



FROM IGNORANCE MAP TO INFORMING PKM4E FRAMEWORK: PERSONAL KNOWLEDGE MANAGEMENT FOR EMPOWERMENT

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ABSTRACT

Aim/Purpose	The proposed Personal Knowledge Management (PKM) for Empowerment (PKM4E) Framework expands on the notions of the Ignorance Map and Matrix to support the educational and informing concept of a PKM system-in-progress.
Background	The accelerating information abundance is depleting the very attention our cognitive capabilities are able to master, contributing to widening individual and collective opportunity divides. Support is urgently needed to benefit Knowledge Workers irrespective of space (developed/developing countries), time (study or career phase), discipline (natural or social science), or role (student, professional, leader).
Methodology	The Design Science Research (DSR) project conceptualizing the PKM System (PKMS) aims to support a scenario of a 'Decentralizing KM Revolution' giving more power and autonomy to individuals and self-organized groups.
Contribution	The informing-science-related approach synthesizes and visualizes concepts related to ignorance and entropy, learning and innovation, chance discovery and abduction to inform diverse audiences and potential beneficiaries.
Findings and Recommendation for Researchers	In substituting document-centric with meme-based knowledge bases, the 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 systems.
Recommendations for Practitioners	The PKM4E learning cycles and workflows apply 'cumulative synthesis', a concept which convincingly couples the activities of researchers and entrepreneurs and assists users to advance their capability endowments via applied learning.

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Impact on Society	The PKMS features provide the means to tackle the widening opportunity divides by affording knowledge workers with continuous life-long support from trainee, student, novice, or mentee towards professional, expert, mentor, or leader.
Future Research	After completing the test phase of the PKMS prototype, its transformation into a viable PKM system and cloud-based server based on a rapid development platform and a noSQL-database is estimated to take 12 months.
Keywords	personal knowledge management, knowledge management, knowledge society, knowledge worker, informing science, ignorance matrix, cumulative synthesis, chance discovery, abduction, memes, knowcations

MANAGING ATTENTION AMIDST KNOWLEDGE DATAFICATION

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). Consequently, the familiar problem of information scarcity (few sources/channels, high associated costs) has recently been transformed into a never before experienced ever-increasing information abundance (the 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)) giving rise to the prominence to ‘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 (Ekbja et al., 2015).

Even though the term ‘Big Data’ gained currency only after digital data volumes rose to the exabyte level, 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 (Ekbja 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”.

However, the scaling of the web with its searchability tools have afforded users to easily publish and unrestrictedly connect with other people and ideas (while the traditional book-design endeavors to contain all relevant information required within the book’s topic to lessen the need for further inquiries). Any part of any content can now 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).

Additionally, we are experiencing a ‘reverse engineering’ of extelligence (referring to externally stored information (Stewart & Cohen, 1999)) and knowledge. Traditionally, knowledge is depicted as the

third level in the traditional Data-Information-Knowledge-Wisdom (DIKW) Hierarchy (Rowley, 2007) or the fourth step in the 7-step Knowledge Ladder (North, Brandner, & Steininger, 2016); in the age of 'Big Data', however, a case can be made that this upward differentiation no longer holds since the digitizing and datafying of content transform existing extelligence and knowledge into sets of 'Big Data and/or Information' (exemplified by Word Clouds, Google Books, Semantic Web) ready to be analyzed for patterns and correlations (Mai, 2016).

The problem is that these trends are depleting the very attention our cognitive capabilities are able to master and are contributing increasingly to individual and collective opportunity divides. In the author's view, this accelerating information load and the lack of adequate tools (Kahle, 2009) pose the presently emerging most crucial barrier to individual and collective development and trigger the urgent need for a (personal) Knowledge Management (KM) Concept and System to support individual Knowledge Workers 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).

A current Design Science Research (DSR) project is aiming to conceptualize such a Knowledge Management Systems (KMS) (Schmitt, 2018b) in support of Levy's (2011) envisaged scenario of a 'Decentralizing KM Revolution' giving more power and autonomy to individuals and self-organized groups. Over the past five years a series of multi-disciplinary publications have disseminated evidence to report on the Personal Knowledge Management (PKM) concept's progress and to validate PKM System's (PKMS) design.

ARTICLE'S DESIGN SCIENCE RESEARCH GAP AND OBJECTIVE

The shortcomings of the KM's current status quo, briefly described in the previous section, has been further detailed in a wider context by employing the SVIDT methodology (Strengths, Vulnerability, and Intervention Assessment related to Digital Threats) (Schmitt, 2018b). This recent article argues that the proposed PKM concept and system substantially breaks with current KM paradigms and practices and, hence, rather qualifies as a disruptive than a sustaining technology. A prior related assessment has presented the PKMS furthermore as a potential General-Purpose-Technology (GPT) (Schmitt, 2016j). GPTs, in general, are characterized as exerting strong and lasting impacts in its own industry (improvement), on technical change and productivity growth across 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) (Cantner & Vannuccini, 2012).

The success of a PKMS-type digital innovation depends on its suitability for and its acceptability by a sufficiently large number of users in order to allow for network effects, an important characteristic of GPTs which apply to goods whose value increases at a geometric rate as more people possess and use them (Garon, 2012). In the PKMS context, these network effects are "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" (Schmitt, 2018b) by offering a range of superior affordances currently not catered for (Schmitt, 2017d).

