ISSN No - 2349-6770

Journal of Knowledge Management Studies

Volume No. 13
Issue No. 1
January - April 2025

ENRICHED PUBLICATIONS PVT.LTD

JE - 18,Gupta Colony, Khirki Extn,
Malviya Nagar, New Delhi - 110017.
E- Mail: info@enrichedpublication.com
Phone :- +91-8877340707

ISSN No - 2349-6770

Journal of Knowledge Management Studies

Aims and Scope

The Journal of Knowledge Management studies provide perspectives on topics relevant to the study, implementation and management of knowledge management. The journal contributes to the development of both theory and practice in the field of knowledge management. The journal accepts academically robust papers, topical articles and case studies that contribute to the area of research in, and practice of knowledge management. Journal covers the following topics

1. Knowledge management and innovative
2. Integrated learning and knowledge infrastructure
3. Communication and organizational culture
4. Knowledge organization, taxonomies and ontology
5. Knowledge creation, retention, sharing and transfer
6. Knowledge databases and repositories
7. Knowledge Innovation Networks
8. Knowledge and communication professionals and leadership
9. Learning organization and organizational learning
10. Techniques and methods for managing knowledge and communication
11. Using information technology to develop knowledge and communication management
12. Practical implementations of knowledge and communication management

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(Volume No. 13, Issue No. 1, January - April 2025)

Contents

Digital Transformation Designed to Succeed: Fit the Change into the Business Strategy and People

Daniela Robu1 and John B. Lazar2

1Alberta Health Services, Calgary, AB Canada 2John B. Lazar & Associates, Inc., Forest Park, IL USA

A B S T R A C T

Digital transformation has become a necessity in our volatile, uncertain, complex and ambiguous (VUCA) world. In their 2019 report, APQC found that 75% of organizations are undergoing digital transformation. Successful digital transformation requires a strong foundation of people, process, technology and content. Selection of the right combination of strategies and deep stakeholder engagement is important in early phases of change when transformation initiatives inform leaders and users why change is needed. Top drivers for digital transformation have business (e.g., increased efficiency and productivity) and people (e.g., optimize user experience with knowledge discovery) facets. This paper illustrates an example of digital transformation in practice led by Knowledge Management, within Alberta Health Services (AHS). AHS is Canada's first and largest province-wide, fully integrated health system with more than 102,700 employees. Employees need a platform for collaboration on projects, as well as documents and idea generation to meet business needs and enable them to become more efficient and effective in their daily jobs. The design, development, and implementation of a collaborative platform within this large organization required close orchestration of strategies, stakeholders' commitments and engagement, represented by a continuum of stakeholders' engagement formats, relationship and trustbuilding. Setting the stage for successful implementation and post implementation required a preview of technological and workforce trends to anticipate the future of work and worker. Fitting the change into overall business strategy, developing the knowledge of how change would affect the workers, and setting up a mechanism to inform leaders about adoption and user engagement were added as overarching strategies to better align with the line of sight in digital transformation. The platform was implemented with 23 business areas that expressed interest; it has demonstrated the potential to enable system transformation if implemented organization-wide. Business value was demonstrated with an ROI calculation on time savings.

Keywords: Digital transformation, system and design thinking, future of work, business value, innovation, business stewards

1. Introduction

Why do some digital transformation efforts succeed and others fail? Digital transformation investments will approach $7.4 trillion by 2023 and 70% of the organizations that invested in 2019 for digital transformation initiatives fail to pay off. That's because the majority of the organizations focus on a specific technology, rather than finding the right balance of fitting the change into the overall business strategy, developing the knowledge of how this change will affect the workers, and setting up a mechanism to inform leaders about adoption and user engagement.

In the design and implementation of digital platforms, best-practice organizations demonstrated exceptional performance by employing strategies, governance models, knowledge flow processes and technologies.

Conducting a study to review and compare seven best-practice organizations, we have learned that each defined their strategy based on the organization needs. For example, Accenture developed KM Social Learning to enable employees to learn from each other through collaboration and knowledge sharing to bring best to the clients. US Department of State considered e-Diplomacy as strategy to enable employees to tap into existing knowledge, leverage experience and expertise within the organizational and regional boundaries, find news ways to connect, collaborate, find and share knowledge anytime, anywhere. KRAFT's strategy, Knowing what we know, enabled employees to capture and transfer knowledge in order to increase efficiency, improve decision making and avoid unnecessary reinvention. WIPRO, developed a 5 S Strategy: Simplify, Standardize, Segment, Secure, Sustain, where employees are involved to deliver innovative solutions through collaboration, knowledge exchange across departments, functions, locations ensuring there is value in the knowledge being created and measuring KM's impact on the business and its customers.

Reference this paper: Robu, A., and Lazar, J. B., 2021. Digital Transformation Designed to Succeed – Fit the Change into the Business Strategy and People. The Electronic Journal of Knowledge Management, 19(2), pp. 133-149, available online at www.ejkm.com
A technology analysis (applications in clinical or corporate domains, geographically dispersed teams, intranet/extranet, size of the organization, document management solution, etc.) was completed, studying seventeen organizations that successfully implemented digital initiatives. It concluded that SharePoint, integrated with different, other tools and technologies, was mainly used to respond to organization needs. Once the strategy was defined, a program was set up, and each best practice organization built their processes and frameworks to identify, capture, transfer, and manage application and use of critical knowledge. The study concluded that across the best practice organizations, similar success factors could be identified: sponsorship from senior leaders; partnership with Human Resources, IT, and Communication; strategy designed to address pain points; focus on people by enabling reward systems; and gamification. See Figure 1.

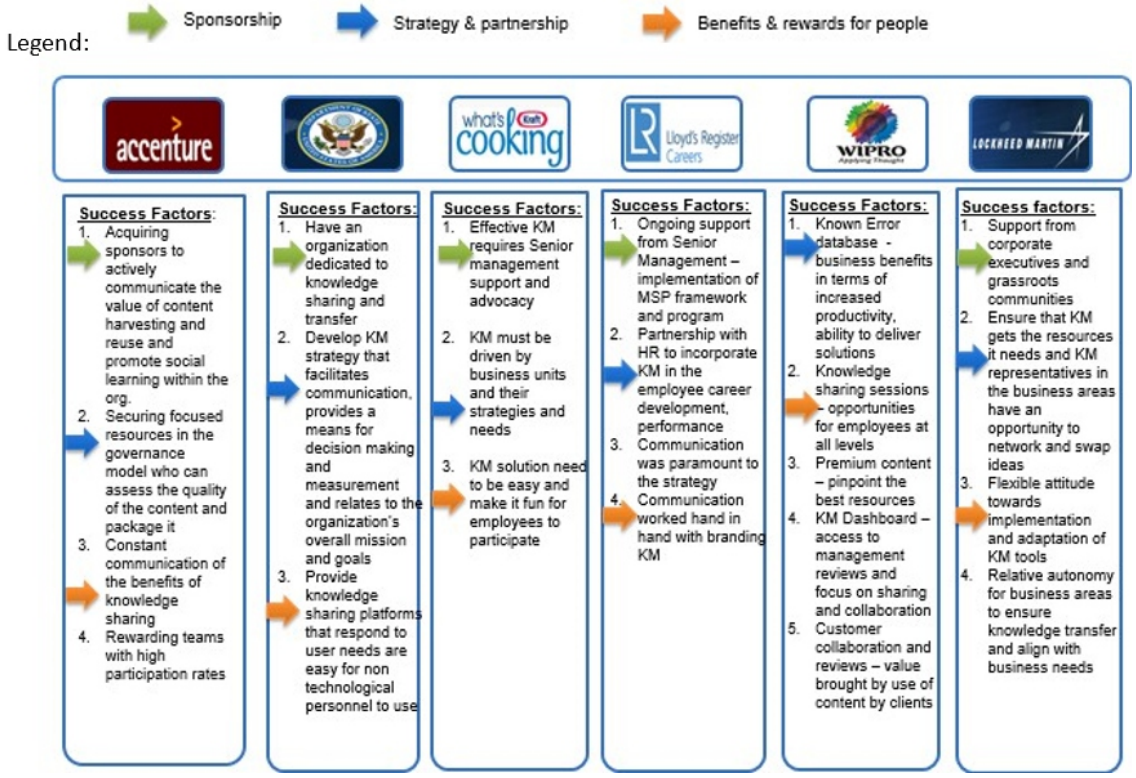

Figure 1: Best Practice organizations: Success factors for implementation of digital transformation initiatives

In this paper, the aim is to demonstrate the value of applying lessons learned from best practice organizations. This includes adopting and adapting strategies, models, and frameworks effectively used in other contexts, then using them in your organization's context. That's the path taken by AHS, described below.

We have discovered that among the variety of variables to consider when designing a digital transformation, organization maturity has proven to be critical. Other components (culture, process management, integration of people, process and technology, knowledge flow) become enablers to drive performance excellence. See Figure 2.

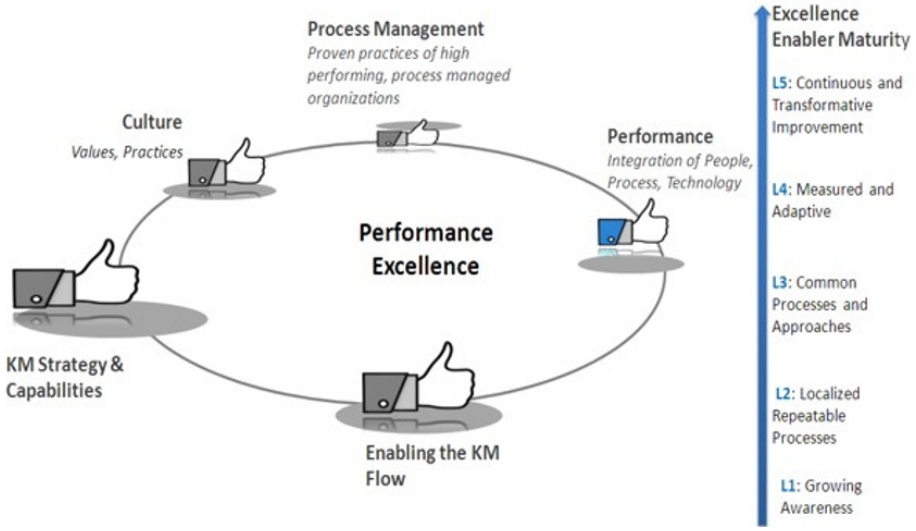

Figure 2: Knowledge management maturity level connected to performance excellence in organization Collaborative Sites (CS) were designed with several factors in mind: organizational maturity, best practices, lessons from this study about conditions for success, and what technologies would fit and meet requirements. A range of approaches, frameworks, and applicable models is illustrated.

1. Background

As organizations implement digital technologies, the nature of work across industries and in organizations is rapidly transforming. Integrated digital platforms are changing where employees get work done and how they share information and learn together. These changes include digitizing data and information, automating processes, applying analytics, and enabling digital interactions.

The question is: Are employees ready and enabled? While some digital transformation initiatives involve only back-end IT work, the majority impact the employee experience in some way. Organizations need to manage expectations for the new ways of doing work and help people through it; otherwise, the experience may be negative. Of course, digital work does offer many positive benefits for employees, such as less time spent on repetitive tasks, better outcomes on document collaboration and sharing of expertise, and integrated online spaces for project work. To enable employees to quickly find the information they need, it is essential to improve findability and usability.

The other question is: Are organizations ready to handle 'the express train' of content overload? Organizations need to find ways to respond to employees' needs: 'Give me what I need, when I need it,' 'User friendly search and find,' 'Critical, relevant and up-to-date results.' Similar to the world of Formula 1 racing, every second counts in health care as well. Digital work is becoming the norm in the day-to-day work for the employees of AHS and the same questions need to be answered.

Healthcare is risk averse, implementation of digital transformation initiatives that disrupt the way

employees do their daily work requires careful orchestration. What is the best way to mitigate the risk and find the right balance to lead digital business transformation and deliver financial results? Designing a roadmap to describe and understand the connection with business strategy, resources, and people required to plan and execute an effective digital business transformation initiative is essential. The design is informed by a toolkit of reviews of models, concepts, best practice organizations and their approaches, and is adapted in the context of the organization.

Fitting the change into the overall business strategy starts with talking to senior leaders, asking them about their business priorities and desired outcomes. The information collected about knowledge flow, what the organization measures today, leads to the goal of determining what is important, such as reducing response time to business opportunities, reducing errors, identifying subject matter experts, and assigning people on project more quickly. The tools and approaches implemented by the digital transformation team should be consistent with the business drivers, strategy, and resources; appropriate measures should be identified at this time. Qualitative and quantitative measures require a data collection system set up with methodology, technology, and data sources (HR, finance, participation and satisfaction, participation in social networking activities, content, text, and sentiment analysis). A step that is usually missed, but very important for continuous improvement and adoption, is to check after implementation with the business leaders to discuss the findings and jointly determine strategies to increase adoption of the change.
A business engagement loop identified by the Knowledge Analytics SM Process (Toolkit 1) guides the KM professionals to align KM approaches with key business drivers and measures.

Organizational change is difficult. The analysis of complementarities can provide insights into organizational dynamics. For example, “even when senior executives have a clear vision of a new strategy for a company, managing the change can be difficult or impossible” (Argyris, 1982; Schein, 2004, Siggelkow, 2002).

Complementarity is an important concept in organizational analysis, and it is based on studying the interactions among pairs of inter-related decisions. If a company is evaluating a trio of decisions: “1) Whether to adopt a strategy that requires implementing frequent changes in its technology, 2) Whether to invest in a flexibly trained workforce, and 3) Whether to give workers more discretion in the organization of their work, the

• Matrix of Change can be used by leaders to assess the feasibility, scope, rhythm and unit of organizational change efforts” (Brynjolfsson, Renshaw and Van Alstyne, 1997). (Toolkit 2)

Developing the knowledge of how the change will affect the workers - “From Gartner's perspective, 'the transformation journey is taking large enterprises especially at least twice as long and costing twice as

long and costing twice as much as they originally anticipated.' In large part this is due to cultural readiness, “53% of the organizations surveyed remain untested in the face of digital challenge and their digital transformation readiness therefore uncertain” (Gartner, Inc., 2020). Cultural readiness is usually connected to the organization's digital business maturity which assesses the readiness for change and understands the required critical capabilities and competencies.
APQC's Levels of Knowledge Management Maturity SM, presents a roadmap for moving from immature, inconsistent knowledge management activities to mature, disciplined approaches aligned to strategic business imperatives (Toolkit 3).

Explaining 'why' the change is needed and creating captivating stories that detail the impact of the transformation and what are the benefits for the workers are also required to succeed in the implementation of a digital transformation initiative.

- Communication strategies with promotions and regular updates are part of the change strategy (Toolkit 4).

New processes are to be developed with input from users during pilots and proofs of concepts. Assessing the critical changes is required for setting up an infrastructure that can facilitate and support new digital business models. Continuously learn from best practice organizations that embed KM digital transformation programs, tools, and approaches into critical business processes and workflows.

Putting Knowledge in the Flow of Work Best Practice Study), presents how organizations like Alcoa World Alumina, MWH Global, Nalco, NASA, and Tata Chemicals have integrated knowledge sharing and collaboration into every aspect of their operations, creating a work cadre that are hardwired to collaborate and share what they know.
Introducing the change into the flow of the work (Toolkit 5) incorporated knowledge-sharing behaviours in the worker performance goals and discussions. It also motivated the employee on a personal level to be recognized for subject matter expertise and career advancement.

Setting up a mechanism to inform leaders about adoption and user engagement - American Productivity Quality Centre (APQC), identified five organizations as “best practice”: EY, MetLife, MWH Global, Nalco, and Wipro Ltd. These organizations focus their measurement efforts on assessing employees' level of engagement with available content as well as the overall user experience.
Connecting People to Content Best Practice Study (Toolkit 6), reported that the top-rated health measure among best-practice organizations is the number/percentage of employees accessing content, which two-thirds consider effective to evaluate content tools and initiatives. In addition, half the partners find it beneficial to conduct surveys in order to gauge employee satisfaction with content and systems.

