Although many powerful applications are able to locate vast amounts of digital information, effective tools for selecting, structuring, personalizing, and making sense of the digital resources available to us are lacking. As a result, the opportunities to connect and empower knowledge workers are severely limited. Thus, recent suggestions urge advancing Personal Knowledge Management (PKM) to provide the overdue support tools for individuals in the envisaged Knowledge Societies. After proposing a PKM for Development (PKM4D) framework, this paper follows up by focusing on the empowerment of the individual in the light of PKM learning cycles and by extending the ignorance matrix in the context of ‘Big Data and Extelligence’. The resulting PKM for Empowerment (PKM4E) framework is a further spin-off of design science research aiming for developing a novel PKM concept/system.

1. **Design Science Research for advancing Personal Knowledge Management Capacities**

A prior ICKM article (Schmitt, 2016h) motivates a novel Personal Knowledge Management for Development (PKM4D) framework to assess and address 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). Its differentiation into six digital ecosystems and twelve criteria have also informed a follow-up article focusing on the overarching Personal Knowledge Management (PKM) concept and the affordances the PKM System-in-Progress (PKMS) is expected to offer to its beneficiaries by extending prior findings concerned with network communities, collaboration and social knowledge sharing (Schmitt, 2017d).

The findings form part of an ongoing Design Science Research (DSR) project aiming to introduce a novel generation of Knowledge Management Systems (KMS) for empowering individuals and self-organized groups. To assure ‘Theory Effectiveness’, the PKMS prototype development has been accompanied by multi-disciplinary publications and presentations (see reference section). With the ICKM2017’s emphasis on the challenges and opportunities of Big Data, this paper will expand on the relevant notions concerning the individual knowledge worker to propose a PKM for Empowerment (PKM4E) Framework.

2. **Managing Attention amidst the Datafication of Knowledge into ‘Big Data/Information’**

Human evolution has not only thrived on big brain memory and communication technology with a high degree of accuracy, but also on an insatiable urge to use this technology for the purpose intended (Hughes, 2011). Just recently, the familiar problem of information scarcity (few sources/channels, high associated costs) has been transformed into a never before experienced ever-increasing abundance of information and ‘Big Data’. Definitions of the latter can be differentiated based on a multi-disciplinary synthesis (sciences, humanities, policy, and trade literature) as follows: (i) product-oriented with a quantitative focus on data size, speed, structure, and/or composition; (ii) process-oriented with a focus on the processes involved in data search, collection, analysis, aggregation, storage, curation, and/or use; (iii) cognition-oriented with a focus on the way human beings, with their particular cognitive capacities and limitations, can relate to data; and (iv) social-movement-oriented considerations with a focus on utopian visions of what can be done and accomplished (Ekbia et al., 2015).

Even though the term ‘Big Data’ only gained currency after digital data volumes rose to the exabyte level (total analog and digital distribution rose from 2.6 Petabytes with 1%
digital content in 1986 to 0.3 Exabytes with 94% digital content in 2007 (Hilbert, 2014), many of the associated epistemological, methodological, aesthetic, technological, legal and ethical dilemmas originated much earlier but are now accelerating in scope, scale, and complexity - including issues of accessibility, interpretability, comprehension, and overload (Ekbia et al., 2015). Simon (1971), for example, pointed out way ahead of the digital revolution that the “wealth of information creates a poverty of attention” and, hence, that “progress does not lie in the direction of reading information faster, writing it faster, and storing more of it” but “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”.

While the traditional book-design seeks to contain all relevant information required within the book’s topic to stop inquiries, the scaling of the web with its searchability tools have afforded users to easily publish and freely connect with other people and ideas. Any part of any content can be disseminated unlimited times and does not necessarily stay unchanged as previously ensured by the physics of paper (making the web vulnerable as a storage device). As a result, the ever-increasing abundance confronting us contains rising stakes of entropy: massive duplications of original content (redundancy), partial (fragmentations) or erroneous (inconsistencies) replications or deletions of records, non-disclosure or subsequent erasure of sources (untraceabilities), unsuitable alterations of content (corruptions), lacking curation and maintenance (decay), as well as outdated (obsolescence) and falsified statements (fake facts) (Schmitt, 2016j).