For disruptive innovations to benefit from network effects requires them to motivate those stakeholders who can make the crucial difference (or switch from current technologies utilized) for making up and exceeding the critical mass necessary. Prior publications have adopted and adapted a multi-stage Appreciation Model (Mostert, 2013) to support such a scenario: "(1) a user just appreciates the idea of the PKMS (*aesthetic elegance creates curiosity*), (2) followed by recognizing a close match with his/her own views (*schematic resonance adds validity*), (3) and then with his/her own experiences and needs (*contextual relevance adds significance*). (4) The added value towards his/her own circumstances is realized (*opportunity based on utility*), (5) followed by making it a personal priority (*responsibility for advancement*), (6) with the final stage of successful implementation and utilization (*enactment*). (7) To keep

utilizing, the added values generated for the user will have to significantly outstrip the user's perceived inconveniences due to time, effort, and self-discipline invested" (Schmitt, 2016h).

The problem is that, for the initial appreciation stages to be grasped, a potential PKMS user's state of mind already requires a certain level of perception and understanding. However, as Kruger and Dunning (2009) observed, 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". Their study results concur with the saying: "Not ignorance, but ignorance of ignorance, is the death of knowledge" (attributed to Alfred North Whitehead).

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. The research objective of this article is, hence, to (1) contribute to the levels of perception and understanding necessary to create self-awareness for the uninitiated (as described by Kruger & Dunning, 2009) as well as for potential influencers to contextualize the PKMS appreciation model and to render it meaningful, (2) identify and integrate relevant research findings, methodologies and practices accordingly, (3) further quality-assess/assure the PKMS concept and design in terms of '*Theory Effectiveness*', a DSR paradigm expecting designs to be purposeful – both in terms of utility (a matter of content) and communication (a question of presentation) to an audience (O'Raghallaigh, Sammon & Murphy, 2011).

The results are meant to serve educators, mentors, consultants, and leaders to support individuals in their self-development and/or guide appropriate interventions for transforming individual into organizational or societal performances. Using novel information technologies and their applications efficiently requires an understanding of their logic and smart operation (Bolisani & Bratianu, 2018). The PKMS design, hence, aims for a concept, functionalities, and interventions to be clearly understood and to be painlessly applied in practice (Schmitt, 2014f). The PKMS is, consequently, supported by a dedicated educational concept (Schmitt & Saade, 2017) which makes extensive use of the content already published and informs its further development. This article fills a vital gap in this educational endeavor.

DSR TO ADVANCE PERSONAL KNOWLEDGE MANAGEMENT

'*Knowcations*'[®], the name chosen for the PKM concept and system, 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. Backed by decentralized PKMS devices and a voluntarily shared cloud-based repository, it aims for (1) managing/growing the *intellectual, social, and emotional capitals* of individuals, (2) by supporting their *creative authorship* throughout their academic and professional careers anywhere as contributors and beneficiaries of *organizational and societal performance*, educational services, and the world's collective extelligence, (3) and by fostering *Creative Conversations* among teams, organizations, and communities for mutual benefit and competitive advantage via network and cloud technologies.

In this endeavor, the DSR paradigm of '*Theory Effectiveness*' is, as alluded to, of vital importance. For its assurance, the PKMS prototype development has been accompanied by publications focusing on the design decisions taken in logical (Schmitt, 2018b), chronological (Schmitt, 2016j), functional (Schmitt, 2015d, 2017d), developmental (Schmitt, 2016h), and educational (Schmitt, 2017g; Schmitt & Saade, 2017) terms. One of these articles also comprehensively presents further DSR-related PKM aspects as evidence of the concept's relevance, utility, rigor, and publishability in Information Systems research outlets evading the need to justify the research paradigm in an ad hoc and fragmented manner with each new paper (Schmitt, 2016j).

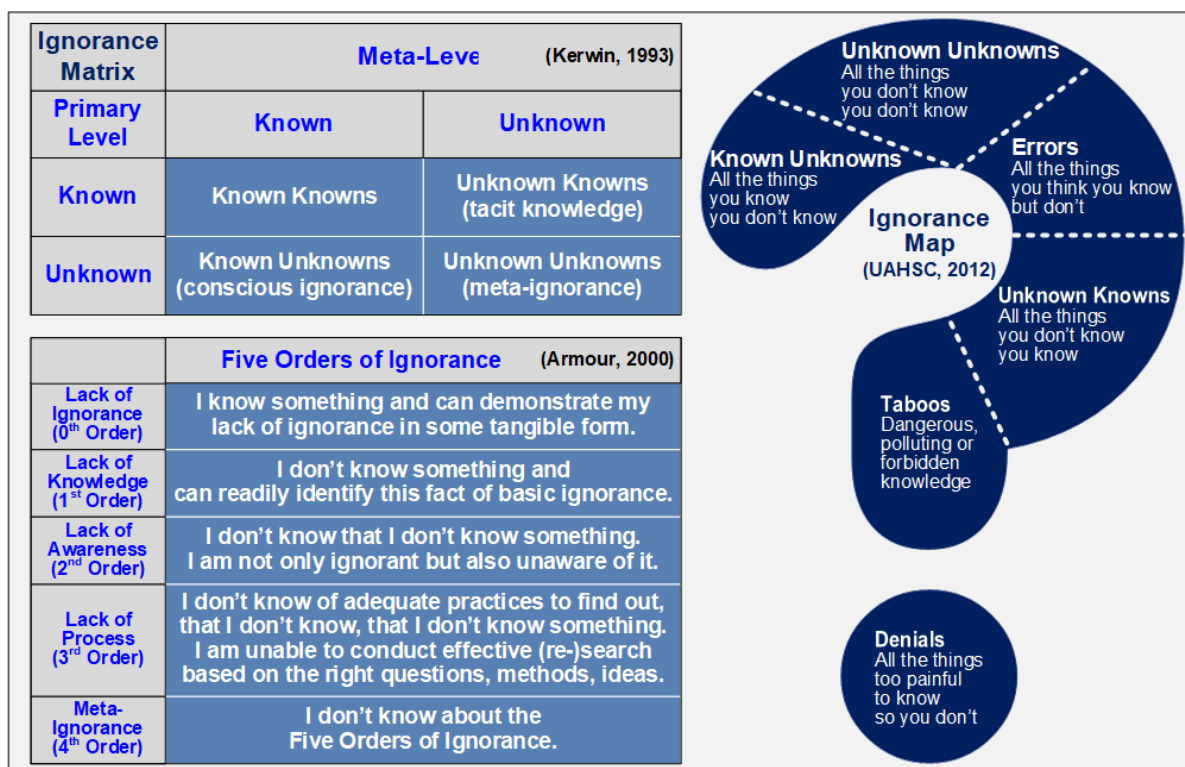


Figure 1: Ignorance Matrix, Map, and Orders (Kerwin, 1993; Armour, 2000; UAHSC, 2012)