Business will continue to transform. As we look into the future, we have to think of the transformation as a benefit, not a threat, and ask ourselves questions differently: Instead of “What technology is doing to us?”

consider “What we will do with technology?” Instead of “It is an inexorable trend!” Consider “It's a powerful tool.” And instead of “It's an inevitable outcome.” consider “It's a product of our choices.” MIT, Digital Business Strategy: Harnessing our Digital Future, 2020 (Toolkit 7).

The IDC FutureScape webinar and research series for 2021 draws one clear conclusion: technology will play an even greater role in getting us all to the next Normal. Four major developments are listed: “Acceleration: Identifying where the crisis and enterprises' responses are accelerating existing IT trends; Remediation: Identifying where enterprises will focus investments in the next two years to remediate shortcoming in existing IT environments exposed by the crisis as well as shortcomings introduced during initial emergency responses; Extension: Identifying where enterprises will seek to leverage technologies to take advantage of competitive and industry disruptions and extend their capabilities in the new normal and Ecosystem Transition: Identify how enterprise responses to the other three developments will alter the IT industry ecosystem itself.”(IDC, 2021)

Designing the roadmap for digital transformation next includes three specific steps. In addition, an ongoing reference to the future of work and how trends are positioned should be factored in. See Figure 3.

Figure 3: Roadmap for Digital Transformation

The roadmap augmented by the Toolkit of concepts, models, and best practices position organizations (in particular, healthcare) in better shape to succeed in digital transformation initiatives.

In 2016, the Knowledge Management (KM) team within AHS, in collaboration with IT and Web Communication, was tasked to determine if AHS-licensed technology met the current organization needs for information and knowledge management. In the same year, a project designed to answer this question was commenced. The design of the project was informed by prior consultation with leaders and technology end users to identify and prioritize pain points. It was also important to have a common understanding of the terms that were used for collaboration, engagement, access, etc. A key discussion for stakeholders' buy-in was to clearly explain the 'why' and 'how' digital transformation could contribute to strategic business priorities and talent management goals.

This pre-project phase primed the right foundation in terms of people involvement and interest, and

implicitly supported the need for a well-defined structure and process for the project moving forward. One year into the future, the output was defined, and the project team would deliver an online platform that integrated technology tools (SharePoint and Tableau) that responded to business needs (reflected in activities to access, engage, collaborate, manage and monitor) as identified by the stakeholders. The intent was to implement the project product on a trial basis for use by interested end-users and evaluate outcomes and ROI of the digital transformation experience for these end-users.

During the project phase, engagement had a significant importance as three layers needed to be balanced: within the project team members, the first cross-functional team of this nature in AHS (with expertise from KM, IT, Web Communication); between project team members and stakeholders; and between project team members and sponsor. Deep engagement starting in the early phases of change helped ensure processes were optimized and people were ready to embrace the benefits of digital transformation. Maintaining the stakeholders' interest during the project was possible by employing an Agile project management methodology that frequently required their input in product development. The sprints were designed to respond to the pain points (e.g easy find and search, improved document, meeting, project management and more engagement tools) identified by users. With this approach, the output, named Collaborative Sites (CS), was ready for implementation in the business areas represented by stakeholders. See Figure 4.

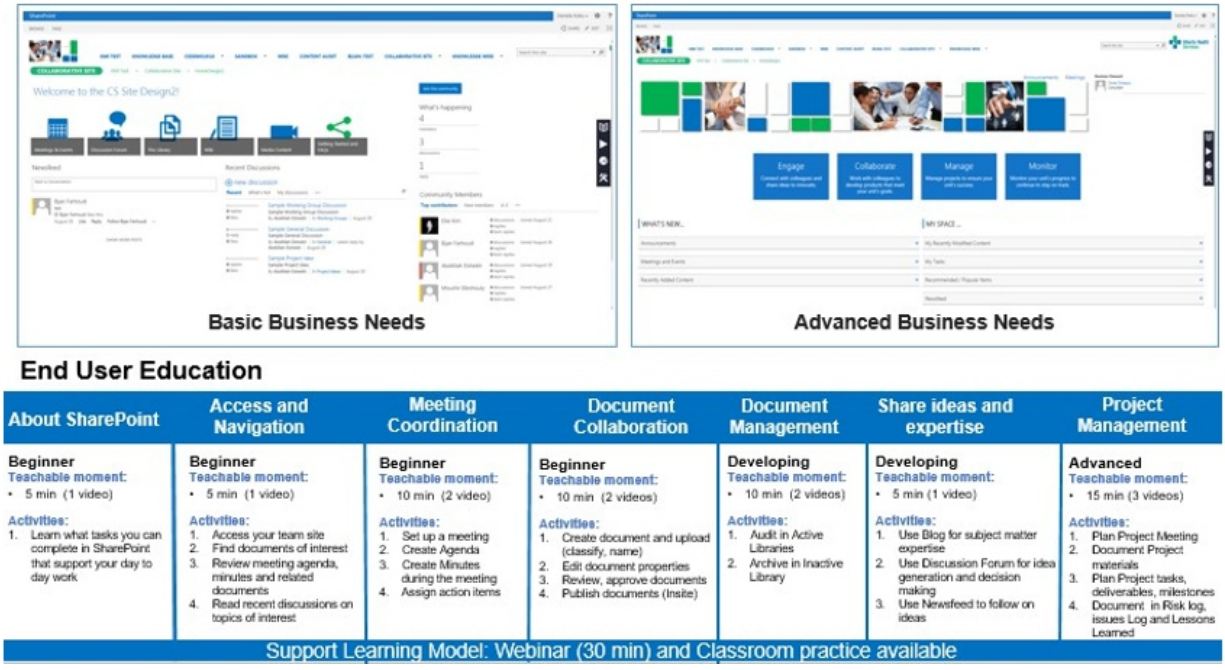

Figure 4: Collaborative Sites

This next phase, transitioning from project to operations, required different engagement strategies. Leading a Collaborative Site implementation in the flow of the work required engagement of employees through effective communication about change while cultivating the skills and capabilities they needed for future success. Leaders also played a significant role in the implementation process. Knowing the priorities of their business areas and the user's maturity level from digital capabilities perspective, they carefully designed how to bring the new ways of completing their day-to-day work. Different implementation designs were deployed: phased implementation of functionalities (e.g., start with document management followed by meeting and project coordination), phased training for user groups (e.g., start with leadership followed by end-users) or full implementation of functionalities and training in the same time with a cut of date from old ways of doing their jobs.

Post-implementation phase highlighted different needs for users and business. It became evident that in addition to document, project and meeting management, each business area had specific processes (e.g., request log to capture intakes, operations log to assign tasks, education needs, repository of questions that require analysis, etc.) that guided their operations model. As users started to use the functionalities and resources provided to support their learning, different training requests were identified.

The evaluation and analysis of Collaborative Sites adoption, usage, efficiency, and quality required the selection of the most responsive Blended Solution (one or multiple interventions that address the same root cause). Content management lifecycle processes required attention as the number of documents created increased exponentially (e.g., audit and archive solutions needed to be designed and implemented). See Figure 5.

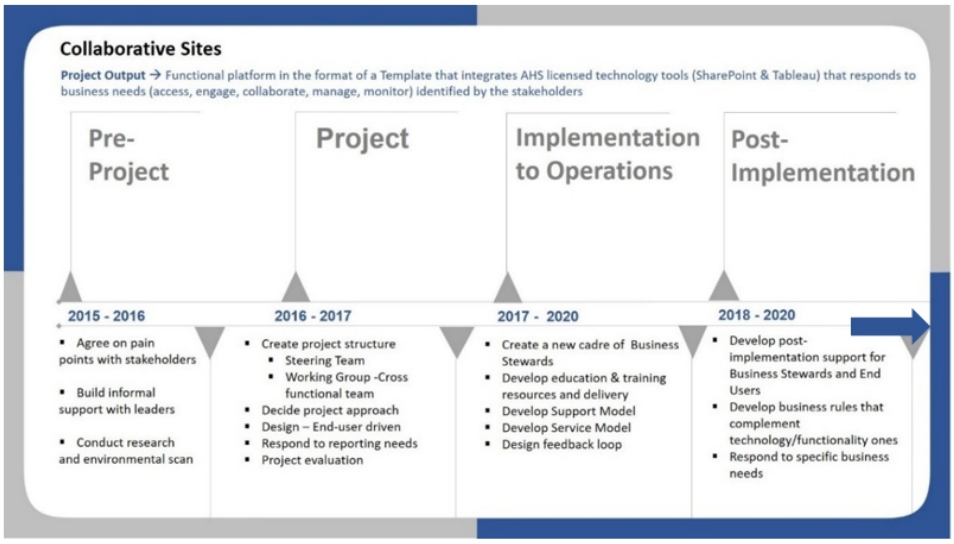

Figure 5: Collaborative Sites Phases

Successful digital transformation requires a careful orchestration of the following components: technology, people, process and content. This implies the design and deployment of different solutions, approaches, models, and methodologies at every stage. "True transformation will engage all, and will require tools, techniques and approaches to involve all in the proposed reforms" (Dickson & Lindstrom, 2010, p. 20).

1.Methodology

Digital transformation initiatives require future thinking and when selecting the methodology, the organizations need to consider where they want to be in three years from the moment of implementation, what business value the initiative will bring, anticipate the technology progress, predict dynamic changes in business priorities, and prepare employees for the future of the work. In order be well equipped with evidence for the approaches that were applied, the following steps were completed:

•Environmental scan that included a study of best practice organizations that were successful with the implementation of digital transformation initiatives (e.g., Accenture, Kraft Foods, US Department of Defense, Lloyd's Register, Lockheed Martin, Wipro) – comparing the strategies, processes, people and content that they have selected to respond to their organization's vision, mission, value (Data collection: Literature review, synthesis; Format: Report)

•Interviews with stakeholders represented a key step in informing the CS design and sprint planning. Thirteen departments were selected based on their interest in knowledge and information management,

•service needs, expertise, experience with use of technology, influencers in the organization. Thirty representatives were identified by department leaders. Eight focus groups (3 Strategic Clinical Networks, Health Information Management, Policy, Primary Care, Clinical Knowledge Content Management, Knowledge Management), were organized to gather details of the business requirements. Each focus group was equipped with the same Business Scenario template (included: scenario name, background, goals, desired outcomes, role/persona, stakeholders, process), and the activity during the focus group was to capture the story of their current processes and pain points for major initiatives and inform what their vision is for the future. The result produced eight complex business scenarios. The functions and processes identified from scenarios were grouped in common and specific business needs across the interviewed areas and captured in a checklist which represented the basis of the CS platform desired functionalities:

•Project/Initiatives: a place in the platform where leaders can have a view of the numerous projects and initiatives, connected to goals to allow opportunity to inform decision making

•Document Collaboration: one-stop shop for clinical knowledge content, clinical, and corporate policy aligned with the content flow from creation to publication; structured place for educational materials

•Engagement: enable social media tools to allow patients, universities, health care professionals to share stories and expertise

•Reporting: ability to have three layers of reporting, strategic, tactical and operational, analytics for site activity and content contribution

The consensus from all focus groups was that all the above activities required creating a global lessons learned repository, reference libraries, best practice repository, and expertise locator space

•The analysis (Data collection: Interview checklist; Format: knowledge maps and database) - (APQC, 2018)

•Review of proven and emerging knowledge management approaches implemented in organizations and the impact of their implementation (Data collection: Literature review and synthesis; Format: Presentation)

•Frameworks integration to cover requirements both from performance and healthcare environment perspective (Data collection: Study analysis; Format: Integrated framework diagram)

•Agile Project Management Methodology – rigorously designed to meet the requirements related to project information creation, storage and sharing (Data collection: Site with tools for document, task, meetings, and risk management; Format: SharePoint site)

•Education models applied such as ADDIE (Assess, Design, Develop, Implement, Evaluate) and adult learning principles for reinforcing knowledge acquisition and reinforcement (Data collection: Objectives, learning activities, knowledge checks; Format: Curriculum) (APQC, 2020)

•ROI (Return on Investment) evaluation methodology to capture employees' reaction, application, business impact and consequently ROI calculation for time savings (Data collection: Surveys; Format: Graphs with trends of employees' adoption of new knowledge over time) (Phillips, Phillips, Stone & Burkett, 2007)

•Review measures to capture user engagement, CS use and adoption and process efficiencies (Data collection: Review of best practice organizations that implemented knowledge management systems;

Format: Presentation)
•Review content management best practices (e.g., processes, procedures, technology, tools) implemented in organization and related audit policies (Data collection: Review of best practices, models to identify critical, relevant, and up-to-date content, frameworks; Format: Reports, publications (APQC, 2013, AIIM)

•Review change management models (strategic level: 7S model; project team: ADKAR model, users: ADKAR and Kotter/Lewin model) that are to be applied across the continuum of the initiative from preproject to post-implementation

4.Collaborative Sites Platform
4.1Innovation and System transformation

4.1.1 Fitting the change into overall business strategy

The Collaborative Sites (CS) journey required system thinking and systematic approaches to advance from innovation to system transformation. A non-conventional approach was considered to address the complexity of this type of initiative in healthcare. Two frameworks – LEADS (Lead self, Engage others, Achieve results, Develop coalitions, System transformation; Dickson & Lindstrom, 2010) and HPT (Human Performance Technology; Van Tiem, Moseley & Dessinger, 2012) – were integrated. See Figure 6.

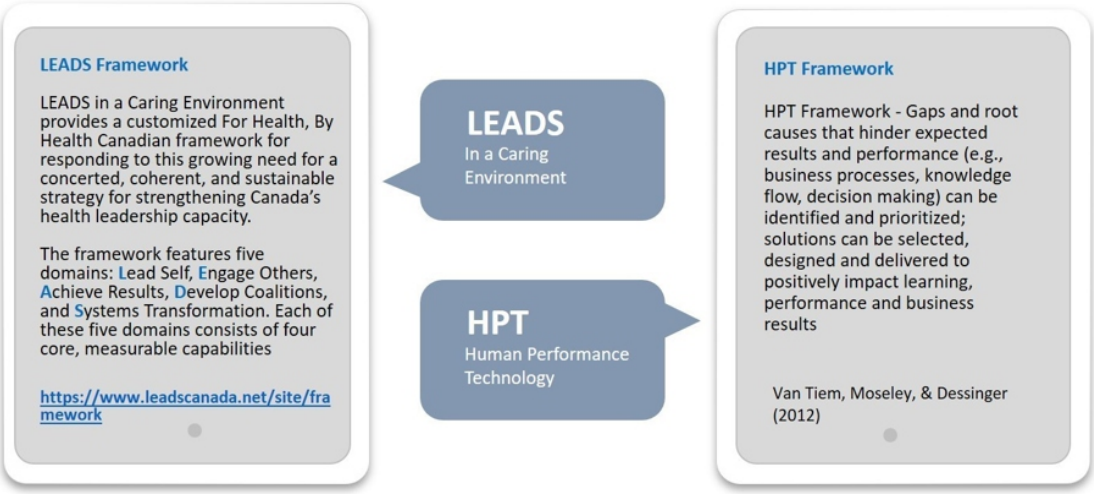

Figure 6: System Transformation: Concept - Integration of LEADS and HPT Frameworks
LEADS in a caring environment framework was integrated with the HPT framework to assist in two ways: identifying the intersection of different domains (Change Management, Knowledge Management and Performance Improvement) and selecting the best Blended Solution (BS) for the Collaborative Sites during the project and implementation in operations. A Blended Solution is distinctive (Lazar, Greenblatt, & Robu, 2017) in that it will likely:

1.include one or more simultaneous, integrated, interdependent, synergistic Interventions;
2.address the same root cause(s) redundantly;
3.require both qualitative and quantitative measures to design and measure effectiveness;
4.align multiple stakeholders; and 5. require faith, courage and stretch.

4.1.2 Steps from Innovation to Implementation
Many organizations dive into digital transformation initiatives without taking the appropriate steps to prepare for transformation. Also, a different mindset is required when it comes to the expectations for

employees' performance – they must learn and apply new knowledge while executing (Edmondson, 2008).

How did we achieve performance excellence as a result of digital transformation?