This trend of depleting the very attention our cognitive capabilities are able to master is, in the eyes of the author, contributing more and more to individual and collective opportunity divides and, thus, unsustainable development. It is further aggravated by the ‘reverse engineering’ of extelligence2 and knowledge. Traditionally, knowledge is depicted as the third level in the DIKW-Hierarchy or the fourth step in the 7-step knowledge ladder (North, Brandner, and Steininger, 2016); in the age of ‘Big Data’, however, a case can be made that this strict differentiation no longer holds since the digitizing and datafying of content transform existing extelligence and knowledge into sets of ‘Big Data and/or Information’ (as in the case of Google books or the Semantic Web) ready to be analyzed for patterns and correlations (Mai, 2016).

To address the issue of entropies, the novel PKMS approach discontinues traditional practices by deviating from Organizational KM systems in four major ways (summarized as Personal, Bottom-up, Meme, and Creative Conversation Focus) and has been presented as a concretized subset of Popper’s abstract World Three (Schmitt, 2016j; Popper, 1972, 1978), as a partially populated archive of the imaginary ‘Library of Babel’ (Schmitt, 2015i; Dennett, 1995; Borges, 1941), as an addition to Earl’s Seven Schools of KM (Schmitt, 2016d; Earl, 2001), as the potential Next KM System Generation (Schmitt, 2015f; Pasher and Ronen, 2011; Levy, 2011), as the inception of Bush’s envisioned ‘Memex’ (Schmitt, 2017e; Bush, 1945; Davies, 2011), and as General-Purpose-Technology and Disruptive Innovation (Schmitt, 2015h, 2016g).

All these characterizations acknowledge the PKMS’s shedding of current document-centric storage practices in favor of the digital re-use of captured unique basic information units (ideas, memes, or business genes (Schmitt, 2016a)) and their embedding in digital knowledge assets and documents via structural references (Signer, 2012; Schmitt, 2014d). It ensures that any one container (e.g. book, paper, report, file, message, or e-learning module) is just one of the many possible constructs for combining knowledge assets (defined “as nonphysical claims to future value or benefits” (Dalkir, 2005)), and that any one knowledge asset is just one of the many possible constructs for combining memes and memeplexes and their modified versions in time and space. It also reinforces ‘personaland-innovation-centered’ methodologies such as Usher’s (2013) concept of ‘Cumulative

2 The term ‘Extelligence’ refers to externally stored information; it represents the cumulative archive of human cultural experience and know-how accessible and augmentable by any individual who knows how. ‘Extelligence’ forms the external counterpart to the intelligence of the human brain/mind and deals in information whereas ‘Intelligence’ deals in understanding; together they are driving each other in a complicit process of accelerating interactive co-evolution (Stewart and Cohen, 1999).
Synthesis’, Bush’s (1945) notion of ‘Associative Indexing’, Levy’s (2011) scenarios of a ‘Decentralizing KM Revolution’ and ‘Creative Conversations’, as well as Wiig’s (2011) assertion that the viability of enterprises and societies result from the organizational and departmental aggregation of innumerable small ‘nano’ actions by individuals.

One of the desirable outcomes is ‘Traceability’: The PKMS views explicit knowledge 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. As the back-bone of modern manufacturing, this feature 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. The resulting affordances lead to the invigorating of digital scholarship, individual and institutional curation, and the transdisciplinary capturing and traceability of knowledge. Accordingly, the PKMS offers - together with the other affordances (Schmitt, 2017d) - appealing opportunities for a wide range of stakeholders engaged in the context of curation (Schmitt, 2015c; 2015i), education (Schmitt and Butchart, 2014; Schmitt, 2016f, Schmitt and Saade, 2017), research (Schmitt, 2015g; 2015h), profession (Schmitt, 2015f; 2016d, 2017a), development (Schmitt, 2014k, 2016h), and entrepreneurship (Schmitt, 2016k, 2017f).

Figure 1 shows at its center the main components of the PKM Systems: (1) the decentralized autonomous devices (Knowcations®), (2) the shared cloud-based repository (Whomer™), (3) an e-Learning Campus (Knowcating™), and (4) the PKM community. Their motivations and objectives have been put forward in the PKM4D framework (left), the meta-concept for approaching a solution3 (top) has been thoroughly interrogated (as briefly recapitulated in this section), and the system design together with its environment (right) has been explicated and visualized together with other renowned KM Methodologies (Schmitt, 2017g) in a three-dimensional Information Space (Boisot, 2004). A Grass-Roots View (bottom) from the perspective of individual knowledge workers is about to be added by this paper as the PKM for Empowerment (PKM4E) framework.