By building on the notion of a PKM for Development (PKM4D) framework (Schmitt, 2016h), this article further adds to the educational rationale. Having already reflected on five renowned KM notions affecting individual knowledge workers (Kolb's Learning Model, Boisot's Social Learning Cycle, Wierzbicki's and Nakamori's Nanatsudaki Model, Nonaka's SECI Spiral, and Pirolli's and Card's Notional Model of the Sensemaking Loop for Intelligence Analysis) and visualized them three-dimensionally in Boisot's Information Space (Schmitt, 2017g), this article further expands the PKMS notion in the context of ever bigger data-information-knowledge-abundance and entropy to propose a PKM for Empowerment (PKM4E) Framework. This framework is based on ignorance-related notions (Figure 1: (Armour, 2000; Kerwin, 1993; Schamanek, 2012; UAHSC, 2012)) which have been extended in prior papers (Schmitt, 2013e, 2014k, 2015d) and presented at a recent conference (Schmitt, 2017h). The reason to further develop these methodologies and integrate them in the PKM4E framework is based on several motives:

- Wiig (2011) emphasizes individuals' better grasp of societal functions and dynamics to make them more knowledgeable and effective in pursuing personal opportunities: "These understandings are built on knowledge of educational options, how to qualify and afford different options and what the future prospects are. In societies without such widespread understanding, people may be ignorant about how to improve themselves, are often less motivated and continue life as before" (p.242).
- In the face of accelerating change, it is also not easy to see how university education equips graduates "to face uncertainty, complexity and values conflict". Management courses ought to reframe "learning as a process of working with unknowns; students learn to find ignorance, embrace it, and eventually resolve or live with it. Embracing ignorance requires turning on its head the strong social prohibition against discussing what we don't know, are unsure of, might be wrong about, are not permitted to think about, or assume but do not question" (McKenna, Standen, & Morrison, 2000, p. 1, 7).

- The ignorance about learning cycles, knowledge acquisition, and imprudent habits form a key barrier to reach understandings: addressing it should neither be too simplistic nor too theoretic. Without grasping these basic notions together with the present-day emphasis on social capital and on how to find extelligence and intelligence when called for, no Personal Knowledge Management device can be of assistance, and the individual is bound to suffer from the currently widening opportunity divides.
- Accordingly, the PKMS concept commits to educational support (Schmitt & Saade, 2017) strengthened by utilizing analogies, metaphors, and supporting visuals and maps, including using colors, icons, and catchy acronyms with the aim to successfully inform diverse portfolios of audiences (Schmitt, 2016j).
- The role of influencers in raising individuals' awareness have been mentioned. A meta-study just confirmed the strongest creativity-innovation-association to be not at the team but at the individual level: Firms, hence, ought to "identify, nurture, and effectively deploy ambidextrous individual researchers" to better support both, the exploitation and exploration of ideas (Sarooghi, Libaers, & Burkemper, 2015). Managers are, furthermore, asked to go beyond the rationalist approach learned in business schools and use their experience for coping with uncertainty and bounded rationality to reduce the pressure of knowledge-absence and to strategize for the future (Bolisani & Bratianu, 2018).

ARTICLE'S AIMS RELATING TO PRIOR PKMS PUBLICATIONS

The proposed PKM4E framework (Figure 3) contributes to a portfolio of prior publications and visual resources in order to fill the gap identified (as indicated by the bottom-left thumbnail in Figure 2). The design of the PKMS concept and prototype-under-development comprises the adopting, adapting, and creating of numerous notions and methodologies. To provide some relevant context for this paper, a selection of fifteen visuals are presented as thumbnails in Figure 2 (referenced for access of their detailed descriptions and full-sized counterparts to provide better resolution and readability). The aim is to walk the talk by providing readers with a condensed mapping without having to first access each of the cited publications. Figure 2, hence, attempts to represent the current scope of the PKMS concept and landscape before the focus turns to the newly added PKM4E Framework. The thumbnails are introduced in a left-to-right/top-down order:

At the meta-level, the key considerations have been explicated based on Popper's notion of Three Worlds and ten purposely devised Digital Ecosystems using the SVIDT (Strengths, Vulnerability, and Intervention Assessment related to Digital Threats) method (Schmitt, 2018b). The PKMS has been positioned in the context of Human Development and Technological Evolution (Schmitt, 2016j) as well as of its potential future impact as General-Purpose-Technology (Schmitt, 2016j). Boisot's Information Space has been adapted to depict PKMS-related actors, workflows, components, and knowledge assets three-dimensionally (Schmitt, 2017g), and the underlying meme-based rationale has also been addressed in detail, as exemplified by the repurposing of a digital content reuse framework for dynamic meme modifications (Schmitt, 2017a).