Thirteen steps were considered in the Collaborative Sites initiative (see Figure 7). By integrating the LEADS framework with the HPT one, we ensured that in each phase of the initiative – pre-project, project, transition from project to operations and post-implementation – system transformation capabilities were linked to desired performance outcomes.

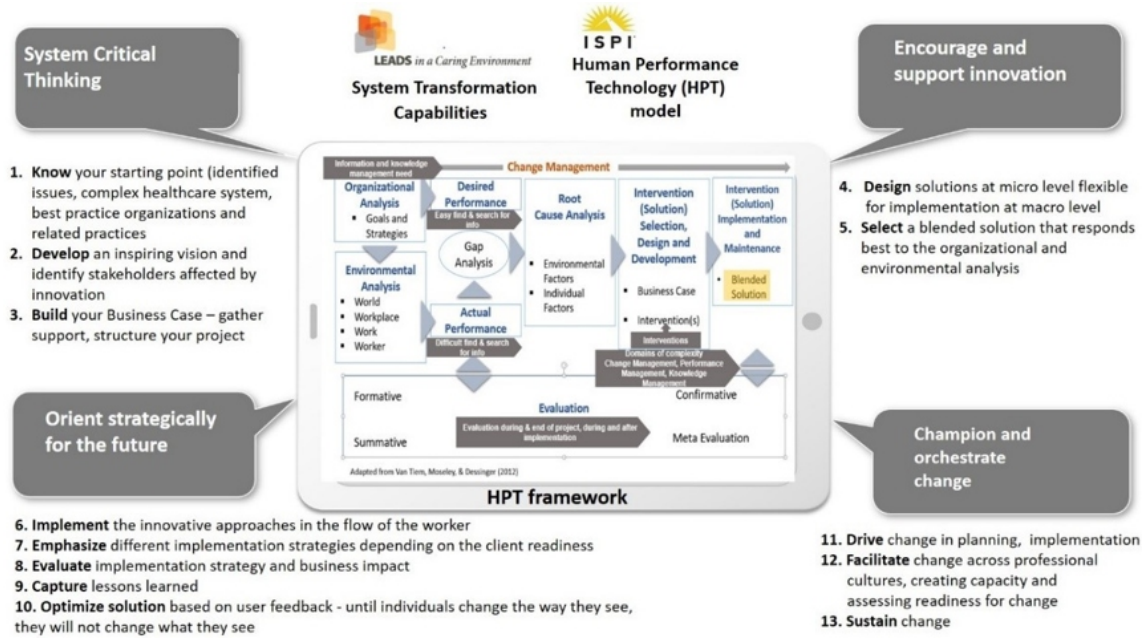

Figure 7: Innovation to System Transformation: Thirteen Steps

One question that has to be answered is how all these frameworks and methodologies really work together. In other words, how do they best blend to be integral parts of the solution and respond in the best way to the desired outcome. The following details attempt to demonstrate in a practical way how they were considered and used in the Collaborative Sites example.

1. Pre-project Phase - System Critical Thinking capabilities

Know your starting point (identified issues, complex healthcare system, best practice organizations and related practices) was designed with attention to stakeholder engagement by inviting them to participate in knowledge mapping. This is one of the most powerful knowledge management approaches to identify and understand the organization's critical information and knowledge management needs. The mapping clearly explained the "why" and "how" so that stakeholders understand how it contributes to business goals. This also helped with the identification of the pain points we needed to address with CS - Improved functionalities and tools for: access – navigation, user interface, engagement, collaboration, and management tools as well as My Space, an individual area that brings forward all the documents, action items and discussions that the employee was involved with (Step 1).

At this point, stakeholders could start to see the potential of the change and an important next step was to develop an inspiring vision and identify all the stakeholders affected by innovation. The best approach to continue to maintain the interest was to develop a prototype that showcased possible outputs of technology and how they responded to the pain points (Step 2).

Momentum was built and stakeholders were ready to support the next step of building the business case and structure the project. Governance for the project was determined by identifying the Sponsors (KM, IT), cross– functional Project Team (IT, KM, Web Communications, Identity Access Management) and Steering Team (participation from 13 departments). A project charter was prepared, and Agile Project Management Methodology adopted (Step 3).

These three steps are anchored in the HPT framework that relate to organizational and environmental analysis, present the gap between actual and desired performance, and identify root causes both at individual and environmental levels.

2. Project Phase - Encourage and support innovation

Future of digital work requires leaders to think how they balance the ratio between what technology does and what the worker does, how their business models change, and design solutions at the micro level flexible for implementation at the macro level. Engagement strategy again played a very important role and required three layers of approaches: business stakeholders were invited to test prototypes and provide feedback on how well the functionalities responded to the identified gaps (five Agile sprints were planned and 16 prototypes refined, based on user feedback); cross-functional team brainstormed and developed different modalities to respond to the needs and regular check-ins with stakeholders provided design course-correction; Sponsors were deeply involved in ensuring the solution put forward met the agreement of all the stakeholders involved. (Step 4).

Multiple variables must be considered when designing a technological solution. It is about People and how the technology aids them in completing their day-to-day job, satisfaction and learning. This required the Project Team to select a blended solution that responds best to the organizational and environmental analysis. Technology was approached from end user-driven design in prototyping, scanning of future trends in Business Intelligence and Artificial Intelligence and integration of proven and emerging knowledge management approaches. The People side was approached from competency development (creating a Business Steward role), roles and responsibilities needed to assist with CS adoption, change management, optimization, and ongoing management of the site (Step 5).

The HPT model proved helpful in identifying the steps in the selection of interventions and prioritizing the ones that create the bundle for the blended solution.

3. Operations Phase - Orient strategically for the future

Embedding digital transformation in organizations by implementing knowledge management approaches encourages engagement by making it easier for the worker to look for, capture, and transfer knowledge in the course of their jobs. Best-practice organizations drive knowledge management further into the flow of work by incorporating knowledge-sharing behaviors in employee performance goals and discussions. With CS clients, the approach was to implement the innovative approaches in the flow of the worker. This was achieved by mapping the CS functionalities and tools to their particular business scenarios from daily activities. It was similar to setting directions on a map from point A to point Z. These scenarios were made available in a Wiki and benefits were identified for each group of functionalities. This activity made the transition easier for staff, from current to new processes (Step 6).

The implementation for this type of transformation in operations involves the cross-functional team and Sponsors. They play different roles now in comparison to the pre-project and project phases and emphasize different implementation strategies depending on client readiness. The cross-functional team now operates following a Service Level Agreement put in place to clarify roles and responsibilities for the team and the type of requests that need to be addressed during the ongoing use of the CS sites. In the Operations phase, the Sponsor is represented by the leader of the business portfolio/department/area. For them, it was important to model different implementation strategies based on their current workload. For example, some Portfolio leaders decided to implement first at the department level (core set of

Business Stewards that will master the usage, then bring the rest of the users on board) or Portfolio leaders decided to implement in all areas at once (assign Business Stewards for all areas and trained in the same time). Depending on their choice, different change management, education, site development approaches were used (Step 7).

To be able to evaluate implementation strategy and business impact, an enhanced support model for workers was developed. Lessons learned from previous implementation informed us that a self-serve model was not enough for the changes brought by digital transformation. The enhanced support model included: Request Log where Business Stewards submit their asks for troubleshooting, need for more training or functionalities to support specific needs; Frequently Asked Questions (FAQs) in the format of an online list that collates the questions and answers from business areas and is grouped on topics (access, security, content, how-to's, etc.); Webinars, conducted to transfer knowledge through simulations and case studies; and Touchpoints, online classrooms to assist with skills reinforcement using job shadowing. Self-Serve tools were also made available, such as Help and Training Library with 92 resources available based on topic, type of support tool (job aid, training bite, video, guideline) and role (Business Steward, End user) (Step 8).

A lessons learned repository was built to capture insights from the training with Business Stewards and users, implementation strategies, challenges and approaches to respond (Step 9).

As business areas started to use the Collaborative Sites, different performance tools were developed for them. The set of tools included: Service Model, a document that specifies the type of changes, updates the Business Stewards can apply to CS or when they need to ask for support, as well as the approvals they need to obtain before applying changes; Business Rules, a document that specifies the management of the site (content audit and archive, user access and permissions, purpose of different tools, transfer of duties in case of transfers/turnover, etc.); and a Change Management Guide developed using the ADKAR (Awareness, Desire, Knowledge, Ability, Reinforcement) model to provide the business areas with a diagnostic tool and related interventions.

Training evaluation – conducted via surveys at the end of each training session, provided us with feedback on how to improve while we were provided training; CS platform evaluation – all the input provided by users was collected in an optimization list and during the first year of implementation, we addressed 40 bugs and improvements; Business impact – time savings, easy access to information were important output measures. An ROI calculation was completed for only one of the CS functionalities – meeting management. The result demonstrated that the new way of coordinating meetings was more efficient, with an ROI of 120%. The analysis of the usage of these tools assisted the team to optimize a solution based on user feedback (Step 10).

HPT framework was helpful in identifying the blended solution needed during implementation and maintenance.

4. Post-implementation Phase - Champion and orchestrate change

4.1.3 Setting up a mechanism to inform leaders about adoption and user engagement

Significant efforts were made to start the wheel of change and the switch from current ways of doing things to the new ways. How can we sustain and scale the adoption? Drive change in planning and implementation is one important strategy. Effective adoption and engagement measures have to be designed and implemented. Adoption becomes powerful when business areas become owners of the change. Structured mechanisms to continue the adoption of CS (monthly meetings with the CS leads and Business Stewards) were put in place. In this way, they could field the type of questions and issues that arise in the user community, address and deploy different approaches to respond. Knowledge management team attended the meetings to respond and provide guidance (Step 11).

Gamification features were enabled to showcase best content, author, contributor using badges, and ratings. These features developed new behaviors in the users and increased motivation to participate and contribute and overall facilitated change across professional cultures, creating capacity and assessing readiness for change (Step 12).

To sustain change, markers of success had to be identified. Best practice organizations measure the extent to which employees are actively contributing, sharing, accessing, and reusing content. Overall engagement rates represent good indicators of health since workers are likely to participate only if the tools are ready to use and content provides a tangible benefit (Step 13). In the CS instance, the analysis of the markers of success continuously informed us what the users needed to optimize in their flow of work. Examples included:

•Request log analysis identified thirteen specific needs that needed to be addressed for different business areas by building solutions to enable efficiency in operations (e.g Educators Hub, Operations and Tracking Log, Project Management Wiki, Course curriculum, registration and management, Research libraries, etc.)

•User Survey analysis identified the need to redesign the Help and Training resource to improve search and find based on user's feedback after 1 year of implementation (Categories: user's roles and group of resources, such as governance, document, project and meeting management)

•Request log analysis informed the implementation team on the type of requests and how to organize themselves in order to become quick in response and follow up actions. The analysis showcased that technical support was the top on the list, followed by education, access issues and enhancement requests

•Education needs analysis required the creation and delivery of an education offering focused on document organization

•Enhance the CS analytics to inform users and leaders about the usage of the site (storage, size of files, types of files). Dashboards and a Content Audit Guide with tools and checklist were developed to assist users in deciding which content to keep in the sites that is critical, relevant and up to date. See Figure 8.

Confirmative, meta-evaluation and communication plan elements from the HPT framework were applied in this context.

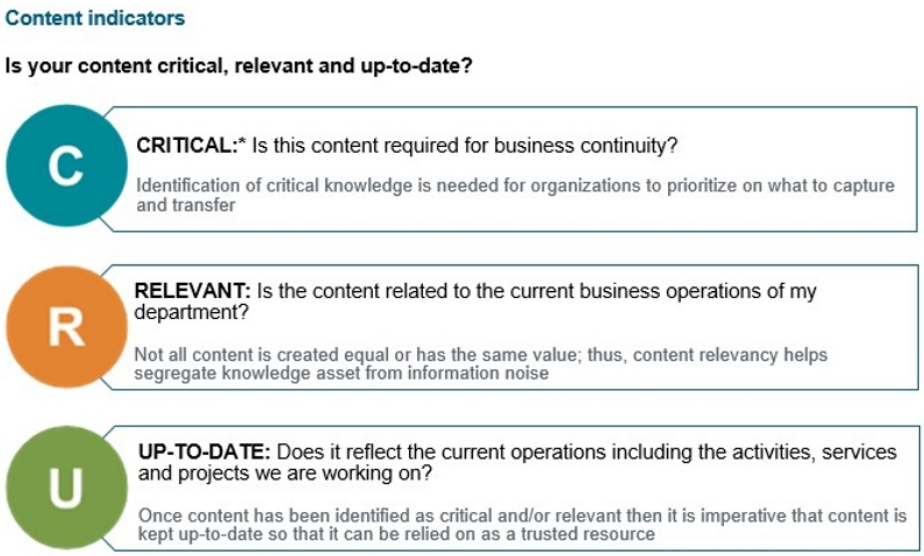

Figure 8: Content indicators that trigger audit actions

To sustain change, leaders and users need tools that measure and present in a snapshot the activities in the site at individual, tea, and department level. A content and web analytics framework was developed to respond to the leadership needs to visualize the status of the CS implementation in their areas (see Figure 9). A set of measures were identified to emphasize user adoption and participation, efficiency and quality, engagement and satisfaction.

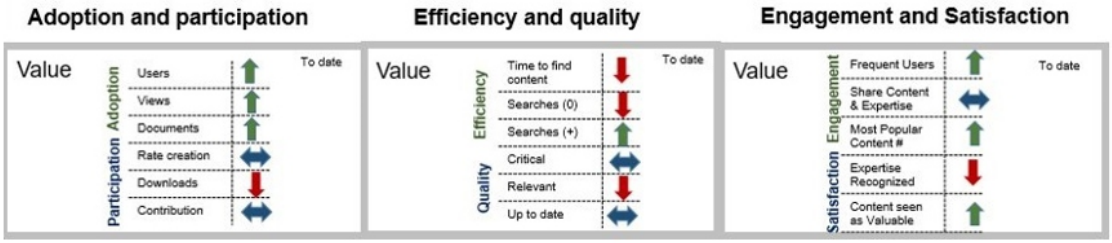

Figure 9: Business Value: Content and Web Analytics Framework

Dashboards and Information Sheets on how to interpret and intervene were developed and launched to the CS users after 2 or 3 years of implementation. For each measure, for example, "Adoption", the Information Sheet included details on: How do I interpret the data? Trends; How do I intervene to course correct? This became a handy diagnostic and treatment tool for leaders to decide the best path forward to improve adoption of digital tools.

4.2.People: Business Stewards Program
4.2.1 Developing the knowledge of how the change will affect the workers

A role called Business Steward was created to aid implementation of the technology (Collaborative Sites), ensure effective management of individual SP sites, and reinforce best practices. Online education and performance support tools were offered to increase their adoption and use. Business Stewards represented the direct connection between the business area (leaders, owners, end users) and Knowledge Management Team.

Their responsibilities are to: champion CS uptake; master CS functionalities (45 functionalities related to the engagement, collaboration, management of meetings, projects and reporting) by completing six training webinars; follow continuing education and training offerings; train team members (end users); follow the CS Service Model to inform what requests; approvals are to be in place for changes to the CS; contribute to the

evolution of the CS and works across teams for consistency; communicate with leads, owners about changes or newly identified needs; use the CS Education and Training resources; administer user access to the C; maintain CS, auditing site from content and access perspectives.

Business Stewards needed to be equipped with new knowledge and skills for the digital workplace. As Business Stewards learned new skills while completing other jobs for their role, which we call knowledge above the flow, a gradual learning path was developed to assist with easy learning and application (see Figure 10).

The training was divided by timing of delivery: during CS implementation with two layers of complexity (awareness and intermediate), and after CS implementation when the Business Stewards have learned how to use the functionalities and now are ready to accumulate more skills on how to manage the CS (advanced).

