 2012.
79. Washington Post. 'Post-Truth' Named 2016 Word of the Year by Oxford Dictionaries. *The Washington Post*, 16 November 2016. Available online: https://www.washingtonpost.com/news/the-fix/wp/2016/11/16/post-truth-named-2016-word-of-the-year-by-oxford-dictionaries/?utm_term=.b5053b945e5755 (accessed on 9 March 2018).
80. Signer, B. What is wrong with digital documents? A conceptual model for structural cross-media content composition and reuse. In *Lecture Notes in Computer Science, Proceedings of the Conceptual Modeling–ER 2010, Vancouver, BC, Canada, 1–4 November 2010*; Springer: Berlin/Heidelberg, Germany, 2010; pp. 391–404.
81. Wilson, T.D. The nonsense of 'knowledge management'. *Inf. Res.* **2002**, *8*. Available online: http://www.informationr.net/ir/8-1/paper144.html (accessed on 9 March 2018).
82. Bernstein, J.H. Transdisciplinarity: A review of its origins, development, and current issues. *J. Res. Pract.* **2015**, *11*, R1.
83. Bernstein, J.H. Disciplinarity and transdisciplinarity in the study of knowledge. *Informing Sci. Int. J. Emerg. Transdiscipl.* **2014**, *17*, 241–273. [CrossRef]
84. Pinheiro, F.A.C. *Requirements Traceability*; Springer: Berlin, Germany, 2014.
85. Mintzberg, H. Developing theory about the development of theory. In *Great Minds in Management*; Smith, K.G., Hitt, M.A., Eds.; Oxford University Press: New York, NY, USA, 2005; pp. 355–372.
86. Schmitt, U. Mapping the territory for a knowledge-based system. In *Lecture Notes in Computer Science, Proceedings of the Computational Collective Intelligence (ICCCI 2017), Nicosia, Cyprus, 27–29 September 2017*; Nguyen, N., Papadopoulos, G., Jędrzejowicz, P., Trawiński, B., Vossen, G., Eds.; Springer: Cham, Switzerland, 2017; Volume 10448. [CrossRef]
87. Mostert, M. *Systemic Leadership Learning*; Knowres Publishing: Bryanston, South Africa, 2013.
88. Garon, J.M. Mortgaging the Memo: Financing and Managing Disruptive Innovation. *Northwest. J. Technol. Intellect. Prop.* **2012**, *10*, 441–483.
89. Usher, A.P. *A History of Mechanical Inventions*; Courier Corporation: Cambridge, MA, USA, 1954.
90. Usher, A.P. *A History of Mechanical Inventions (Revised Edition)*; Courier Corporation: North Chelmsford, MA, USA, 2013.
91. Peschl, M.F.; Fundneider, T. Theory-U and emergent innovation. Presencing as a method of bringing forth profoundly new knowledge and realities. In *Perspectives on Theory U: Insights from the Field*; Gunnlaugson, O., Baron, C., Cayer, M., Eds.; Business Science Reference/IGI Global: Hershey, PA, USA, 2013; pp. 207–233. Available online: https://mpra.ub.uni-muenchen.de/66538/1/MPRA_paper_66538.pdf (accessed on 9 March 2018).