In terms of Institutions and Knowledge Societies, a PKM for Development (PKM4D) Framework initially created to assist knowledge workers to determine their personal development options and strategies (Schmitt, 2014k) has been extended to specify and assess KM interventions in a wider context (Schmitt, 2016h). A United Nations Scenario of Knowledge Mass Production over time has been expanded to reflect the information entropy issues alluded to (Schmitt, 2016j). The differences and synergies between the traditional organizational and the novel personal KM Systems have been explored (Schmitt, 2018a) as well as between Nonaka's Models of SECI and Ba and the PKM concept (to be further updated in a paper-in-progress). To permit further comparability, an entity-relationship-diagram has also been made available (Schmitt, 2017e).

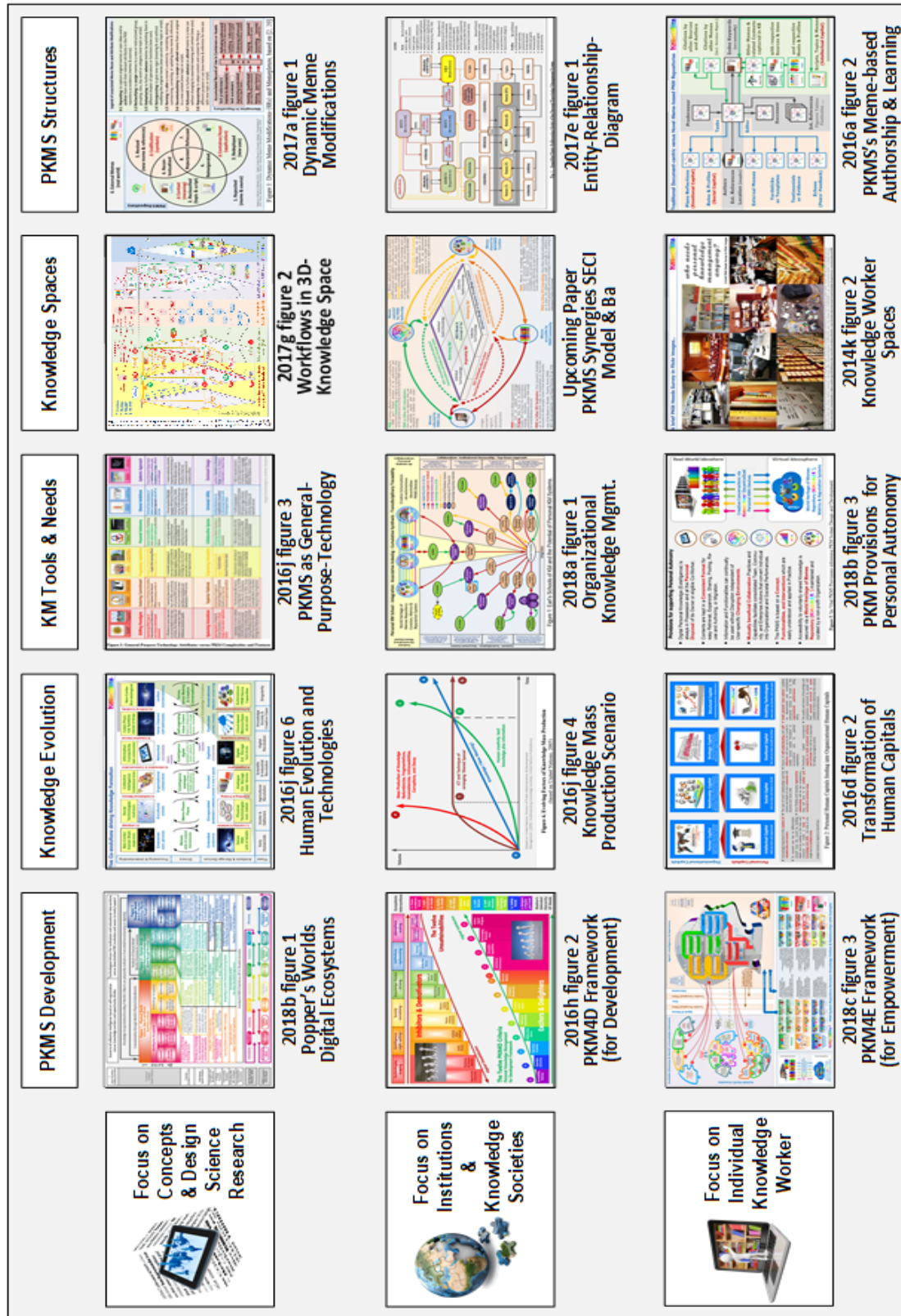


Figure 2: Visualizing the PKMS Landscape
(thumbnails with references to author's publications)

In filling the gap in the developmental perspective, the PKM4E framework (bottom-left thumbnail Figure 2) is portrayed below in Figure 3. It provides the context for the individual knowledge worker, which provides a basis for transforming the intellectual, social, and emotional capitals of an individual into the Human Capitals referred to by organizations (Schmitt, 2016d). While larger organizations utilize IT-based KM systems, small-and-medium-sized enterprises (SMEs) might be unable to employ them due to their top-down, heavyweight, prohibitive institutional approaches requiring high maintenance and large investments. Hence, novel systems aiming for entrepreneurs and individuals need not only to focus on grass roots, bottoms-up, lightweight, affordable, personal applications, but also have to center around provisions and affordances currently not catered for (Schmitt, 2018b) as also portrayed in a poster showcasing current typical knowledge worker spaces (Schmitt, 2014k). Accordingly, the differences a PKMS intervention can make has also to be communicated at the grass-roots practical level, as exemplified by comparing traditional document-centric with novel meme-based authorship approaches (Schmitt, 2016a).

The PKM4E is a generic framework; it applies not specifically only to the PKMS, although – with the addition of the Knowcations’ section in Figure 3 (bottom) – it is applied here as a means to initialize one’s PKMS understanding, so that potential or novice users of the PKMS community are adequately informed for proceeding to the other notions and methodologies (exemplified in Figure 2), bearing in mind that any learning taking place is based on the cycles and relationships expressed by the PKM4D framework (although further relevant notions are later added, e.g., experiential learning, foraging/sensemaking loops, or SECI cycles).