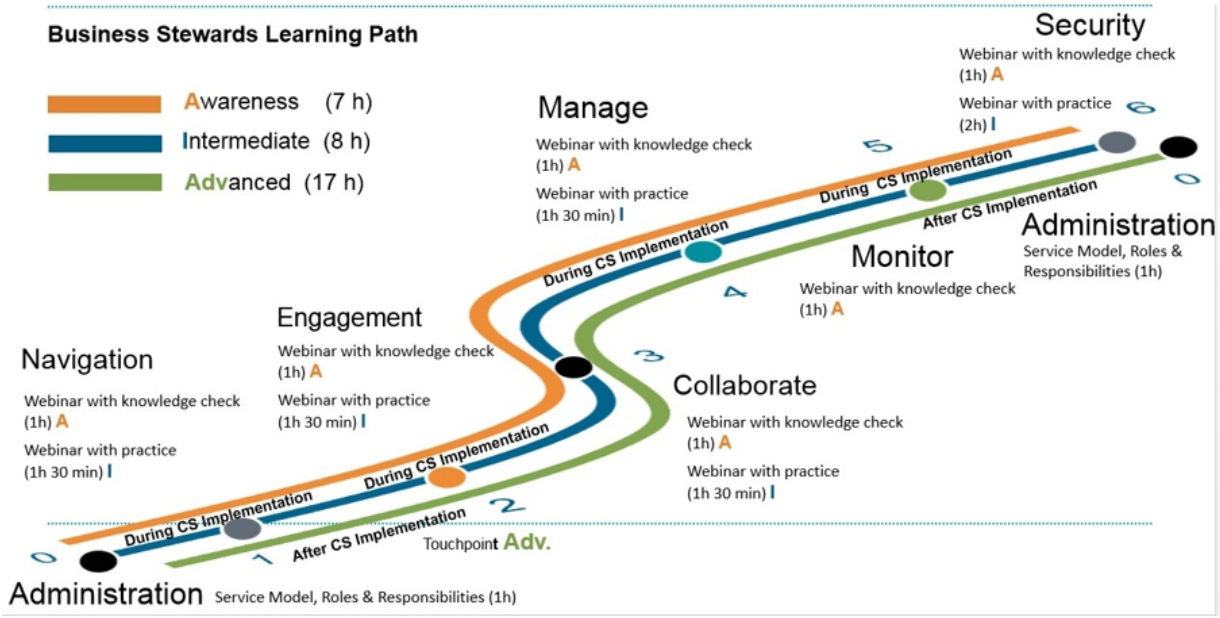

Figure 10: Business Stewards Learning Path

Upon completion of the modules (Administration, Navigation, Engagement, Collaborate, Manage, Monitor, Security), the Business Stewards received a Certificate of Achievement that highlight their enhanced capabilities in digital work.

4.3.Technology: Knowledge management approaches integrated in functionalities

The AHS information and knowledge management need was addressed by analyzing best practice organizations and implementing relevant knowledge management approaches that made sense in the context of the organization: demonstrated business value, increased people engagement and enhanced collaboration. A mapping was completed to connect the pain points identified by the stakeholders (need for more engagement, sharing, collaboration, management and monitoring tools) to proven (e.g., lessons learned, knowledge base, Communities of Practice, etc.) and emerging (e.g., Ask the expert, newsfeeds, analytics-dashboards) knowledge management approaches (see Figure 11). Technology features were aligned to develop the tools that covered these approaches. Twenty knowledge management approaches are embedded within CS (7 proven, 13 emerging). This ratio also indicated the need for a concerted effort for both education/training and change management.

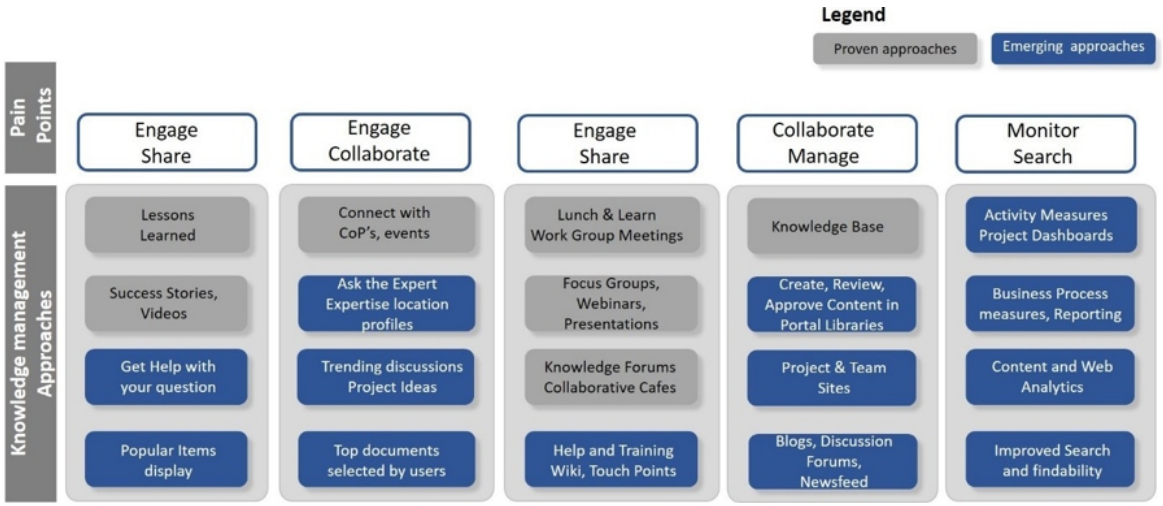

Figure 11: Proven and Emerging Knowledge Management Approaches Embedded within CS

1.Conclusions

Enhancing stakeholder engagement in digital transformation initiatives require robust process and people- focused foundations in order to be successful and sustainable. The strategies and blended solutions can include a wide range of permutations between the change management, knowledge management, and performance improvement domains. Organizations can achieve digital transformation while driving deeper engagement and better results for the business. Rebalancing mind and machine, platform and product, and core and crowd represent the future of the work and organizations. There are eight aspects that require continuous attention when leading these types of changes:

5.1People

1.End User adoption – clearly explain the reason for the change and engage them through the entire change process and WIIFM (What's In It For Me) and business value.
2.Dynamic stakeholder engagement – stakeholders continue to be actively involved and responsive in the post- implementation phase, continuing to model adoption and business rules.
3.Create new working relationships – recognize the need to act and build competencies in users, as well as modeling the change with mentoring and coaching to make it work.

4.Workers' role changes – machine/technologies replace repetitive tasks in the flow; however, a set of skills remain the domain of people. Science, technology, engineering, and math are valuable for programming and decision making; Creativity - thinking outside the box to handle exceptions; Social skills – empathy, motivation, and interpersonal skills are crucial for managing information, decision making, and collaborative efforts. Physical dexterity – machines can dominate in the world of robots, but many jobs require dexterity that only human touch can achieve.

5.Managers' role changes – enable experimentation and data-driven decision making and help teams design good experiments and make fair and objective analyses that lead to the “best” answer; develop coach-like approaches for team members, developing them towards high performance and helping them build on their strengths and mitigate their weaknesses; set a context and vision for the team, and constantly work to align the workers to that vision.

5.2Processes

1.Enhanced support model – be available to provide training; respond to questions; support learning at all levels (beginner, intermediate, advanced); make resources available to build and maintain trust and performance.

2.Value of feedback to optimize – be responsive to user feedback before, during and after implementation; demonstrate through follow-up updates and improvements that their input counts.

3.Continuously evaluate – evaluate what you do; capture gaps and opportunities.

Collaborative Sites were implemented in 23 departments, the corporate business area and few hospital administrations. This represents a limitation. If implemented organization-wide, more lessons learned could be drawn and the digital transformation strategy and roadmap adjusted accordingly. Collaborative Sites continue to evolve, driven by priorities in the organization, user identified needs, and progress in technology. This represents another limitation and challenge.

Next steps include analysis of the specific needs and development of a toolkit of templates that can be used across the CS users, automated workflows for repeated steps and Artificial Intelligence/Machine Learning to support users with their questions (chatbots, sentiment analysis). The challenges ahead relate to the constant rebalancing required to fine tune the digital transformation engine.

Acknowledgements

I would like to express my appreciation to Barbara Brady-Fryer, PhD, Senior Provincial Director, Knowledge Management, Marc Leduc, Senior Provincial Director, Health Evidence and Innovation, Patty Wickson, Executive Director, Innovation Evidence Evaluation and Impact, Provincial Clinical Excellence for sponsoring the collaborative site project, continuous mentoring, support and guidance. I want to thank the following colleagues from Knowledge Management Technology team for helping finalize the project and assist with implementation and post implementation: Moushir Elbishouty, PhD, Sr. Consultant, AbdAllah ElSheikh, MSc, Sr. Consultant, Bijan Farhoudi, Msc., Sr. Consultant, Jackie Sibilla, Consultant, Octavian Cismas, MLIS, Consultant, Tracey Ohrn, Consultant, Ellie Kim, MAS, Sr. Consultant, Ken Raeside, Sr. Consultant and Brianna Kopp, Sr. Consultant. I give special thanks to my family – Mihai, Ion, Florinuta and Nicolae – for always being there for me.

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‘Good to know’: An Exploration of the role and Influence of Professional Ethics in ICT Bodies of Knowledge (BoKs)

Clare Thornley1, Wanda Saabeel2, Shane McLoughlin3 and Sinéad Murnane1
1Innovation Value Institute, Maynooth University, Ireland
2Promanad, Rotterdam, The Netherlands
3LERO, Innovation Value Institute, Maynooth University, Ireland

A B S T R A C T

:As our dependency on ever-more complex, opaque, and ubiquitous information and communication technologies (ICTs) increases, ethical concerns about the development of those technologies are also rising. One approach to mitigate these concerns is to improve the maturity of the ICT profession through codification of its knowledge base and professional ethics. In this paper, some key theoretical approaches to ethics with a long-established tradition within Philosophy are explored and how these approaches may manifest in the codification of knowledge within ICT Bodies of Knowledge (BoKs) is discussed. BoKs provide a common vocabulary and knowledge inventory to aid communication and encourage shared values and practices, particularly in emerging professional areas such as the ICT profession. Thus, identifying and understanding how ethics are codified in ICT BoKs is important for maturing ICT professional practice in general, and more specifically, for the resolution of ethical concerns. This paper 1) explores considerations and approaches to how ethics are incorporated within ICT BoKs, and 2) conducts content analysis on how ethics are codified within the content structure of ICT Boks. It is found that theoretical ethical approaches are rarely explicated cited in BoKS though, in the more mature BoKs, the discussion of ethics does include consideration of most of the major philosophical approaches. The implications of how knowledge about ethics is described and integrated into the wider knowledge infrastructure of the ICT profession including curriculum guidelines and accreditation processes is discussed. In a wider contribution to the Knowledge Management discipline, potential lessons to increase maturity for other emerging professions through the development of BoKs are also outlined.

Keywords: Bodies of Knowledge; knowledge codification; ethics; ICT profession; Knowledge Management; professional education

1. INTRODUCTION

Knowledge Management (KM) concerns knowledge, but what kind of knowledge is ethics? This is not only a question for individuals but also plays out in the workplace and wider society. How can we know what is 'good' and how can we get better at doing it? If we have better knowledge of what 'good' is and how to behave in ethical ways, does this make it more likely that people's behaviour will improve? The concept of professional ethics is familiar within our understanding of established professions, such as Medicine or Law. If professionals have expert knowledge and power over important parts of our lives, for example our health, we expect them to be responsible and ethical in how they operate. We also expect them to have knowledge of their own professional guidelines and to know how they might work

in practice. In contrast, professional ethics are less defined or understood in newer or emerging professions such as the Information and Communications Technology (ICT) profession. The question of how the ethics of emerging ICT professions are codified and managed is becoming progressively more important in light of society's growing intertwinement and dependence on ICT, particularly given newer technologies such as AI and IoT (Lemonne, 2018). Many major safety critical infrastructure systems, for example, are increasingly dependent on ICT. As the complexity, iteration, and pervasiveness of ICT in all facets of life increases, and as significant risks of negative impacts of ICT emerge, public concern about potential ethical implications also increases. Simultaneously, as these technologies develop, new professions start to emerge around them. As these professions mature, their knowledge is codified, and processes are put in place to consolidate and share knowledge, as well as develop a shared sense of ethical professionalism. Over time, knowledge about ethics becomes more embedded within the profession. Professional ethics is distributed throughout all professionalism documentation, i.e. codes of ethics, certifications, accreditation, etc. Ethical issues or questions are addressed in a more integrated fashion and are seen to shape other areas of professional knowledge.

Reference this paper: Thornley, C., et al., 2021. 'Good to know': An Exploration of the role and Influence of Professional Ethics in ICT Bodies of Knowledge (BoKs). The Electronic Journal of Knowledge Management, 19(2), pp. 150-164, available online at www.ejkm.com

As professions develop, they generally codify their expert knowledge in a structured document described as a Body of Knowledge (BoK). A BoK is a structured representation of the proposed and/or practised knowledge needed to function as a profession, as well as its scope or jurisdiction. In many cases, these BoKs are described as a reference guide to 'the Body of Knowledge'. Thus, they are often explicitly defined as a partial 'snapshot' of the full Body of Knowledge, which exists in multiple publications and the expertise of professionals. These are nearly always developed by a relevant professional body or organisation, though some can be developed through government policy initiatives. Importantly, these often explicitly cover some description of professional ethics within that domain as well as often implicitly reflecting an ethical posture in various ways. The inclusion and degree of ethical knowledge in BoKs (or indeed, its exclusion) is itself an ethical stance. The very existence of BoKs and their knowledge claims in identity forming and empowerment of groups has ethical implications. Similarly, a BoK's knowledge claims and their application in structuring or producing a 'legitimate' profession may have wider societal ethical implications (Greenfield, 2017). A BoK invariably reflects ethics, explicitly or implicitly, which will have intentional and unintended ethical implications. Thus, both knowledge and ethics are central to the concept of professionalism (Saks, 2012). BoKs do not operate in isolation but both represent and influence the education, training,

, and practice of the profession, through books, curricula, accreditation, etc.

Getting better at developing usable and relevant BoKs, as well as considering and incorporating ethics, is an important current policy and social issue for the ICT profession (EU Commission, 2018). Despite this increased policy focus on ethics and ICT related BoKs, they have received little corresponding academic attention. In light of this, this paper examines the current state of play regarding the integration of ethics within ICT professional BoKs. The following research questions guide this study:

RQ1 How is ethics codified within the content structure of ICT professional bodies of knowledge?
RQ2 How does the treatment of ethics in BoKs relate to the main ethical theoretical approaches?

To address these questions, we begin by (1) exploring existing literature at the intersection of ICT Professionalism, BoKs, and ethics. We then (2) conduct content analysis on prevalent high-level ICT BoKs that influence the ICT profession. Furthermore, (3) we select three BoKs that have the highest level of ethics integration and we analyse them further to gain deeper insights into their approach to ethics.

Finally, we carve the path to a research agenda connecting ethics and its relationship to professional knowledge. The nature of how ethics can be integrated into BoKs and how this may be linked to known ethical theoretical approaches is discussed. The possible implications for more effectively integrating ethics into other tools or aspects of professionalism are then outlined. Whilst we contribute to the understanding of knowledge about ethics within the ICT profession, insights gained may also be applicable to other professions, particularly those newly emerging.

The contribution of this study is threefold. It is the first analysis of how knowledge about ethics is codified in ICT BoKs and how this relates to wider ICT professionalism. Secondly, in the more detailed analysis of the high maturity BoKs, it develops an initial framework for how the three main ethical approaches relate to different approaches to discussing ethics in ICT professionalism tools and documentation. Thirdly, arising from these findings, it discusses the ways in which this may increase our understanding of the relationship between knowledge, ethics, and professionalism. This is an important contribution to KM both theoretically and practically, informing approaches to improving how knowledge about ethics is managed and developed within any professional sphere. Getting better at understanding the nature of professional knowledge and how it relates to professional ethics is only going to get more important as expert knowledge becomes increasingly specialised.