![Fig. 1. PKM4E Framework complementing other Narratives and Visualizations of the PKM Concept/System.](image-url)

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3 The complexities for devising a PKM solutions constitute a ‘wicked’ problem (ill-defined; incomplete, contradictory, changing requirements; complex interdependencies) where the information needed to understand the challenges depends upon one’s idea or concept for solving them (Rylander, 2009).
3. PKMS Concept and Devices from the Perspective of Knowledge Workers

A knowledge worker experiences the PKMS as a centralized ‘World Heritage of Memes Repository (WHOMER)’ which links to and assists his/her grass-roots, decentralized, networked, personal KMS device. Its aim is to offer overdue support for (1) Managing/growing his/her Intellectual, Social, and Emotional Capital, (2) Supporting Creative Authorship throughout his/her academic and professional careers anywhere - and in his/her capacity as contributor and beneficiary of institutional and societal performance, educational services, and the world’s collective extelligence, (3) Fostering his/her Creative Conversations among teams, organizations, and communities for mutual benefit and competitive advantage via network and cloud technologies. As such, it not only allows building upon knowledge already acquired but also holding on to one’s personal KMS device as one moves from one project or responsibility to the next, and to further one’s capability to self-develop/actualize as an essential prerequisite of personal autonomy and sovereignty. As an enabling driver of Knowledge Societies, it also supports leadership through effective stewardship of one’s own and one’s mentees’ careers, capabilities, values, and capitals.

In this context, the rationale for introducing the PKM4E Framework is to provide transparency on how individual knowledge workers can be better informed and equipped to cope with the accelerating growth of attention-consuming ‘Bigger Extelligence and Knowledge’ alluded to (Schmitt, 2013f, 2014c). In terms of the educational aims of the PKM concept (Schmitt and Saade, 2017), the PKM4E Framework provides an applied grass-roots’ view to complement the three other narratives and their visualizations (fig. 1).

3.1 The ‘Ignorance Matrix’ as the Root of the PKM4E Framework

The root of the PKM4E Framework is the notion of the ‘Ignorance Matrix’ (Kerwin, 1993; Armour, 2000; Schamanek, 2012; UAHSC, 2012), which had been extended in an earlier short paper (Schmitt, 2013e). Figure 2 presents a substantially revised version with related learning cycles and predicaments. While the left side presents relevant external knowledge areas, the personal knowledge clusters (placed on the background of a head) are shown on the right side consisting of:

- **Explicit, Codified, Accessible Knowledge**: The ‘known knowns/knowers (kks)’ resemble all our explicit or formal knowledge as well as the social relations we know we know or have access to; they form the base we are operating from at any given time and are complemented by the ‘known unknowns (kus)’ covering things we know we do not know; these are personal knowledge gaps in need of being addressed, but also involve knowledge avenues briefly explored but found to be futile.

- **Tacit, Conscious, Accessible Knowledge**: The same two categories apply but need to be further differentiated according to their ‘Explicability’. While ‘kus’ can usually be addressed via learning (explicable) or imitation (inexplicable), ‘kks’ can be identified by conscious stocktaking (explicable) or relying on observers’ feedback (inexplicable).

- **Tacit, Unconscious, Accessible Knowledge**: ‘Unknown knowns/knowers (uks)’ need to be extracted by knowledge engineers or peers via interviews or tests (explicable) or via black-box (input-output/cause-effect) analysis (inexplicable).

- **Accessible Ignorance**: The desirable clusters above are complemented by personal ignorances in the form of ‘known “false” knowns (kfks)’ (things we think we know but do not, as, for example, errors, wrong assumptions, outdated or obsolete information) as well as ‘known denials & taboos’ including things or people not supposed to know, things better not to know or being denied to have taken place, or things too painful to know/own up to.