As expressed in a prior paper (Schmitt, 2017a), the PKMS (in contrast to its organizational counterparts) “is to enable 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 (2002) 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.” PKMS users obtain the means to retain and build upon knowledge acquired by reinforcing Usher’s (2013) ‘Cumulative Synthesis’ approach for real-time iterative innovation and Wiig’s (2011) assertion that the viability of enterprises and societies are based on the aggregation of innumerable small ‘nano’ actions by individuals. They are also able to take their Personal KMS with them as they move from one project or responsibility to the next.

PKMS DEVICES - THE PERSPECTIVE OF KNOWLEDGE WORKERS

IGNORANCE MATRIX AND MAP - THE ROOT OF THE PKM4E FRAMEWORK

At the root of the PKM4E Framework resides, as briefly indicated, the notion of the ‘Ignorance Matrix, Map, and Orders’. Figure 3 presents a substantially revised version with related learning cycles and predicaments. While the top-left section presents relevant external knowledge areas, the top-right image of the head shows four personal knowledge clusters to be described below (three of its four corners also depict further concepts relevant in the context: the extended DIWK hierarchy, Bloom’s cognitive process dimensions, and the notion of human capital as an aggregation of interdependent intellectual, social, and emotional capitals). The interface between the two sides indicates the conversion process by individual intelligent agents from external sources (signals & memes) into data, information, and thence into knowledge through filtering processes (tunable perceptual and conceptual filters) that are driven by the individual’s preferences, feelings, and the prior knowledge possessed (Boisot, 2004). The same filters apply when memes and/or knowledge assets shared by the PKMS community (Figure 3, bottom-left section) in the World Heritage of Memes Repository (WHOMER) are accessed as indicated by the blue arrows of PKMS Utilization and Capturing.

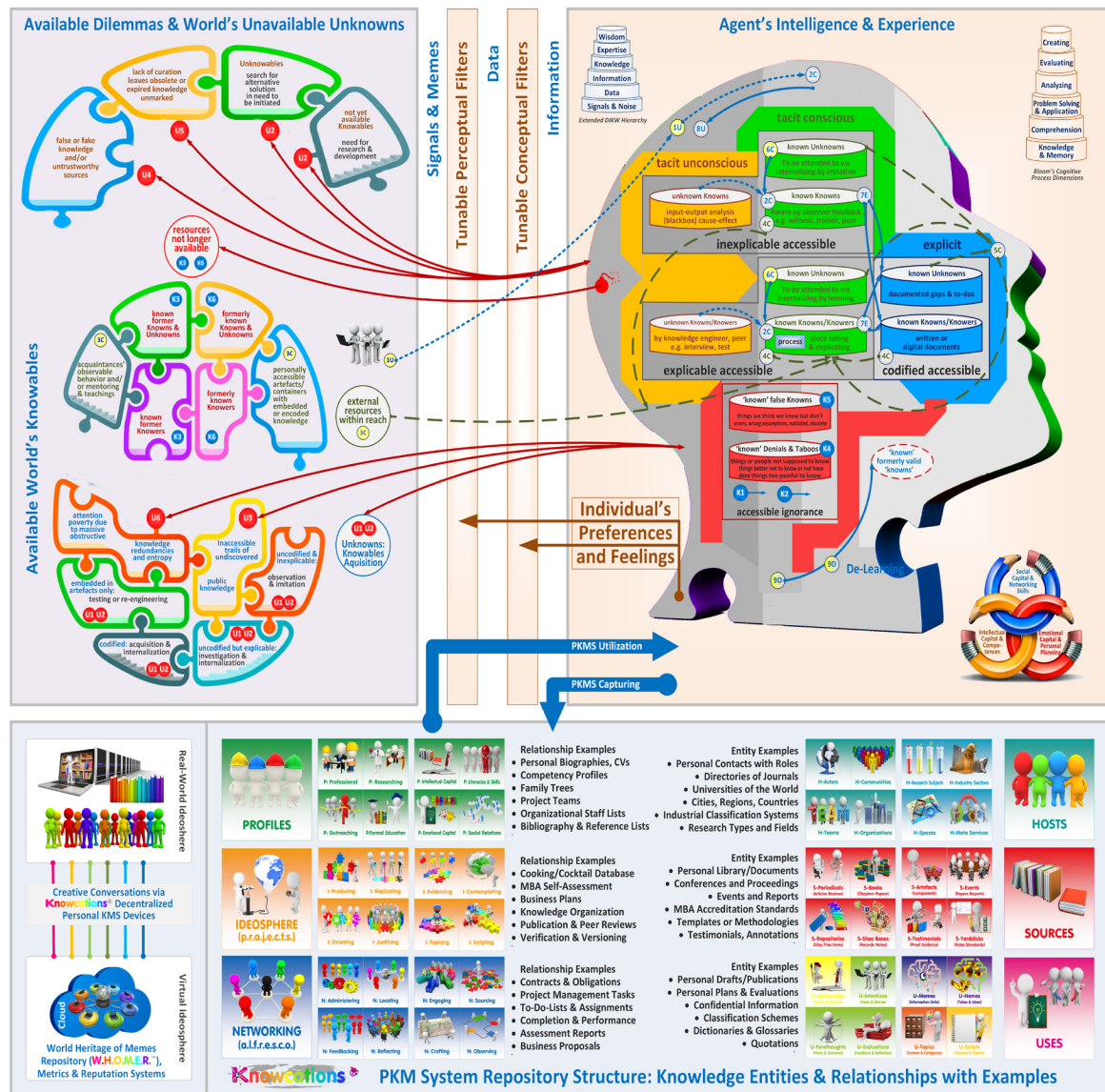


Figure 3: PKMS Ignorance Matrix with Personal Learning Cycles and Fallacies/Wastes (incorporating Kerwin, 1993; Armour, 2000; Schamanek, 2012; UAHSC, 2012)

Explicit, Codified, Accessible Knowledge (blue color)

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 (green color)

The same two categories apply but need to be further differentiated according to their 'Explicability'. While 'KU' are typically attended to via imitation (inexplicable) or learning (explicable), 'KK' need to rely on observers' feedback (inexplicable) or can be identified by conscious stocktaking (explicable).