The paper is structured as follows. In section 2, we overview the core concepts of this paper: : ICT Professionalism; Bodies of Knowledge (BoKs); Curriculum Guidelines and Accreditation; Ethics; Professional Ethics. The relationship between Knowledge and Ethics is also discussed. In section 3, we outline our method for BoK selection and approach to analysis. Section 4 presents the results of analysis and introduces the framework of the key themes and ethical theoretical approaches. Section 5 is a discussion of the potential impact of how different approaches to the codification, description and integration of ethics within professional BoKs may influence how ethics is incorporated or not into professional identity and practice. Finally, section 6 draws some conclusions on the implications of this study for KM as a discipline and how insights from ICT BoKs may have possible lessons for other emerging professions. This concludes with some suggestions for future research on the topic of ethics and knowledge within the ICT profession.

1. Literature Review

In this section, we discuss the nature and scope of ICT as a profession, as well as significant developments in relation to research and policy linking the ICT profession with ethics. The major theoretical approaches to ethics are introduced with some discussion about how they manifest in the context of ICT. It also covers the focus of this paper, i.e. the nature of Bodies of Knowledge (BoKs), and associated professional documentation including curriculum guidelines and codes of ethics in more detail. This general overview provides context to the subsequent discussion as well as the wider research agenda of ethics, knowledge, and ICT professionalism proposed in the conclusion.

1.1ICT professionalism

ICT is a hard topic to define clearly and professionalism is a disputed concept. Grasping these combined concepts is therefore rather complex. The 'European Centre for the Development of Vocational Training' (CEDEFOP) defines ICT professionals in terms of, 'conducting research, planning, designing, writing, testing, providing advice and improving information technology systems, hardware, software and related concepts for specific applications. They develop associated documentation and design, develop, control, maintain and support databases and other information systems to ensure optimal performance and data integrity and security' (CEDEFOP, 2016). This implies the scope of an ICT professional can be quite varied, in terms of research, practice, and ICT focus, with ethical considerations more explicitly evident concerning data integrity and security.

In relation to the exact nature and value of the professions, there is a long disputed historical debate on their role, as observed by Saks (2012), whilst Eraut (1994) discusses 'newer' professions such as education and their struggles to gain equivalent autonomy and status compared to more established professions. Within ICT, there have also been some robust debates on the relevance of professionalism to the field. In Australia, for example, one author argued 'that Computer Societies have been bewitched from the pursuit of their humanistic objectives by the lure of professional status' (Holmes, 1974, p.127).

Here we see that professionalism, as well as incorporating ethics, may sometimes be perceived as a distraction from ethics. Despite these debates, authors generally agree on the importance of a profession's relationship to at least some expert knowledge, and that some ethical approach be adopted. As expert knowledge is key to professionalism, with ethics also important in this regard, we examine how they can be connected. Ethics in terms of professionalism is also distinct from general ethics as it explicitly applies only to those within the profession: the possession of expert knowledge bestows particular ethical obligations.

Connecting ICT professionalism with ethics is particularly salient in relation to high profile disasters and frauds caused or enabled by ICT, which can severely weaken public trust in ICT and those who develop and use these systems. In parallel, there is growing concern about ICT ethics and an emerging consensus that ICT ethics must be explicitly addressed (van der Linden et al., 2017) as part of the general drive towards professionalism. As the ICT profession is relatively immature compared to the well-established professions of Law and Medicine, and as society's dependence on ICT increases, it is imperative that standards improve. Furthermore, maturing the ICT profession can have associated economic and social benefits. For example, this could include a reduction of risks posed by ineffective development and use of ICT, due to poorly trained ICT labour with inadequate ethical awareness.

There has been some prior research and policy work on maturing the ICT profession within the European context (McLaughlin et al., 2012) which has developed a model of ICT professionalism based on literature analysis and data collection from stakeholders. The model consists of four building blocks: a) Competences; b)Bodies of Knowledge; c) Education and Training; and d) Professional Ethics. 'Competences' are primarily concerned with workplace skills, which can be practically demonstrated; 'Education and Training' are concerned with improving consistency and standards, in some cases through certification; 'Bodies of Knowledge' concern developing an agreed core structured knowledge reference; and 'Professional Ethics' is about improving the level of ethical knowledge, behaviour, oversight and responsibility within the ICT profession.

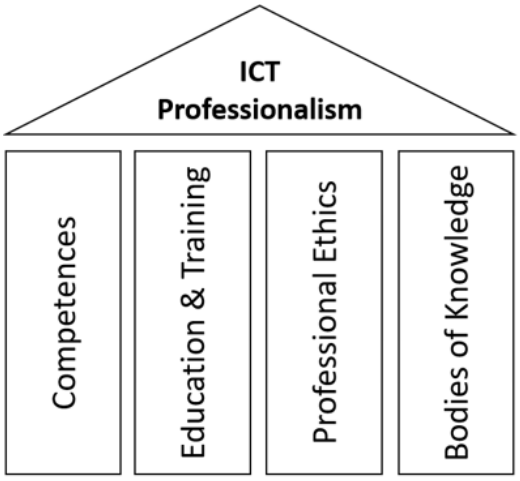

Figure 1: The Pillars of ICT Professionalism (adapted from McLaughlin et al., 2012)

The European Commission's policy drive for developing ICT professionalism, as part of the overall Digital Europe Strategy (The European Commission, 2019), aims at maturing these building blocks in an integrated way. The key question, however, is: how exactly can these building blocks be integrated both conceptually and in practice? It is not too difficult to integrate a competence framework into a training programme (Sanz et al., 2018), nor is it problematic to consider how to use a Body of Knowledge as part of developing competences. Ethics, however, does present a challenge in terms of integration, as it appears to have important differences from the other types of professional knowledge. The path is less clear than the other aspects of professionalism as people can disagree on ethical priorities and there are some cultural differences (Sherry, 2013). A recent review of ethics as part of ICT policy revealed both core agreements and differences within the EU, for example, former Eastern bloc countries held different perspectives than some Western European countries (Thornley et al., 2018).

Indeed, dilemmas and complexity are often highlighted as key parts of ethics and ICT (Runciman, 2019; Thornley et al., 2011). Some areas of ICT raise particular concerns in terms of transparency and accountability, such as Artificial Intelligence (Koene, Clifton and Hatada, 2019) and efforts have been made to map their internal workings to visible connections to known moral norms (Tubella et al., 2019) . Many ICT professional areas are cross-sectoral in that they directly affect and support a very wide range of sectors outside ICT. Cyber security, for example, is critical to many sectors and articulating cyber security ethics in all these varied areas is challenging (Yaghmaei et al., 2017) with many complex ethical trade-offs. The potential ethical implications of the increasing role and ubiquity of data is a broad concern and this is addressed as a business issue in the professional literature (Lynch et al., 2016) as well as in the more academic sphere (Floridi and Taddeo, 2016). Regulating the ethics of emerging professions can also be seen as a challenge to their independent professional status in some cases (Eraut,

1994) and can be a difficult balancing act.

2.2. Bodies of Knowledge

Part of KM is about enabling knowledge sharing through effective codification. Bodies of Knowledge (BoKs) are explicitly designed to model, codify, and share common core agreed knowledge, normally for specific professional groups. A BoK is knowledge codified to make it easier for professionals to complete their duties and tasks. BoKs are both normative (this is what a professional should know, in some cases with priority areas defined) and descriptive (this is some detail on the content of knowledge that professionals need). Their content structure generally contains a section explaining the purpose, scope and intended audience. The knowledge they describe/define is grouped into categories/areas KA and subdivided into further knowledge items (KI) or units (KU).

From our study of ICT BoKs, regarding the 'types' of knowledge they include, it can cover concepts, models, theories, and methods. These can vary in the degree of abstraction depending on the nature of the profession and how specific the particular BoK is. Some BoKs allocate different knowledge items into specific levels of professional knowledge depending on how advanced or specialised they are. More commonly, some Knowledge Areas or Units are mandated as essential for all professionals, whilst others are allocated to specific professional sub sectors. The question of how to include ethics within ICT BoKs has received more attention recently, and will be discussed more in the findings section, but there are acknowledged tensions between demonstrating that 'ethics' is everywhere for everyone and also including enough detailed ethics content to actually guide teaching and professional development. BoKs exist for many professions but are normally only discussed or critiqued when a nascent profession feels it needs one, e.g. recent work on requirements engineering (Penzenstadler et al., 2013), or when a major update is required, e.g. project management (Morris, 2001).

BoKs are explicit knowledge, according to Nonaka's (1994) distinction between explicit and implicit or tacit knowledge, as they are always written down or 'codified'. At the same time, they draw heavily on tacit knowledge as they are typically devised through consultation with experts. The method of their development generally involves a literature review of key sources to identify topics and new trends and then a consultative period (Sefton, Shea and Hines, 2011) to consolidate and attempt to reach consensus. While there is no single agreed method for development, this broad outline is used as a common approach (Morris, 2001; Morris et al., 2006) though different professions rarely acknowledge methodological input from other professional BoKs. So far in our literature review, we found no real input in BoK development from KM expertise on knowledge codification, such as expertise on

improving elicitation methods (Gavrilova and Andreeva, 2012).

BoKs are not only a recent development but are discussed in an historical sense when studying books or artefacts that represent specialised ancient knowledge such as Shamanism (Rutz, 2013). They are often afforded a kind of reified status and are described as ontologies, 'representations of', and in some cases, have an almost totemic status (Durkheim, 1912) in symbolically externalising the shared identity of a profession. This is particularly notable in the rhetoric of BoKs in emerging professions, such as massage therapy (Sefton, Shea and Hines, 2011). They can be linked explicitly to the human body as part of a critique of the tendency to focus on learning and knowledge as purely cerebral rather than embodied (Peters, 2004; Claxton, Lucas and Webster, 2010). Indeed, the term 'Bodies of Knowledge' as opposed to, for example, 'Knowledge Reference Guide', does perhaps indicate that BoKs suggest an incorporation of knowledge into the physical practices of a group. In many cases, BoKs explicitly claim that they are merely a representative artefact of the actual Body of Knowledge, which only exists in the sum of all relevant literature and the expertise of professionals. Thus they can be both a codification and an acknowledgement of the limits of codification, with no sense of perceived contradiction. They are knowledge with a clear purpose and codification is seen as useful insofar as it furthers that purpose. A BoK, however, does not need to claim complete exhaustivity or exclusivity of all relevant knowledge.

BoKs concern issues of identity, developing or furthering professionalism and, in some cases, claiming and disseminating knowledge by formerly marginalised groups. A strong example of this is the women's movement in the 1970s. Up until that time, medical knowledge about women's bodies was owned and controlled by the predominantly male medical establishment. The seminal book 'Our Bodies Ourselves' (Hawley et al., 1971) was developed and published by women in an accessible form, which also incorporated the lived experience of women's embodied lives (Davis, 2007). Both the book and the associated discourse around its publication are fascinating examples of the role formalising knowledge can have in creating shared identity and empowerment. Thus, whether BoKs formally include ethics within their structure or not, they often have a value driven motivation in their formation, development, and dissemination. These developments are not without dissenting voices, such as recent discussion on the validity and usefulness of the SCRUM Body of Knowledge (Kim, 2020) and the ongoing debate on the validity and objectivity of the Psychiatry Profession's Classification Manual of Mental Disorders (Spiegel, 2005).

2.3.Curriculum guidelines and Accreditation

BoKs are part of a wider domain knowledge infrastructure, being increasingly allied to competence

development through links with curriculum guidelines and competence frameworks (Morris et al., 2006) for their related professions. Curriculum guidelines are published by some ICT professional bodies and these provide more detailed specifications for the content, ordering, assessment, and delivery of courses. In some cases, the distinction between a BoK and curriculum guidelines is not completely clear cut. In any case, curriculum guidelines will refer to or include content from their associated BoK. If educational institutions then wish to have their courses accredited by the relevant professional body, they must include BoK content in their courses and structure it in line with the curriculum guidelines. In these cases, BoKs can have a particular influence as they flow directly into curriculum guidelines and are linked to curricula or course accreditation. This accreditation matters, as it demonstrates to potential employers that the course covers material deemed as essential and useful by the professional body. It can happen in different ways, sometimes quite directly as is carried out by the Australian Computing Society (ACS) and other times via another standards body as is done by the Association for

Computing Machinery (ACM). The way ethics is included and integrated in the BOK and associated processes, if done well, should result in professionals entering the workplace with the required ethical knowledge and skills to apply it. Accreditation processes linking to a BoK that includes ethics will require the accredited institution include ethics tuition in its accredited ICT programme, often with quite directive guidance on how this must be done, e.g. integrated within modules and as a stand-alone module.

Competence or Skills Frameworks are used more in continuing professional development (CPD) and professional education. The inclusion of ethics in these furthers the integration of ethics into professional development and identity. This increases the potential role of ethics in BoKs, as there is a push from educators and employers to incorporate ethics in professional education. This is partly due to decreased public trust in professions per se and how high profile disasters (Gelles, 2019) and privacy leaks have decreased public trust in the ICT profession.

For example, the IEEE has recently completed extensive work on ethics for AI and autonomous systems (IEEE SA, 2020) in response to growing public disquiet. The IEEE's initiative incorporates educational guidance and is moving towards certification. The recently updated European e-Competence Framework (e-CF, 2019) now includes ethics as a Transversal Aspect designed to influence all competences. There is also currently a European project, Ethics4EU, on improving the teaching of ethics in computing curricula (Ethics4EU, 2021).

2.4Ethics

Ethics generally concerns the study of what is right or wrong (or morals), why that might be so, and how humans engage with these concepts (Rachels and Rachels, 2019). This includes understanding systems of values, their application, and resulting implications. It has a long history of study within Philosophy and can be broadly grouped into three main approaches: virtue ethics; deontological ethics; utilitarianism/consequentialism. Virtue emphasises moral character and was initially developed by Aristotle (Aristotle, 350AD). Deontology emphasizes duties or rules and following those rules regardless of consequences. Finally utilitarianism (Mill, 1863) or consequentialism emphasizes the need to weigh up the positive and negative consequences of actions before deciding what is the right course of action to take (Hursthouse and Pettigrove, 2018).

Depending on which theoretical approach is taken, there are different perspectives on what knowledge about ethics might be. In virtue ethics, it is primarily implicit aspects of a person and their identity that guide behaviour, suggesting education and mentoring might be the best approach to impart knowledge/values and fully integrate it into a person's mindset and practice. In a rule-based approach, it suggests developing guidelines incorporating the correct ethical approach, and then ensuring everyone knows the rules and is compliant with them. This can include formulating and formalising code(s) of ethics. It may also include encouraging compliance by linking ethics codified in BoKs to graduate certification or even accreditation of the educational institute itself (i.e. curricula must be based on a BoK of which ethics is a part). The consequentialist approach requires the ability to weigh up the likely implications of actions, so it is in one sense knowledge or data driven. This is not straightforward, however, as the knowledge required to correctly assign ethical actions in different possible scenarios is different from gaining knowledge about what those scenarios may be. If taken at an individual level, it could also suggest a strong legal or compliance-based approach to ICT professional ethics, whereby ICT professionals would be obliged to behave in an ethical fashion due to fear of punitive legal sanctions if they do not. On a broad ICT level, this was part of the motivation for the heavy fines payable by organisations if they breach the guidelines of the European General Data Protection Regulation 2016/679.

Thus, we can see that one's view of 'what ethics is' affects the approach to improving ethical standards within a profession and how one might include ethics in a Body of Knowledge. It can also be dependent on one's view of the nature and role of a profession in relation to tackling ethics. The link between individual understanding and values, social or professional norms, and the connection between knowledge and practices are complex factors, which influence how knowledge about ethics plays out in a profession. There remains the concern that even if professionals are provided with very clear

knowledge about ethics that they may still not necessarily apply them in professional practice. This is an issue with a long history, as Aristotle was concerned with the problem of 'weakness of will' which is the paradox, as he saw of it, of knowing what is right and still failing to take the right action.