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4 Gurteen (2006) places - rather than the socio-economic criteria of an individual’s type of work as in Florida’s (2012) Creative Class - the virtue of responsibility at the center of his reflections: “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. No one tells them what to do. They do not take ‘no’ for an answer. They are self-motivated”, “take responsibility for their work and drive improvement”.
3.2 The Significance of Personal Learning Cycles (PLC)

The Personal Learning Cycles (PLC) depicted in figure 2 and summarized in table 1 include (1U) unconscious experiential learning by imitation to create implicit or tacit knowledge and (2C) its potential subsequent internalization. Alternatively, they involve (3C) taking stock of personally accessible artefacts and people, (4C) personal explicit information and knowledge, (5C) as well as knowledge gaps, (6C) triggering conscious learning to fill these gaps, resulting in (7E) additional personal explicit knowledge. Subsequently, some of the applied ‘known knowns’ might become ‘second nature’ to (8U) unconsciously lead to further personal tacit knowledge.

In a dynamic environment, continuous progress and changes take place and newer knowledge adds to or substitutes for older knowledge rendering some of our own ‘knowns’ obsolete. Accordingly, we are in need of keeping our intellectual, social, and emotional capital in a continuous mode of maintenance by monitoring our environment and being guided. This enables us, when needed, to take deliberate corrective action via (9D) de-learning and (1U-8U) new learning.

3.3 Personal Knowledge Management Challenges, Predicaments, and Wastes

Additional to the personal learning cycles discussed, figure 2 and table 2 also distinguish and visualize predicaments and wastes. In the PKMS context, they manifest themselves in the form of missed opportunities or losses (time, money, status) or negatively impacted relationships and well-being.

Table 1: Summary and Legend of PKMS’s Personal Learning Cycles (PLC) as depicted in Figure 2

<table>
<thead>
<tr>
<th>PLC</th>
<th>Description of PLCs</th>
<th>Transforming from</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>1U</td>
<td>Unconscious learning by imitation (others’ knowns)</td>
<td>Tacit&lt;sup&gt;U&lt;/sup&gt;</td>
<td>Tacit u&lt;sup&gt;U&lt;/sup&gt;</td>
</tr>
<tr>
<td>2C</td>
<td>Transformation of tacit into conscious tacit or implicit knowledge (through learning/understanding/sharing/articulating/explaining)</td>
<td>Tacit&lt;sup&gt;C&lt;/sup&gt; or Tacit u&lt;sup&gt;C&lt;/sup&gt;</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>3C</td>
<td>Taking stock of personally accessible artefacts and people</td>
<td>Hosts&lt;sup&gt;C&lt;/sup&gt; or Artefacts&lt;sup&gt;C&lt;/sup&gt;</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>4C</td>
<td>Being aware of one’s personal explicit information &amp; knowledge</td>
<td>Explicit&lt;sup&gt;P&lt;/sup&gt;</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>5C</td>
<td>Deliberate analysis of knowledge gaps</td>
<td>Ignorance&lt;sup&gt;P&lt;/sup&gt;</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>6C</td>
<td>Conscious learning to fill known knowledge gaps</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>7E</td>
<td>Transformation of implicit/explicable into explicit knowledge</td>
<td>Tacit Explicable c&lt;sup&gt;P&lt;/sup&gt;</td>
<td>Explicit c&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>8U</td>
<td>Applied Knowledge becomes ‘second nature’ and tacit knowledge</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt;</td>
<td>Tacit u&lt;sup&gt;P&lt;/sup&gt;</td>
</tr>
<tr>
<td>9D</td>
<td>De-Learning of obsolete knowledge and new learning</td>
<td>Tacit c&lt;sup&gt;P&lt;/sup&gt; or Explicit c&lt;sup&gt;P&lt;/sup&gt;</td>
<td>out</td>
</tr>
</tbody>
</table>

Legend: (u)nconscious (c)onscious (H)osts (V)ectors (P)ersonal (I)gnorance

Table 2: Summary and Legend of PKMS’s Predicaments and Wastes as depicted in Figure 2