Tacit, Unconscious, Accessible Knowledge (yellow color)

Unknown Knowns/Knowers (UKs) need to be identified via black-box (input-output/cause-effect) analysis (inexplicable) or to be extracted with the help of knowledge engineers or peers via interviews or tests (explicable).

Accessible Ignorance (red color)

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 or taboos (KDTs)* 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.

THE SIGNIFICANCE OF THE PERSONAL LEARNING CYCLES (PLC)

The *Personal Learning Cycles (PLC)* (Figure 3) 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 contacts, (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.

Table 1: Summary and Legend of Personal Learning Cycles (PLC) as depicted in Figure 3

PLC	Description of PLCs	Transforming from	To
1U	Unconscious learning by imitation (others’ knowns)	Tacit ^H	Tacit u ^P
2C	Transformation of tacit into conscious tacit or implicit knowledge by learning/understanding/sharing/articulating/explaining	Tacit ^H or Tacit u ^P	Tacit c ^P
3C	Taking stock of personally accessible artefacts and people	Hosts ^P or Artefacts ^P	Tacit c ^P
4C	Being aware of one’s personal extelligence, knowledge, contacts	Explicit ^P	Tacit c ^P
5C	Deliberate analysis of knowledge gaps	Ignorance ^P	Tacit c ^{PI}
6C	Conscious learning to fill known knowledge gaps	Tacit c ^{PI}	Tacit c ^P
7E	Transformation of implicit/explicable into explicit knowledge	Tacit Explicable c ^P	Explicit c ^P
8U	Applied Knowledge becomes ‘second nature’ - tacit knowledge	Tacit c ^P	Tacit u ^P
9D	De-Learning of obsolete knowledge and new learning	Tacit c ^P or Explicit ^P	out
Legend: (u)nconscious (c)onscious (H)osts (V)ectors (P)ersonal (I)gnorance			

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.

PERSONAL KM PREDICAMENTS AND INEFFICIENCIES

Additional to the personal learning cycles discussed, Figure 3 and Table 2 also distinguish and visualize *predicaments and inefficiencies* due to one’s own ignorance or to the quality of knowledge identified/created to potentially overcome it. 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 2: Summary and Legend of Predicaments and Inefficiencies as depicted in Figure 3

#	Feature (6As)	K#	Commons of the Knowns	U#	Commons of the Unknowns
1	Awareness, Know-how	K1	Unaware of unconsciousness or unconscious tacit knowledge	U1	Lack of method/process know-how or tools to tackle <i>(Un)Knowns</i>
2	Knowability, Articulation, Explicability	K2	Non-explicable tacit knowledge and lacking persuasiveness	U2	Unability differentiating between <i>Knowables & Unknowables</i>
3	Accessibility, Losses	K3	Losses institute <i>known former (Un-)Knowns or Knowers</i>	U3	Available inaccessible trails of Undiscovered Public <i>Knowables</i>
4	Trustworthiness, Accuracy	K4	Unwary of knowledge based on <i>Denials, Taboos, or Superstition</i>	U4	Unaware of false knowledge and/or untrustworthy sources
5	Authenticity, Validity	K5	Expired or incorrect knowledge leads to <i>known 'false' Knowns</i>	U5	Lack of curation leaves obsolete or expired knowledge unmarked
6	Attentiveness/Grasp and Recall	K6	Slips/incomplete recall lead to <i>formerly known (Un-)Knowns or Knowers</i>	U6	Attention poverty due to massive knowledge redundancies/entropy

The resulting Commons of six Knowns and six Unknowns are further characterized in the following two subsections.

THE COMMONS OF THE KNOWNs

Unaware of unconsciousness or unconscious tacit knowledge (K1)

Nonaka's SECI Loop Model promotes the externalizing of implicit or tacit knowledge in an organizational context for subsequent combination, internalization, and socialization (Nonaka, Toyama, & Konno, 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.

Non-explicable tacit knowledge and lacking persuasiveness (K2)

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 is 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).

Losses institute known former (Un-)Knowns or Knowers (K3)

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 (Schmitt, 2012).

Unwary of knowledge based on Denials, Taboos, or Superstition (K4)

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. These fallacies include the psychological suppression of realities to evade distress and pain caused, for example, by traumatic events/experiences or escapes from reality.

Expired or incorrect knowledge leads to known 'false' Knowns (K5)

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.

Slips/incomplete recall lead to formerly known (Un-)Knowns or Knowers (K6)

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 UNKNOWNNS

Lack of method/process know-how or tools to tackle Unknowns/retain Knowns (U1)

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 (4th Order Ignorance (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" (*Knowns* and *Unknowns*) as well as to avoid involuntarily letting things slip from "known" to "unknown" categories.