2.5.Professional Ethics

Professional ethics is strongly related to the general use of the term ethics but is by its nature less universal. Professional ethics, as codified and articulated in various ways, are explicitly only applied to the profession in question, not the general population (Davies, 2004). Since part of what defines a profession is an organised group of people bound by defined specialist knowledge they use for a certain purpose, we argue that knowledge and its use have a more primary focus in professional ethics than in ethics in a general sense. Professional ethics incorporates a sense of duty or obligation towards the people who use and rely upon the professional's services who, by definition, do not share all of the professional knowledge or they would not need to consult them. There is often a power disparity between the professional and the client and the professional has an obligation to use their knowledge in the interests of the client and not to betray trust. This does not totally trump wider social ethical obligations, though it can conflict with them quite strongly, for example, a lawyer defending a murderer in court even if s/he is personally certain they are guilty. Within ICT professional ethics, there may be cases when the social good would be seen as more important than the request of the client, e.g. a company requesting illegal surveillance, or an HR algorithm which disadvantaged women or black people. In these cases often, though not always, it is a rushed , short-cut approach which can inadvertently cause the creation of biased systems or noncompliant use of technologies. Thus the desire of company to reduce costs and increase profits can be in conflict with professional ethics.

Recent discussions on improving professional codes of ethics suggest moving away from a rule-based approach to a more principles-based approach. The American Institute of Certified Public Accountants (AICPA), for example, has recently added a new conceptual framework to their professional ethics by suggesting that all its members regard every questionable situation, circumstance, transaction, or relationship by attempting to view it through the eyes of an imagined reasonable third party (Spalding and Lawrie, 2019). There is also some suggestion to more closely link the approach to professional ethics with the existing practices and ethos of the relevant profession. This is demonstrated in recent work on the use of pragmatic care and design principles to inform engineering ethics (Nair and Bulleit, 2020) and incorporating ethics into the software design process (Gordon et al., 2020). Furthermore, recent work has also examined means of 'ethical deliberation' as a remedy to the uncertainties of the software design process, whilst acknowledging availability and constraints of time and resources

allocated to projects (Gogoll et al., 2021).

2.6. Professional Ethics Documentation

Ethics in most professions is not only implicit, but also explicitly codified in some way as a reference document. Similar to a BoK, this documentation is both aspirational and representational of the ethics that the profession espouses and enacts. In our study of ICT BoKs, we identified multiple methods of documenting ICT professional ethics, including codes, case studies, educational materials, and references to legal cases (ACM). Codes of Ethics usually include some general ethical principles then become more specific about how that might translate into actual conduct in practice. Some codes explicitly acknowledge that professionals may face situations where they perceive an ethical dilemma or a case where two ethical principles may be in conflict (e.g. privacy and public safety) and deciding on the 'right thing to do' is not a simple case of applying a certain ethical principle. Both the Association for Computing Machinery (ACM) and the Australian Computer Society (ACS) include case studies in their ethics material to allow education and discussion around ways to approach these dilemmas. The ACS in particular offer detailed guidance on how the case studies relate to particular parts of the codes of ethics.

The ACM discussion of the legal use of the ACM code is interesting. It has been used as a legal defence for professionals to refuse government requests for customer information, arguing that the right to privacy is a stronger ethical force that legal compliance if (and only if) that legal compliance is clearly anti-privacy. This demonstrates that professional codes of ethics, whilst not legally binding, are recognised within the legal profession as indicative of a profession's accepted practice and have a high standing. It is hard to envisage that if the ACM had failed to codify their ethics that a similar argument could be made just because 'the ACM generally thinks that privacy is very important'.

3. Method

3.1 Selection for review

The criteria for the inclusion of ICT BoKs in the review were authority, i.e. the BoK is from an established and known institution, and availability, i.e. it is possible to locate and access the BoK. A review of significant ICT BoKs involved initial selection through a literature search using the search terms 'BoK', 'Body of knowledge', or 'Bodies of Knowledge', combined with different ICT related terms, ranging from broader (ICT, IT, computer, software, etc.) to narrower terms (project, data, service, security, etc.)

to ensure comprehensive coverage. This was extended through searching websites from authoritative bodies and sources in the field. These BoKs indicate what is considered relevant knowledge for their specified field. The selection of BoKs were verified through two stakeholder meetings with experts in the ICT professionalism field who were selected on the basis they had published on the topic or contributed as experts to previous EC ICT Professionalism projects. Thus, the list cannot claim to be exhaustive, but it is reasonably representative.

Twenty-three BoKs were analysed in total. Six BoKs addressed the generic level of ICT management and seventeen focused on more detailed specialist areas. ICT has many different specialisms thus there are more specialist BoKs than generic BoKs but the more general BoKs often have a broader influence. As BoKs are often part of a suite of resources for a profession (i.e. knowledge infrastructure) including other items such as competence frameworks, codes of ethics and certification programmes, we also noted if the BoK referred to ethics material in related resources.

After examining how the BoKs incorporated ethics, we selected three, based on how well and thoroughly ethics was integrated in both their structure and content, and how that was further integrated with other tools of professional maturity, namely codes of ethics, curriculum guidelines and accreditation. In these high scoring cases, we reviewed how ethics was considered in the relevant BoK in more detail, examining key themes and drawing connections between different theoretical ethical approaches.

3.2. Analysis methods

We used content analysis through a reading of the full text of the BoKs and a final check using the search function in Word for ethics and related terms. Our first step was to ascertain where ethics was overtly incorporated within the overall content structure, i.e. scope, introduction, KI/KU etc. We then further examined the ways in which ethics were explicitly present in the BoKs, i.e. in definitions and concepts, and links to the domain knowledge infrastructure. We reviewed whether ethics was included as core to the BoK, i.e. as a knowledge item or knowledge unit within the knowledge structure. Next we examined where ethics was mentioned in other parts of the BoK, for example the introduction or purpose section. If the BoK had a separate references or literature section, we reviewed this list for sources related to ethics. The final analysis looked at how the BoK linked ethics to the domain knowledge infrastructure, i.e. to other professional resources such as codes of ethics, curriculum guidance, or incorporation into a professional certification process.

1. Results

4.1Summary Results from all BoKs

The results are analysed in two stages. First, we provide an overview of key findings with a summary table describing the main findings. Second, we explore how ethics is portrayed in three of the BoKs, selected due to their higher stage of professional maturity, in more detail.

Table 1 shows the results from the initial analysis and provides an overview of the BoKs surveyed, whether and how they included ethics, and if there were other ethics content sources available such as a code of ethics and/or guide to professional conduct. The main finding is that all but one of the BoKs we surveyed did include ethics in some way, the only exception being the 'Enterprise Architecture Body of Knowledge'. Even in this case the BoK mentioned ethics as important, which would be developed in the future. We then carried out some detailed analysis of the BoKs that included ethics, to ascertain if they could be usefully further categorised. We examined them to see where and how exactly ethics was discussed in the BoK. The results show the following key findings:

4.1.1Findings related to ethics within structure of BoK

- Ethics is most commonly a knowledge unit (18/23)
- Ethics in over half of BoKs is included as part of introduction/purpose/overview (12/23)
- Ethics is rarely the heading of a general knowledge area (4/23)

4.1.2Findings related to ethics within definitions and concepts of the BoK

- Ethics is rarely explicitly linked to leadership (2/23)
- Ethics is sometimes included in definition of professionalism (5/23)

4.1.3Findings related to link of ethics in BoK to other professional resources or processes

- Ethics included in the definition of professionalism tends to make it part of the certification process (3/5)
- The 2 that include professionalism but do not certify ethics have no certification process at all

Table 1: Overview of BoKs and ethics (*"n/a": item not applicable i.e. non-existent. **"?": no data could be found)

BoK Title	Ethics included in BoK?	Ethics as KA/KU/KI in BoK?	Ethics in other parts of BOK?	How is ethics included in other parts?	Ethics related sources in references	BoK linked to certification?	Ethics part of certification?	Separate code of ethics/ conduct?	Code of ethics mentioned in BoK?
GENERAL BOKs									
Core Body of Knowledge for ICT Professionals - ACS, 2015	✓	✓	✓	In definition ICT profession	n/a	✓	✓	✓	✓
Common BoK for Computing and ICT - CIPS, 2012	✓	✓	✓	In vision of BoK, in definition ICT professional	✓	✓	✓	✓	✓
Digital Practitioner BOKs - TOG, 2019	✓	✓	×	n/a	n/a	×	×	×	n/a
The European Foundational ICT BoK - EC, 2015	✓	✓	✓	In definition ICT professional	n/a	×	×	×	n/a
Domain description bachelor of ICT - HBO-I, 2019	✓	✓	×	n/a	n/a	×	×	×	n/a
Computer Science BoK - ACM/IEEE, 2013	✓	✓	✓	Work ethic critical; part of curriculum. Professional responsibilities	✓	✓	✓	✓	✓
SPECIALISED BOKs									
Business Analysis BoK v3 - IIBA, 2015	✓	×	✓	As behavioural characteristic in competences: short description	n/a	✓	×	✓	×
Business Process Management Common BoK 3.0 - ABPMP, 2013	✓	×	✓	Code of ethics: practical description of responsibilities	n/a	✓	?*	✓	✓
Cyber Security BoK 2.0 - NCSC, 2017	✓	✓	✓	ethical responsibilities', ethical hackers	✓	×	×	×	n/a
EDSF Data Science BoK v2 - IABAC, 2019	✓	✓	×	n/a	×	✓	✓	×	n/a
Enterprise Architecture BoK - EABOK Consortium, 2014	×	×	×	(Code of ethics important in future)	×	×	×	×	n/a
Enterprise Information Technology BoK - IEEE/ACM IT, 2017	✓	✓	×	n/a	×	×	×	×	n/a
IT Architecture BoK 2.0 - IASA, 2019	✓	✓	×	n/a	×	✓	?	✓	✓
IT Security Essential BoK - U.S. Dept.Homeland Security, 2007	✓	✓	×	n/a	n/a	×	×	×	n/a
Open Service Management Foundation BoK - OSM Alliance, 2017	✓	✓	×	n/a	n/a	×	×	×	n/a
Project Management Professional BoK 6 - PMI, 2017	✓	✓	✓	Term used in factors. Being ethical as quality of a leader.	✓	✓	✓	✓	✓
Quality BoK - ASQ, 2009	✓	✓	×	n/a	n/a	✓	?	✓	×
Scrum BoK 3.0 - SCRUM study, 2016	✓	✓	×	n/a	n/a	✓	?	×	n/a
Software Engineering BoK - IEEE, 2014	✓	✓	×	n/a	✓	✓	?	✓	✓
Systems Engineering BoK - IEEE, 2018	✓	✓	✓	Term mentioned in knowledge areas	✓	×	×	✓	✓

BoK Title	Ethics included in BoK?	Ethics as KA/KU/KI in BoK?	Ethics in other parts of BOK?	How is ethics included in other parts?	Ethics related sources in references	BoK linked to certification?	Ethics part of certification?	Separate code of ethics/ conduct?	Code of ethics mentioned in BoK?
The Information Management BoK - Blytheway, 2014	✓	×	✓	Ethical principles as part of case example	n/a	×	×	×	n/a
Usability BoK - UXPA, 2012	✓	×	✓	Terms 'ethical considerations' and 'ethical issues' used	n/a	✓	?	✓	×
Wireless Engineering BoK 2 - IEEE, 2012	✓	✓	×	n/a	×	×	×	✓	✓
Total (out of 23 BoKs)	22	18	11		5	11	4	11	8

We found two main approaches to including ethics in ICT BoKs, which are combined in some cases. The first approach includes ethics within the structure of the BoK as a general Knowledge Area (KA). Including ethics as a Knowledge Area brings it up a level of abstraction, strengthening its position and increasing visibility and coverage, though this approach is rare. More commonly, ethics is covered as a specific Knowledge Unit (KU) or Item (KI). This approach positions ethics as an essential piece of knowledge within the BoK, but it remains subordinate to the knowledge structure rather than being an overall or generally applicable concept. In most cases, where ethics was addressed within a KI or KU, the term is just mentioned without any further explanation or discussion. As a second option, ethics may be included as part of the introduction, mission, or purpose of the BoK. Here, ethics is presented as a general context but may not be intrinsically incorporated into the core of the BoK. Rarely, is ethics both discussed in the mission and identified as a core and common required knowledge area.

4.2 Analysis of selected BoKs

Three BoKs were selected for more detailed analysis. They were chosen because they had a high level of BoK maturity and linked closely to related ethical and professional documentation in their field such as certification and codes of ethics. All three were general ICT BoKs, rather than specialism-focused, so were more likely to offer broader insights for other professions. The three BoKs that were selected are as follows:

Core Body of Knowledge for ICT Professionals – Australian Computer Society (ACS), 2015

Common BoK for Computing and ICT – Canada's Association of Information Technology Professionals (CIPS), 2012

Computer Science BoK – Association for Computing Machinery (ACM)/Institute of Electrical and

Electronics Engineers (IEEE), 2013

We were interested to see if the approach in these BoKs to describing or codifying knowledge about ethics could provide useful insights for BoKs and related professions that wish to improve ethical standards and develop professional maturity. In particular, we were seeking any evidence of the use of ethical theories in how ethics and knowledge about ethics were discussed in these BoKs. We present our findings under key themes or

characteristics that emerged from these selected BoKs and review to find whether we can establish a connection between the BoKs and one or more theoretical ethical approaches.

Table 2: Overview of BoK ethical themes and theoretical approaches to ethics

	Virtue	Deontological	Consequential
ICT professionalism & societal aspiration	✓		
Ethical theories in teaching	✓		
Diversity and inclusion	✓	✓	✓
Limits of knowledge		✓	✓
Responsibility & consequence			✓

4.2.1 ICT professionalism and societal aspiration

The selected BoKs make strong aspirational claims about ICT and computing as a profession, its potential to dramatically affect society for good or ill, and the resultant responsibility of the ICT professional. This is stronger in the ACM/IEEE BoKs but the CIPS BOK makes explicit reference to the CIPS vision document 'CIPS in the 21st century'. This suggests an appeal to virtue ethics as it encourages intrinsic ethical values and a sense or personal ethical responsibility. It is also informative as it explains the enormous social and ethical implications of ICT and corrects immediately any view that ICT is merely a technical subject and profession. It is reasonable to conclude that in the more mature BoKs, the nature of the profession is explicitly extended beyond the technical and a conscious effort is made to instil a sense of responsibility and pride.

4.2.2.Ethical theories in teaching

The ACM/IEEE and the ACS discuss the nature of ethical theories and include them in guidance on what should be taught to students. The stated goals are to equip students with a deep understanding of ethics and to learn to apply theories and models in different situations. A key insight is that theories of ethics should be included but they must be integrated and related to specific problems or technologies and grounded in a discussion on what shared values will inform them. The ACS BoK states that this kind of ethical knowledge will take time for a professional to develop as they gain experience. Thus it is

both abstract and grounded in practice. The CIPS BoK includes ethical theories in its 'Professionalism and Ethics in Computing and IT' Knowledge Area and states that professionals should be able to deal with and manage ethical dilemmas. This Knowledge Area is also labelled Knowledge Area A and is the first one described in the BoK, which may possibly indicate primacy though this is not stated. The CIPs BOK categorises its knowledge into three levels and ethics is required at the highest level of understanding (application). The CIPS BoK also has an extensive ethics section in their reference list. Not all of the ethics references link directly to ICT, suggesting that a broader theoretical understanding of ethics is encouraged. None of the selected BoKs explicitly favours one or other ethical approach, nor select one as most appropriate to ICT.

4.2.3Diversity and inclusion

This is covered both in the sense that it is an ethical obligation to be aware of and respect diversity in race, gender, disability, etc. and also in acknowledging important cultural or national differences to professional ethics. Local adaptation of general values is generally seen as preferable to a full-scale acceptance of moral cultural relativism. Diversity of cultures and potential conflict is also covered, with guidance provided on approaching this through related professional documentation. Ethics is not just seen as an individual decision on particular work place issues but in most cases is linked to wider social and environmental concerns such as diversity, inclusion, and sustainability. The ethical approach taken in these sections of the BoKs is generally more pragmatic or consequentialist, with some appeal to virtue ethics. In many cases, of course, the equality and diversity issues are legally enforced so they are rule led or deontological but this has not been set by the ICT profession. Within ICT BoKs these values are portrayed as a given that one must respect and follow.