<table>
<thead>
<tr>
<th>#</th>
<th>Feature (6As)</th>
<th>K#</th>
<th>The Commons of the Knowns</th>
<th>U#</th>
<th>The Commons of the Unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Awareness</td>
<td>K1</td>
<td>Unaware of unconscious tacit knowledge</td>
<td>U1</td>
<td>Unaware of KM processes or methods and knowledge gaps</td>
</tr>
<tr>
<td>2</td>
<td>Articulation and Explicability</td>
<td>K2</td>
<td>Non-explicable tacit knowledge and lacking persuasiveness</td>
<td>U2</td>
<td>Unable to differentiate between ‘Knowables’ &amp; ‘Unknowables’</td>
</tr>
<tr>
<td>3</td>
<td>Accessibility and Recall</td>
<td>K3</td>
<td>Loss of Knowledge</td>
<td>U3</td>
<td>Available but inaccessible trails &amp; ‘knowables’</td>
</tr>
<tr>
<td>4</td>
<td>Accuracy and Trustworthiness</td>
<td>K4</td>
<td>Unaware of knowledge based on denials or superstition</td>
<td>U4</td>
<td>Unaware of false knowledge and/or untrustworthy sources</td>
</tr>
<tr>
<td>5</td>
<td>Authenticity/Validity</td>
<td>K5</td>
<td>Expired knowledge</td>
<td>U5</td>
<td>Obsolete or expired knowledge</td>
</tr>
<tr>
<td>6</td>
<td>Attentiveness/Grasp</td>
<td>K6</td>
<td>Memory slips, incomplete recall</td>
<td>U6</td>
<td>Knowledge redundancies and entropy</td>
</tr>
</tbody>
</table>
Figure 2: PKMS Ignorance Matrix with Personal Learning Cycles and Fallacies/Wastes (incorporating Kerwin, 1993; Armour, 2000; Schamanek, 2012; UAHSC. (2012)
The Commons of the Knowns

- **K1. Missed opportunities due to unconscious unconsciousness:** Nonaka’s SECI Loop Model promotes the externalizing of implicit or tacit knowledge in an organizational context for subsequent combination, internalization, and socialization (Nonaka et al., 2000). In the PKM’s individualized context, being unaware of one’s implicit or tacit knowledge is potentially being ignorant of one’s personal strengths or weaknesses and their relevance for personal progress and/or improvement.

- **K2. Non-explainable tacit knowledge:** By converting tacit knowledge into a tangible, explicit form [using words, numbers, and symbols], it can be communicated much more widely, with less cost, and persistent over time. But, to demonstrate high skill levels of codification and authorship, a knowledge worker has to meet the required quality encompassing accuracy, readability/understandability, accessibility, currency, and authority/credibility (Dalkir, 2005).

- **K3. Known former knowns, unknowns, or knowers:** To keep up and remain à-jour, notes, contact details, and copies are taken and stored in diverse arrays of devices. Over time, memories fade, copies deteriorate, and with it the ability to recall the locations and contents of our fragmented personal knowledge inventories and archives. Nevertheless, we are unable to part with our accumulated hard and soft copies which slowly but steadily drift from potential value towards dead ballast. To a degree we are also aware of our ignorances; we might have made plans to address them or have taken deliberate decisions to accept them since expense and time exceed the perceived benefit of investing in that knowledge at particular points in time (e.g. a source considered not to be useful for a current project). Accordingly, this category includes things and contacts we know we once knew, were aware of, or had access to, but access opportunities ceased due to loss, misplacement, contractual limitations, insufficient maintenance/care, or lost trust/confidence.

- **K4. Known denials & taboos:** At times, we also might deliberately deny knowing, because we are not supposed to (taboos, faith, secrets) or we want to avoid accountability and potential retributions. Theses fallacies also include the psychological suppression of realities to evade distress and pain caused, for example, by traumatic events/experiences or escapes from reality.

- **K5. Known “false” knowns:** Individual erroneous beliefs, assumptions, and judgements as well as outdated know-how can represent a formidable barrier to personal and collective progress and achievement. This type of ignorance does not only stem from inadequate instruction and role models, but also from a lack of constant maintenance of our intellectual, social, and emotional capitals which can push this category up to unacceptable levels. In “The Half-Life of Facts”, Arbesman (2012) has singled out the underlying causes, naming them preferential attachments, phase transitions (tipping points), decline effects, publication and taxonomic bias, shifting baseline syndromes, factual inertia, and change blindness. These misconceptions include all the instances where we are mistakenly thinking that we are right due to errors, wrong assumptions, or outdatedness.