If relevant content to fill knowledge gaps is available, it is screened/sorted to be classified/interpreted via the filters depicted to give it relevance and purpose. 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 (in line with cognitive process dimensions) while persistently advancing his/her judgment and intuition leading to wisdom. However, as allude to earlier, unskilled people suffer the dual burden of erroneous conclusions leading to unfortunate choices as well as lacking metacognitive ability to realize their incompetence (Kruger & Dunning, 2009, p. 30)

Unability differentiating between Knowables & Unknowables (U2)

To acquire knowledge efficiently to address important any *known Unknowns* have to be critically examined, if they can be categorized as *Knowables* (we might not know but others do; as either codified,

embedded, uncoded explicable, or uncoded inexplicable) 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.

Available inaccessible trails of Undiscovered Public Knowables (U3)

The PKMS 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-rich 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).

Unaware of false knowledge and/or untrustworthy sources (U4)

The bar of the associated challenges has been further raised owing to the need for an ability to recognize '*Post-Truths*' (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" (Wang, 2016). As Weinberger (2011, 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."

Lack of curation leaves obsolete or expired knowledge unmarked (U5)

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 a vulnerable storage device.

Attention poverty due to redundancies/entropy of knowledge/extelligence (U6)

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.

PKMS'S FOCUS ON CUMULATIVE SYNTHESIS AND ABDUCTION

The entities and relationships shown in the PKM4E Framework subdivide the personal 'ground zero' of KM. They represent the grass-roots level of competencies to be developed which have been

summarized by Sisson and Ryan (2016) as accumulating (managing capturing and memory) and organizing (managing thoughts and engagement) knowledge (termed *Kenmacy*), using (Bloom's bottom three cognitive process dimensions) and reasoning about (Bloom's top three cognitive process dimensions) knowledge (termed *Cognitacy*), and representing, storing, and communicating knowledge (termed *Mediunacy*). Operationally, the PKMS's supporting logics and logistics in these endeavors are closely aligned to Usher's (1954) notions of '*Cumulative Synthesis*', '*Chance Discovery*', and '*Abduction*'.

Usher's Notion of Cumulative Synthesis

In giving an account of the real-time iterative innovation activities of knowledge workers, Usher (1954, 2013) presents the emergence of novelty "as an accumulation of many individual items over a relatively long period of time. The magnitude of the individual item is small, but through [processes of] '*Cumulative Synthesis*' the product becomes important" (Usher, 2013, p. 61). Not every individual knowledge item, idea or meme captured might be of immediate utility, but, what might be considered to be irrelevant or misguided at a given time may turn out to be valuable later, and vice versa (Garud, Gehman, Kumaraswamy, & Tuertscher, 2016).

'*Cumulative Synthesis*' convincingly couples the activities of researchers and entrepreneurs by entailing a generic iterative sequence (Usher, 2013, p. 65): (1) The perception of a problem or opportunity as an incomplete or unsatisfactory pattern, (2) which prompts the setting of an appropriate stage to assemble all the data essential to a solution, (3) in order to facilitate acts of insight, (4) followed by critical revision and full mastery of the new pattern (including prototyping), (5) as one of the prerequisites for a successful innovation.

It not only reflects the chronology of the steps taken in the PKMS design science research project, but also represents one of the key inner-working heuristics and practices at the PKMS grass-roots level. It exemplifies how the PKM concept and system reinforces the use of proven methodologies and how it affords its user community with opportunities to advance their capability endowments via applied learning. The user interface is guiding this process providing for:

- The capturing and amendment of relevant PKM-entities and their associated content, as presented by the bottom-frame-right icons in Figure 3: Hosts, Sources, Uses (with sub-entities and examples).
- The capturing of the respective relationships between these PKM-entities, as shown by the bottom-frame-middle icons in Figure 3: Profiles, Ideosphere, Networking (with sub-relations and examples).
- The curation required to cater for entities' and relationships' changes over time, respectively the durations which determine their legality, authority, validity, actuality or state-of-the-art, for example, office holders, occupancies, contractual responsibilities, expiration dates, expertise attributed to or powers vested in someone as well as the elimination of redundancies (WHOMER services).

The WHOMER repositories and curation services have been further detailed and visualized as meme-into-knowledge-asset-transformation-chart, entity-relationship-diagram, and three-dimensional knowledge space (Schmitt, 2016c, 2017e, 2017g). They assure that the PKMS affords the means to retain and build upon knowledge acquired, to track down knowledge shared by others to assimilate, and to facilitate productive contributions and collaborations between fellow learners and professional acquaintances. Personal learning cycles are reinforced and the risks of the predicaments related to Knowns and Unknowns are minimized or avoided.

In the process, the approach merges distinctive voluntarily shared knowledge objects/assets of diverse disciplines into a single unified digital knowledge repository (WHOMER) and provides the means for advancing current metrics and reputation systems (Nielsen, 2011). The assets' representations are based on memes and their relationships which allow for a progressively emerging - as Bush (1945) put it, "extensive mesh of associative multidisciplinary trails of alternative pathways" reducing

the existence of undiscoverable public knowledge (U3) and lessening the risk to get stuck in finding Unknownables (U2).

In its shared unique state, every knowledge item and asset become available for learning and personalized curation as well as reusable in new contexts (U1). 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) can be allowed to 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 (U6) on exploiting their knowledge and/or its further exploration (Schmitt, 2016d).

Notions of Chance Discovery and Abduction

Given the lack of process knowledge (*4th Order Ignorance*) alluded to (U1), the question remains do other enabling methodologies exist to clarify and/or ease the crucial first step of perceiving a problem or opportunity as an incomplete or unsatisfactory pattern (*first step in Usher's Cumulative Synthesis*) as well as gaining from unlocking the curiosity, validity, and significance barriers (*first steps in the Mostert-inspired PKMS appreciation model*).