4.2.4 Limits of knowledge

A theme perhaps of most pertinence and interest to KM is that the very action of being clear on the content and boundaries of one's professional knowledge is identified in itself as a sign of ethical maturity. If ICT professionals are clear on their knowledge area and professional responsibility, they have an obligation not to act outside of this area and to honestly report if they are asked to operate outside of them. Professionalism is all about the limits of knowledge and the public acknowledgement of expertise held by the professional. The honest and explicit line between knowledge and ignorance is key. Failure to stay within one's areas of expertise can both be illegal and have terrible consequences, though this is not explicitly spelled out in its coverage within the BoKs. Concern for the limits of knowledge has strong philosophical foundations. The Socratic tradition emphasises very strongly the importance of humility and honest acknowledgement of ignorance (Plato, 399AD).

4.2.5Responsibility and consequences

ICT is acknowledged in all the selected BoKs as having a major impact on society and that many safety critical systems and infrastructures depend upon it. In the CIPs BoK, there is a specific Knowledge Item on Safety Critical Systems, which includes Public Safety as a component. Risk and safety are addressed in all three selected BoKs.

The discussion around these encompasses all theoretical approaches to ethics. An ICT professional has an ethical responsibility (virtue ethics), the consequences of error are potentially catastrophic (consequentialism), and there are also legal implications and rules (deontological ethics) surrounding these high-risk areas.

4.2.6 Power and inferred trust

There is strong theme in the BoKs that power gained by expert knowledge must not be abused. This is perhaps particularly urgent in ICT as it is often invisible power that the public are not aware of. The technology is also beyond what most in the general population can understand. This is usually addressed in the introduction section to operate as reminder of why it is important to be clear on knowledge.

4.2.7 Compliance

Knowledge of the relevant codes of ethics, legal obligations, and organisational procedures that help enforce ethics, such as whistle blowing, are also part of the knowledge content of these BoKs. This is in one sense a deontological approach and also makes clear that professional ethics is not the activity of a 'lone hero' but should be enabled by good management practices and effective legal sanctions within wider society. Thus is it included a specific knowledge item and, naturally, its inclusion depends upon reasonable professional maturity in terms of the existence of a code of ethics.

2. Discussion

This research provides some analysis and discussion on the relationship between knowledge, ethics and professionalism through the study of ethics within ICT Bodies of Knowledge. It has shown how BoKs are both implicit and explicit in their approach to KM and that they have the capacity to integrate ethical aspiration, professional mission, and detailed technical knowledge. A particular area of current concern regarding ICT ethics is transparency in the growing field of Artificial Intelligence. This study provides a perspective that can help ground some of the current 'moral panic' regarding such ethical issues in the

ICT domain. It demonstrates that one approach to tame this fear is to carefully articulate knowledge and directly relate it to professional identity and practice. The careful connection between the clarification of knowledge limits and ethics in these BoKs offers some insights into why there is so much public concern around AI, as with AI those limits are very difficult to define transparently.

It is clear from the analysis of the more mature BoKs that theoretical approaches to ethics are not explicitly called out as a justification for specific types of ethical knowledge but that all the major ethical theories are implicitly incorporated. The more mature BoKs require that ethical theories are part of the core knowledge of ICT professionals and this is generally explicitly linked to specific actual issues that will arise in practice. The stated aim is to equip ICT professionals with the theoretical tools and understanding so they can successfully identify assess and manage ethical issues in the workplace. This can be understood as a method to facilitate the integration of theoretical knowledge with personal values and professional practice.

This issue of integration and connection between theoretical knowledge and practice is echoed or reflected in the role that ethics appears to take in the maturity of the ICT profession. The highly developed BoKs we surveyed, which contained a well-considered and integrated discussion of ethics, also had the strongest connections to other various aspects of professional practice and knowledge such as accreditation. At the higher end of maturity, BoKS that include ethics in both their definition of professionalism and their certification and educational resources have more effective ways of sharing knowledge about ethics within their field. How a profession deals with knowledge and how it integrates this into its other structures is a sign of professional maturity.

6. Conclusions and future work

This section will examine two main conclusions of this work, firstly in terms of KM and secondly in terms of its implications for other professions apart from ICT. The first conclusion is what this work can mean for the development of KM as a discipline. As discussed in our literature review, we did not find any KM literature on the development or use of BoKs. BoKs are a fascinating combination of explicit knowledge that refers to implicit knowledge. They also have a complex purpose of sharing knowledge and linking to other knowledge processes such as education. Our work has shown how knowledge within BoKs contains ethical knowledge at both an abstract and more concrete level. BoKs are essentially a starting point for 'putting knowledge to action' and warrant further study as both a method and approach. Higher quality BoKs and a more widespread understanding of their role may help mitigate growing concerns about professional values and ethics in businesses and wider society.

Secondly, the insights that have been provided on the relationship between professional ethics and BoKs can also help inform other professions and new emerging ICT specialities. It demonstrates that ethics and expert knowledge cannot be seen as separate areas. The most benefit is gained when a profession carefully articulates the nature of ethics as knowledge and ensures coordination between different types of professional documentation and practices. It also shows that it is not surprising if the development of BoKs and professional ethics can cause conflict and disagreement. This will not be straightforward as professional knowledge is often disputed, and issues of power and identity will surface. As BoKs are often the first stage of professional maturity for new professions, it also shows that the considered inclusion of ethics into a BoK makes a solid ground for ethics in other professional processes such as education. Finally, the underlying assumption around most research and policy work on ICT professionalism is that it is playing 'catch up' with the more established professions such as Medicine and Law, which are highly regulated and have serious sanctions for professional misconduct. It might, however, be useful to critically engage with how these professions actually articulate knowledge about ethics in their BoKs and associated processes and see if the newer emerging profession of ICT may be able to inform or provide new insights into more established professions.

In terms of future work on the specific topic of ethics and professional knowledge within ICT, a more detailed analysis of how other professional documentation and resources consider ethics would be a useful next step. How exactly is ethics covered in ICT codes of ethics and other resources and processes such as accreditation guidance and curriculum development? In terms of the wider societal impact of ICT, a study of how ICT ethics is discussed in policy documents or relevant legal decisions would also increase our understanding of how knowledge about what is 'good' can actually be implemented in practice.

Acknowledgments

The authors would like to acknowledge the support of the European Commission in funding many ICT professionalism projects and in particular the key leadership role of André Richier.

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A Review of Literature on Human Behaviour and Artificial Intelligence: Contributions Towards Knowledge Management

Elizabeth Real de Oliveira and Pedro Rodrigues
Universidade Lusíada - Norte, Portugal

A B S T R A C T

The main purpose of this research paper is to understand how artificial intelligence and machine learning applied to human behaviour has been treated, both theoretically and empirically, over the last twenty years, regarding predictive analytics and human organizational behaviour analysis. To achieve this goal, the authors performed a systematic literature review, as proposed by Tranfield, Denyer and Smart (2003), on selected databases and followed the PRISMA framework (Preferred Reporting Items for Systematic reviews and Meta-Analyses). The method is particularly suited for assessing emerging trends within multiple disciplines and therefore deemed the most suitable method for the purposes of this paper, which intends to survey and select papers according to their contribute towards theory building. By mapping what is known, this review will lay the groundwork, providing a timely insight into the current state of research on human organisational behaviour and its applications. A total of 17795 papers resulted from the application of the search equations. The papers' abstracts were screened according to the inclusion / exclusion criterions which resulted in 199 papers for analysis. The authors have analysed the papers through VOSviewer software and R programming statistical computing software. This review showed that 60% of the research undertaken in the field has been done in the last three and a half years and there is no prominent author or academic journal, showing the emergence and the novelty of this research. The other key finds of the research relate to the evolution of the concept, from data-driven (hard) towards emotions-driven (soft) organisations.

Keywords: Human Behaviour, Big Data, Artificial Intelligence, Knowledge Management and Creation

1. INTRODUCTION

Understanding human behaviour has been crucial for businesses, for as long as businesses exist. How to unveil people behaviour regarding motivation, engagement, and loyalty towards a company? How to gain deeper insights into your customers wants and desires? Creating useful knowledge for businesses to act upon and build strategies is no longer a mirage if you consider how much technology has helped us in the last twenty years.

To shed some light into this body of knowledge, the authors undertook a systematic literature review focusing published academic research, which addressed the understanding of human behaviour through artificial intelligence, machine learning and the application of neurosciences tools.

The first moment in history where machines were viewed as having intelligence was when in 1950, Turing1 published his seminal article "Computing Machinery and Intelligence" where he described how to create intelligent machines, in particular, how to test their intelligence. This Turing Test is still considered today as a benchmark to identify intelligence of an artificial system (when a human interacts with another human and a machine and we are unable to distinguish the machine from the human). Today artificial neural networks and deep learning form the basis of most applications we know, they are the basis of image recognition algorithms used by Facebook, speech recognition algorithms that fuel smart speakers and self-driving cars (Haenlein & Kaplan, 2019).

We are surrounded by data, which is useless, unless it can be transformed into information, which then must be transformed into knowledge. Big data is in fact a big buzzword in recent years. Nevertheless, as described in a recent editorial from the Academy of Management Journal written by Simsek and colleagues (2019) there still is a great deal of ambiguity and even confusion on what Big Data is and what it means for organizational and management researchers.

Taming big data an artificial intelligence through machine learning can be the key to address many management issues, such as, how to identify real talent within and for your organization, knowing when your best employee is about to quit, predict consumer preferences and address unique consumer differences, amongst many others.

Reference this paper: Real de Oliveira, E., and Rodrigues, P., 2021. A Review of Literature on Human Behaviour and Artificial Intelligence: Contributions Towards Knowledge Management. The Electronic Journal of Knowledge Management, 19(2), pp. 165-179, available online at www.ejkm.com
According to Hoeschl and Barcellos (2006, p. 12) "the possibility of translating human intelligence to plastic artificial base has a clear limit: If intelligence can be generated from these elements, it must be necessarily different from human one, because results happen from different human elements." Also, to materialize knowledge (to safeguard it) one must find a way to manipulate, store and transmit it within the organisation. These authors name this as the biggest challenge of AI intelligent solutions over of the last decades.

In the original science fiction film Blade Runner, directed by Ridley Scott in 1982, and later in its sequel Blade Runner 2049, an interesting philosophical dilemma is put forwarded: are robots able to feel emotions? And if so, what makes us humans? The film set in a dystopian future, creates an interesting conundrum since humans develop machines that replicate humans but give them a date of expiration (they have a four-year life span) to enslave them to perform tasks humans do not want to do. The dilemma of "humanity" reaches its peak at the end monologue, performed by the character Roy Batty, entitled "tears on the rain". At this moment, the machine / human saves the life of its human prosecutor while sheds "invisible" tears on the rain, while his lifespan is ending. These replicants were created as

adults but memories of growing up were implanted in their brains. These memories allowed them to feel empathy towards humans and develop emotions.

Where do we establish the limits? The knowledge that can be generated through AI and machine learning and the possibilities that it creates to generate more knowledge is a huge challenge for organisations and societies. Across different scientific areas researchers are on the verge of taming the challenges of the usage of AI for better performances. For businesses AI represents productivity, efficiency, but also new ways to do things to innovate and break barriers. Knowledge that creates knowledge in a Fibonacci spiral.

Inspired by these thoughts the authors raise the following questions: how artificial intelligence, machine learning, big data and neurosciences, applied to human behaviour, have been treated, both theoretically and empirically, over the last twenty years, regarding creating knowledge through predictive analytics and human organizational behaviour? How this field of research has been applied to create, retain, and develop knowledge within organisations?

1. Research Methodology

The aim of this research is to present the evolution of studies regarding human behaviour within organisations and highlight the relevance of new research intending to inspire research ideas by recognizing gaps or inconsistencies (Cronin, 2008) and/or creating theoretical frameworks (Coughlan, 2007). For this study, the authors followed the proposed methodology and process for conducting systematic literature reviews by Tranfield, Denyer, and Smart (2003). For verifying each step of the process the PRISMA guidelines were also adopted. This is a well-establish method aimed at systematizing knowledge in an orderly and consistent way, increasing its efficiency and effectiveness pro the generated output. PRISMA allows to systematize information verification practices, justifying all inputs and outputs, that is, papers included and excluded. This is a six steps method including, definition of research question and inclusion/exclusion criteria; collecting and selection of the studies; extracting and presenting the most relevant information and data; analysing and synthesizing information (Moher et al, 2009).

The database chosen for collecting data was B-On (the online knowledge library) since allows access to full texts from over 16,750 scientific international publications from 16 publishers, including the web of knowledge (Wok). To apply the search equations (combination between keywords), the following limitations within B-On were used: a) disciplines: economics; business and management, marketing; and sociology; b) restricted to access to full text; c) timespan: from 2000 until 2020 (current date); d) only peer reviewed journals.

The search equations were applied, and the researchers conducted an initial rigorous screening based on the article tittle, keywords and abstract. To be included on the database papers had to address human behaviour within organizations and to address how this behaviour was studied or understood through predictive analytics, neurosciences, big data, artificial intelligence, or machine learning.

Search equations, initial results and final selection numbers can be seen in the following table.

Table 1: Search equations

Search Equation	***Results***	***Selection***
Artificial Intelligence *and* Machine Learning	2817	6
Artificial Intelligence *and* Human behavior	298	13
Artificial Intelligence *and* Human behaviour	361	9
Artificial Intelligence *and* Human profiling	2	2
Artificial Intelligence *and* Predictive Analytics	225	6
Artificial Intelligence *and* Big Data	394	5
Artificial Intelligence *and* Neurosciences	90	5
Artificial Intelligence *and* Knowledge Management	724	5
Artificial Intelligence *and* Knowledge Creation	46	5
Artificial Intelligence *and* Gaming	32	5
Machine Learning *and* Human behavior	298	6
Machine Learning *and* Human behaviour	339	3
Machine Learning *and* Human profiling	10	1
Machine Learning *and* Predictive Analytics	117	5
Machine Learning *and* Big Data	810	5
Machine Learning *and* Neurosciences	117	7
Machine Learning *and* Knowledge Management	821	5
Machine Learning *and* Knowledge Creation	42	3
Machine Learning *and* Gaming	28	5
Human behavior *and* Human profiling	132	5
Human behaviour *and* Human profiling	138	3
Human behavior *and* Predictive Analytics	23	3
Human behaviour *and* Predictive Analytics	23	3
Human behavior *and* Big Data	177	3
Human behaviour *and* Big Data	177	3
Human behavior *and* Neurosciences	673	2
Human behaviour *and* Neurosciences	673	3

Human behavior *and* Knowledge Management	1791	3
Human behaviour *and* Knowledge Management	1767	3
Human behavior *and* Knowledge Creation	115	3
Human behaviour *and* Knowledge Creation	114	3
Human behavior *and* Gaming	246	3
Human behaviour *and* Gaming	246	2
Human profiling *and* Predictive Analytics	0	0
Human profiling *and* Big Data	5	5
Human profiling *and* Neurosciences	6	4
Human profiling *and* Knowledge Management	15	5
Human profiling *and* Knowledge Creation	1	0
Human profiling *and* Gaming	1	1
Predictive Analytics *and* Big Data	180	5
Predictive Analytics *and* Neurosciences	2	2
Predictive Analytics *and* Knowledge Management	48	5
Predictive Analytics *and* Knowledge Creation	2	1
Predictive Analytics *and* Gaming	1	1
Big Data *and* Neurosciences	18	4
Big Data *and* Knowledge Management	596	5
Big Data *and* Knowledge Creation	29	5
Big Data *and* Gaming	16	2
Neurosciences *and* Knowledge Management	84	4
Neurosciences *and* Knowledge Creation	5	2
Neurosciences *and* Gaming	41	3
Knowledge Management *and* Knowledge Creation	2858	4
Knowledge Creation *and* Gaming	21	3
Totals	17795	204

After elimination of duplicates a total of 199 articles were included in our analysis. The authors opted to keep the search equations quite open, since if they narrowed them down, for example: Neurosciences and Knowledge Creation and Machine Learning results would be zero. Instead, we have considered it useful to have broader search equations, such as: knowledge management and knowledge creation (n=2858) and then screening the abstracts for relevance. Also, the noun "behaviour" was spelled in the American and British forms to encompass all possible results.