- **K6. Formerly known knowns, unknowns, or knowers:** Forgetfulness and bad memory cause our non-obsolete knowledge to deteriorate, but even if we do remember, limited access to or loss and misplacement of records might still prevent a total recall. Hence, time and effort need to be re-spent to regain the status of knowledge we once commanded. The category covers things and people we forgot we know, forgot we are aware of or forgot we can access due to forgetfulness, memory loss, or dementia.

The Commons of the Unknowns

- **U1. Stagnation due to lacking Means/Tools to tackle unknown Unknowns:** In surroundings of ever-increasing ‘unknown unknowns’ and expectations of tackling increasingly complex problem spaces, individuals feel the pressure to engage in wider or unfamiliar contexts of often multi-disciplinary nature in order to widen their horizons. Hence, this predicament refers to the lack of process knowledge (Armour, 2000) and suitably efficient means to become aware of relevant ‘unknown unknowns’ and how to confront them (management of learning at the meta-level). In our context, this need of
process knowledge literacy (to which this paper contributes) applies to all categories of the ignorance matrix. Lack of it considerably inhibits Personal Learning Cycles and their aim to keep à-jour, to intentionally move things from "unknown" to "known" as well as to avoid involuntarily letting things slip from "known" to "unknown" categories. If relevant content to fill knowledge gaps is available, it first is screened and sorted via perceptual filters and then classified and interpreted via conceptual filters to give it relevance and purpose, all guided by the knowledge worker’ prior knowledge, preferences and feelings (Boisot, 2004). By putting information into context, giving it meaning, and integrating it into one’s frames of references, it turns into personally accessible and potentially actionable knowledge of an individual who might be able to demonstrate it as expertise while persistently advancing his/her judgment and intuition leading to wisdom. However, Kruger and Dunning (2009, p. 30) note that 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”. The study results concur with the saying: “Not ignorance, but ignorance of ignorance, is the death of knowledge”.

- **U2. Inefficiencies due to lacking Validation of ‘unknown unknowns’**: In addressing gaps, any ‘unknown unknowns’ have to be critically examined, if they can be categorized as ‘Knowables’ (we might not know but others do) or ‘Unknowables’ either temporary (nobody knows yet) or permanently (nobody will ever know). Snowden’s Cynefin Model (2002) shows that the distinction is of particular relevance when systems or decision-making contexts change from simple and complicated to complex and chaotic.

- **U3. Available but currently inaccessible trails and ‘knowables’**: The PKMS, as alluded to, deviates from the document-centric KM systems and is based on the capturing, storing, and re-purposing of basic information structures (memes or ideas) and their relationships (to create information-richer knowledge assets and other archetypal reconstructions thereof) rather than storing and referencing them the conventional way in their containers only (e.g. book, paper, report) (Schmitt, 2014d; 2016a). In his imaginary ‘Memex’, Bush (1945) refers to this approach as ‘associative indexing’ and foresees that as an added benefit of capturing the currently relinquished trails (which can be voluntarily shared by the author), “the inheritance from the master becomes, not only his additions to the world’s record, but includes for his disciples the entire scaffolding by which they were erected”. The beauty of accumulating and curating this feature is the transgression of disciplinary boundaries and, thus, of minimizing the risk of creating ‘Undiscovered Public Knowledge (UPK)’. UPK literature argues “that within the voluminous expanse of scholarly literature as a whole, there exist pieces of knowledge that, if combined, would yield new and unexpected knowledge. […] Any advance in information science that facilitates the ability of researchers (or general users) to make new connections will thus enhance the rate of scholarly (and technical and other sorts of) advance. Yet we tend to evaluate information retrieval only in terms of whether users find what they look for. We should instead/also appreciate the value of alerting them to a range of related paths of exploration” (Szostak, Gnoli, López-Huertas, 2016).

- **U4. Unawareness of false knowledge and/or untrustworthy sources**: The bar of the associated challenges has been further raised 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” (Washington Post, 2016). As Weinberger (2012, p.12) noted: As the traditional physical filters and authorities lose their grip, “we can now see every idiotic idea put forward seriously and every serious idea treated idiotically”.