Magnani, Arfini, and Bertolotti (2016) define this act of becoming aware of and grasping the significance of a potentially impacting event on one's situation as '*Chance Discovery*' (and related processes such as chance curation). Chances "are data, or clusters of data, bearing a strong affinity with the concept of *Affordance*" (a notion utilized to determine the PKMS's features across six digital ecosystems (Schmitt, 2017d)). "The individuation of an affordance, just like that of a chance, is an inferential process" termed '*Abduction*', "aiming at finding out explanatory information" starting from a set of already available data, information, or events in order to pave the way "from what is known to what is not known yet" (Magnani et al., 2016, p. 330, 332-333).

Magnani et al. (2016, p.334-335) present the resulting chance-and-knowledge-discovery-process as an agent-centered system where an agent's dominion of expertise depends on the knowledge possessed or within reach in his/her cognitive environment but can be considerably marred by a smaller or larger degree of illusion about the true state of his/her competence, access, and command of resources. The abductive 'response' to an ignorance problem, hence, might be masked by the "*presumptive attainment*" of the task at hand although it continues to persist. It follows that "not only the agent's knowledge but her ignorance as well is pivotal in the discovery of new chances" (p. 329), knowledge, and affordances. Two remedies are proposed (pp.336-338):

- To prevent overlooking existing alternative chances in an agent's central well-known environment, "*Selective Abductive Inference*" suggests scrutinizing the specific ignorance or illusion for the best among possible choices or explanations and raising awareness to adapt an agent's decision-making. The Apple iPhones 5C and 5s models exemplify the chance-discovery process concerning an already well-known system where three problematic but minor issues (prices, colors, materials) were changed to significantly modify the decision-making processes of a new consumership of younger generations.
- To prevent overlooking any kind of existing chances in an agent's peripheral unaccustomed fields, "*Creative and Trans-Paradigmatic Abduction*" has to transcend and widen the scope of an agent's central ordinary expertise, perspectives, and interests by successfully integrating relevant, so far, peripheral areas and/or new hypotheses, paradigms, fields of investigation. Such an intervention is risky and, hence, outcomes might have negative effects. The invention of the Google Glasses, as an example, offered a range of promising chances by creating a radical new generation of devices but peripheral to the engineers' familiar expertise systems.

Table 3: Designerly Interpretation of Peircean Signs related to Abduction

	Abduction (open signs)	Induction (actual)	Deduction (formal)
Modes for making inferences (Shank & Cunningham, 1996) based on Classes of signs (Peirce, 1931-1958) plus [designerly interpretations (Chow, Jonas, & Schaeffer, 2009)]	1 Hunch 2 Omen [Form] 3 Metaphor Analogy 4 Clue, Symptom 5 Pattern [Scenario] 6 Explanation [Principle]	7 Identification 8 Prediction 9 Model Building	10 Deductive Reasoning
Dealing with (Shank & Cunningham, 1996)	Potentiality, Possibility	Actuality	Regulation, Regularity
Supporting (Chow, Jonas, & Schaeffer, 2009)	Projection	Analysis	Synthesis

The notions discussed are reflected in the cycles and interdependencies of Figure 3. In terms of the PKMS concept and system, functionalities offer a range of novel affordances to the user community (Schmitt, 2017d), while the memes and their dynamic relationships captured via associative indexing facilitate superior chance-and-knowledge-discovery-processes in well-known and, particularly, peripheral or unknown domains.

A further guiding feature of the abducting process in the PKMS context is the applicability of its classifications during knowledge capturing, learning, reasoning, and authorship (*Shank's and Cunningham's (1996) Modes for Making Inferences based on Peirce's (1931-1958) Classes of Signs*, Table 3 [example referring to appreciation model]):

- A *Hunch* denotes the possibility of a possible resemblance indicating that one's initial observations might require further inquiry and observation to potentially lead to evidence [\Rightarrow 1. curiosity].
- An *Omen* deals with possible resemblances where one has to determine if some actual observation might lead to the identification of a present more general phenomenon or resolution [\Rightarrow 2. validity].
- A *Metaphor* or *Analogy* deals with the manipulation of resemblance to create or discover new potential rules of order or to notice corresponding approaches [\Rightarrow 3. significance].
- A *Clue* or *Symptom* indicates some past state of affair or circumstances and deals with possible evidence to detect some more general phenomenon or beneficial application [\Rightarrow 4. utility].
- A *Diagnosis* or *Scenario* involves the formation of a possible rule, state, diagnostic judgment, or decision based on available evidence, observations, and/or body of clues [\Rightarrow 5. responsibility, priority].
- An *Explanation* deals with a possible plausible formal general rule or action which might serve to simplify other explanations, to create a pattern to account for other data to be further tested over time, or to motivate implementations [\Rightarrow 6. enactment].

CONCLUDING REMARKS AND THE WAY AHEAD

In summary, the PKMS affordances and chances provide the means to tackle the widening opportunity divides by providing individual knowledge workers with continuous life-long support from trainee, student, novice, or mentee towards professional, expert, mentor, or leader. By holding on to one's personal KMS device as one moves from one project or responsibility to the next, one's capability to self-develop/actualize is also strengthened as an essential prerequisite of personal mobility, autonomy, and sovereignty.

The PKMS features add transparency and momentum to the digital asset production and value creation and, with it, to the evolution of knowledge at the personal, entrepreneurial, 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 (Schmitt, 2018a). 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. KM, hence, should not only be understood "as a means of deploying efficiently the existing knowledge resources but also as strategizing for decreasing knowledge-absence and minimizing the risks associated with it in decision making. Managers should go beyond the rationalist approach learned in business schools and use their experience to cope with Knight's uncertainty and Simon's bounded rationality in strategizing for the future and reducing the pressure of knowledge-absence" caused by knowledge incompleteness, indeterminacy and incommensurability (Bolisani & Bratianu, 2018).

Further publications and posters are under review or planned to address a PKMS Sustainability Vision, the synergies between the SECI Model and PKMS, 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.

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