- **U5: Obsolete or expired knowledge**: Any web content - or copied fractions or distortions of it - can be disseminated unlimited times and is – if it becomes obsolete or is no longer valid - impossible to correct or mark as expired. Also, content does not necessarily stay unchanged as previously ensured by the physics of paper, making the web vulnerable as a storage device.
- **U6. Attention poverty due to massive obstructive redundancies in dealing with extelligence**: Today’s information abundance or overload - as it is experienced by many - is fed by high degrees of noise and trivial chatter as well as replicated, fragmented, misconstrued, and incomplete contents exaggerated by missing, broken, or pretentious web links or references. The advances in search engines are unable to keep pace and, hence, daunting, discouraging, and time-wasting necessities are taking over and weaken individuals’ productivity and advances. Accordingly, our limited time budgets and attention spans are preventing us from following any of the more fruitful learning cycles portrayed earlier.

A recent meta-study just concluded that the strongest association between creativity and innovation occurs not at the team but at the individual level: Firms ought to “identify, nurture, and effectively deploy ambidextrous individual researchers” to better support both, the exploitation and exploration of ideas (Sarooghi, Libaers, and Burkemper, 2015). These findings underpin Usher’s ‘Cumulative Synthesis’ approach (2013) as well as Wiig’s assertion that the viability of enterprises and societies result from the organizational and departmental aggregation of innumerable small ‘nano’ actions by individuals (Wiig, 2011).

With a PKM system, a user obtains the means to retain and build upon knowledge acquired as well as to track down knowledge shared by others for assimilation and to facilitate productive contributions and collaborations between fellow learners and professional acquaintances. His/her personal learning cycles are reinforced and the risks of the predicaments related to Knowns and Unknowns are minimized or avoided.

The novel PKMS approach merges distinctive voluntarily shared knowledge objects/assets of diverse disciplines into a single unified digital knowledge repository and provides the means for advancing current metrics and reputation system (Nielsen, 2011). The assets’ representations are based, as alluded to, on memes and on - as Bush (1945) put it - “an extensive mesh of associative multidisciplinary trails of alternative pathways”. In its shared unique state, every knowledge item becomes available for learning and personalized curation as well as reusable in new contexts. To enhance trans-disciplinary scholarship and communication, any meme being updated, invalidated, or recognized as out-of-date or fake can (as ancestor in an as-built genealogy) notify dependent (stored or prospective child) memes and their authors (U4/U5) utilizing the pathways captured. These features allow individuals and institutions to better focus their time and attention on exploiting their knowledge and/or its further exploration (Schmitt, 2016d).

### 4. Concluding Remarks and the Way ahead

In the context of human development, the author considers the over-abundance of information as the currently emerging, latest barrier to individual and collective development (Schmitt, 2014b). It can be expected that the prospective realities (Internet of Things, Semantic Technologies, Post-Truths) will further defeat the very attention our cognitive capabilities are able to master. Autonomous PKMS devices are able to make the crucial next difference by providing the overdue support tools for knowledge workers and by stimulating the logics and logistics of new knowledge formation. To prosper, these systems once they become available need to be adopted on a large scale to swiftly populate the cloud-based, no-SQL supported WHOMER knowledge base with new and existing (explicit) versions of what Popper (1978) termed world:3’s abstract objective knowledge.

The PKMS features provide the means to tackle the widening opportunity divides by affording individual knowledge workers with continuous life-long support from trainee, student, novice, or mentee towards professional, expert, mentor, or leader. They also add transparency and momentum to the digital asset production and value creation and, with it, to the evolution of knowledge at the personal, institutional, and societal level. In a co-evolutionary PKMS-OKMS context, the absorptive capacity, ambidexterity, and resulting dynamic capability of organizations can be strengthened considerably, not at the expense of disinterested employees but as a means to motivate them by serving their self-interests, an urgency only recently highlighted again in the context of ISO 9000 (Mittelmann, 2016).
Further publications and posters are under review or planned addressing a PKMS Sustainability Vision, demonstrations and tutorials/workshops, and how the PKMS concept compares to, can make use of and add to semantic web technologies. 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.

References
(The sequence of letters used to differentiate the author’s multiple publications in any year include gaps since some papers/articles are not referenced. The letter designations, however, are used consistently for referencing across all publications to better guide readers and, hence, have also not been revised in this article.)

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