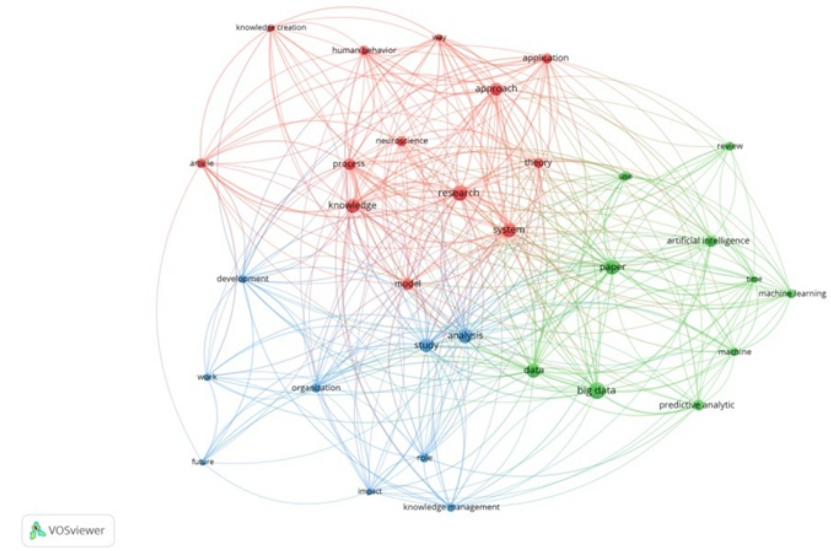
The next steps were to conduct descriptive statistics (using VOSviewer and R programming) and content analysis that will be described in the next section.

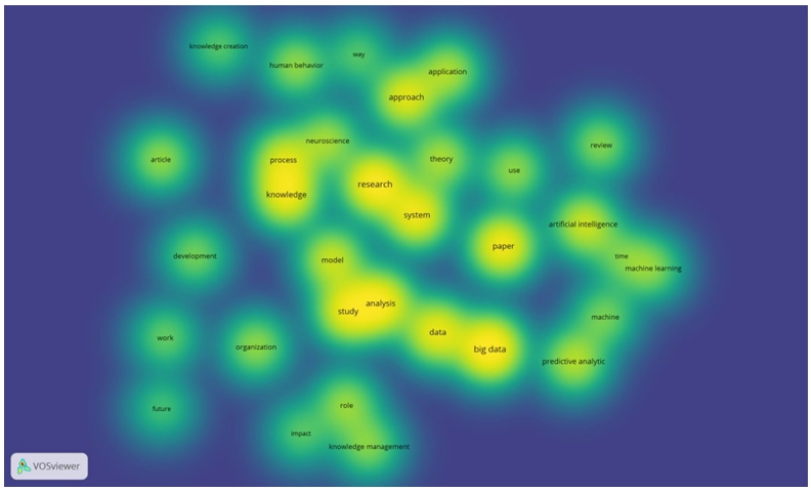
1. Research Findings

An analysis of the database showed that 60% of work published by researchers happened after 2016. Between the year 2000 and 2015 the average publication regarding these topics were 5,25 papers a year, while between 2017 and 2019 the average was 30 papers a year. This demonstrates an increasing interest on the topic, around 30 papers a year, nevertheless this amount still represents a very short number of articles on a specific subject.

3.1 Cluster Analysis using VOSviewer and R Programming

The VOSviewer software is a tool for constructing and visualizing bibliometric networks and R is a language and environment for statistical computing and graphics. The authors have analyzed the outputs from the filtered search equations (199 articles) and results are presented in the following figures (network and density graphs).





Figures 1 and 2: VOSviewer Network and Density Graph

To produce an analysis of the network graph, the authors did not considered words such as paper, article and research, which were mentioned several times due to the nature of the sources (and could not be eliminated from the software). Looking at the network graph, one can see the existence of 3 main clusters that can be identified by the intensity of relationships and size of the density (showed in yellow) characterized by the words analysis, knowledge, and big data. One might deduce that the Big Data cluster reflects the great scientific production around this theme, with direct relationships with artificial intelligence, machine learning and predictive analytics. In the analysis cluster, there is a strong relationship index with concepts such as, organization, role and knowledge management, driving the future. The knowledge cluster has a strong association with neurosciences studies, human behaviour and knowledge creation. The VOSviewer network graph also shows the opposite positioning of knowledge creation and knowledge management, where knowledge management is closely associated with big data and, on the other hand, knowledge creation is closely associated with knowledge and human behavior, positioned relatively far from the topic of big data.

An annual scientific production chart was also produced (using R programming).

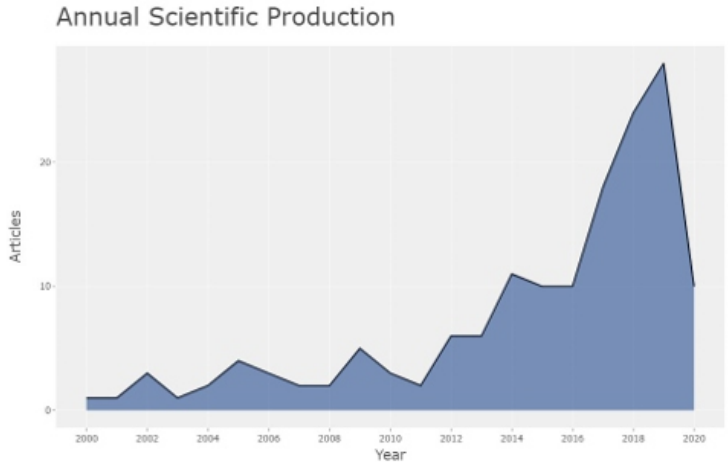


Figure 3: Annual Scientific Production Chart

According to the Annual Scientific Production Growth Chart, we can detect a steady but slow production rate until 2006, with an increment from 2016 that reaches its peak in the year 2019. The year 2020 is an enigma mainly due to the pandemic period, that started in the beginning of the year, which could cause delays in publications and that may not indicate a decrease interest on the topic.

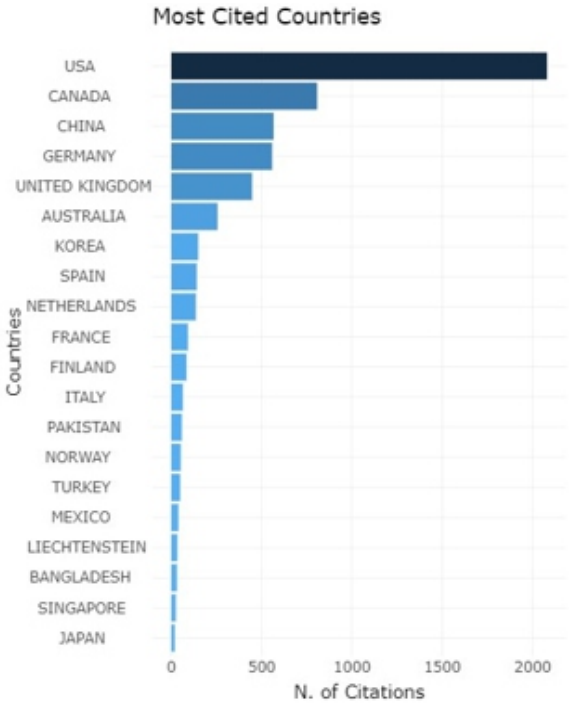


Figure 5: Most Cited Countries Chart

According to the most cited countries chart, USA is found to be the country with the largest scientific production, followed by Canada and China, whereas only two European countries appear in the top 6, Germany and the United Kingdom, respectively. To understand the differences between countries the authors analyzed the Delloite Report "Future in the balance? How countries are pursuing an AI advantage" (2019). According to this report "for years, the United States has been a leader in public and private AI research. Consider the last several years of venture capital investment in the AI sector. In 2012, venture capitalists funded US$282 million in AI initiatives, and that number skyrocketed to US$5 billion by 2017. The following year, AI investments by VCs topped US$8 billion" (p. 15). Canada and China are also mentioned in this report, although Canada is appointed as having a cautious approach to the application of AI since "they confront a host of issues regarding ethical implications, enhanced cyber vulnerabilities, and questions of talent readiness" (p.10). Pertain to China its "government has declared its ambition to become the world's leading AI innovator by 2030" (p.11).

According to this survey "no matter where organizations are on their AI journeys, their approach to tackling these questions varies. Some are playing catch-up with their global rivals. Others are addressing their aims through focused projects, or by pursuing larger-scale initiatives. Some early adopters are much more focused on training
and skills development than others" (p. 16). "There's clearly no one-size-fits-all approach to adopting and integrating AI. AI-fuelled transformation of businesses and industries appears to be coming rapidly, and the window for differentiation is shrinking. Much hangs in the balance—including the future competitiveness of companies and even whole countries" (p. 17).

Figure 6: Most Relevant Sources Chart

According to the most relevant sources chart, we found that the Journal of Knowledge-Based Systems is the source that has the most relevant publications, with almost twice as many relevant publications as competitors, followed by the Journal of Management Information Systems and Knowledge and Process Management Journal.

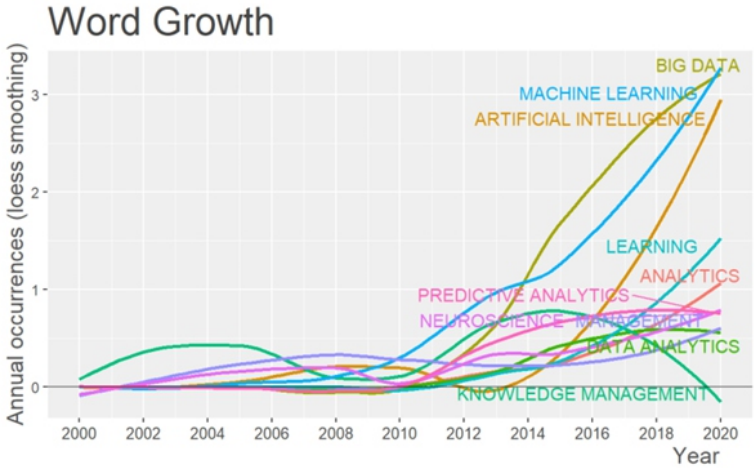


Figure 7: Word Graph

According to the graph, in the last 3 years the most searched words were Big Data, Machine Learning and Artificial Intelligence, evidencing a relevant growth since 2014. Until then all the research terms followed similar patterns. If we consider the interest AI has gained in the different countries that are adopting these techniques this could be considered quite logical. Also, “knowledge management” production rate tendency over the years did not follow the other subjects. It is interesting to observe the increase of the term “learning”. One may assume that knowledge has been replaced by the term learning.

3.2.Content Analysis

Content analysis was performed using a chronological review of the subject within specific timespans to

conduct the content analysis.

3.2.1 From 2000 until 2004

Within this timespan articles focused on machine learning and artificial intelligence for fuzzy models for scheduling problems and decisions processes in manufacturing diminishing human error (Nematii, 2002; Akyol, 2004); predicting gaming behaviour (Hinnar et al, 2004); behavioural simulation for coaching purposes (Summers, 2004); the role of mind in human and organizational behaviour (Seni and Seni, 2000; Setterret, 2002; Wolozin, 2004); planned (Bamberg, 2003) and consumer (Morik, 2002) behaviour.

3.2.2 2005 – 2007

During this period articles focused on the emerging nature of knowledge management (Chua, 2005) and creating and sharing knowledge via the web using artificial intelligence (Cheung et al, 2005; Chen et al, 2005; Cracker and Coenen, 2006). Other papers found addressed using informatics and neurosciences to monitor behaviour (French et al, 2007; Monekosso and Remagnino, 2007).

3.2.3 2008 – 2010

In 2008, Michael Buttler concluded that knowledge has "plasticity". By that he meant that different stakeholders, including scholars and practitioners, perceived differently the development and application of neuromarketing. Understanding this could be crucial for knowledge creation and diffusion.

Human decision-making process can be modelled and controlled (Moffat and Medhurst, 2009) and the future can be forecasted, as market behaviour, market dynamics, market analysis, organizational strategies for volatile new markets, and profiling products and services which do not currently exist, but which markets are ready to accept (Zenobia et al, 2009).

In 2010, Faber and Peters, present the idea that Knowledge can be identified as the driving force behind human behaviour and that this behaviour can be changed through, amongst others, information technology. Seni and Seni (2010) proposed that cognition, in the broad sense, was not exclusive to living organisms since, certain kinds of social organizations, such as businesses, possess elementary cognitive capabilities by virtue of their structure and their functions. Both authors propose the idea of "sociocognitivity" based on neuroscience and biopsychology applied to any organization: (1) The theory of intelligence and of intelligent systems; (2) The neurological theory of memory as distributed, hierarchical neuronal systems; (3) The theory of cognitive action in general and of learning in particular.

3.2.4 2011 – 2013

Lin and colleagues (2012) presented a study on the emotional expression and artificial intelligence in the interaction between computers and humans in order to understand users' emotions.

Giraldo et al (2013) showed how computer science and cognitive neuroscience could be merged to propose an effective profiling scheme by content personalization through the identification of an individual's learning behaviour. In 2013, Aztiria and colleagues studied intelligent environments (IE) where the technology adapts its behaviour to the users, even anticipating their needs, preferences, or habits. The environment learns how to react to the actions and needs of the users.

3.2.5 2014 – 2016

Buttler et al (2016), explore the potential links between human biology and management and organization studies. The authors defined, what they considered to be a new field as “organizational cognitive neuroscience” (OCN). In their paper they revealed three clusters of activity, covering the fields of economics, marketing and organizational behaviour (considered as an outlier), which contributed to a greater understanding of the biological mechanisms that mediate choice and decision-making.

Human behaviour understanding plays a fundamental role in several innovative application domains such as smart video surveillance, ambient intelligence and content-based video information retrieval (Acampora et al, 2015). These authors propose a hierarchical architecture, based on a tracking algorithm, time-delay neural networks and fuzzy inference systems, aimed at improving the performance of current human behaviour analysis systems in terms of scalability, robustness and effectiveness in behaviour detection.

Lavín et al (2015) studied cooperative behaviour aiming to understand the motives behind people's subscription to a specific organization and whether their motivations are consistent with traditional experimental evidence about cooperative decision-making. Their results revealed a conjunction between structural frames and individual ethical values to be critical for explaining human cooperation.

Yu-Ping et al (2015) combined machine-learning techniques with functional neuroimaging data to characterize the set of processes that give rise to associations between brands and personality. They have showed that brand personality traits could be captured by the weighted activity across a widely distributed set of brain regions previously implicated in reasoning, imagery, and affective processing, i.e., brand personality traits appear to exist a priori inside the minds of consumers.

Emotion is a cognitive process and is one of the important characteristics of human beings that makes

them different from machines (Nahin et al, 2014). In their paper they have attempted to detect user emotions by analysing the keyboard typing patterns of the user and the type of texts (words, sentences) typed by them. To analyse data they've used several machine learning algorithms and manage to demonstrate above 80% accuracies in identifying emotions.

Smidts et al (2014) sketch the development of consumer neuroscience as a discipline and compare it to neuroeconomics. They also provide important insights into individual differences in decision-making and shed some light into the predicting decisions from brain activity and their reliability as measurements of consumer behaviour.

3.2.6 2017

Kraczla (2017) undertook a research on human profiling based on personality traits. The rationale assumed that personality factors constitute a fundamental indicator of development potential of a particular person, and as such, it was possible to depict his/her functioning style in a job position and hence predict professional suitability in performing a given professional role.

Michie et al (2017) present the Human Behaviour-Change Project (HBCP) using artificial intelligence and machine learning. The purpose of their work was to (i) develop and evaluate a 'Knowledge System' that automatically extracts, synthesizes, and interprets findings from evaluation reports to generate new insights about behaviour change and improve prediction of intervention effectiveness and (ii) allow users, such as practitioners, policy makers and researchers, to query the system easily and efficiently.

Shmueli (2017) coined the term Behavioural Big Data (BBD), meaning the very large and rich multidimensional datasets on human behaviours, actions, and interactions, which have become available to companies, governments, and researchers. In his work he describes the BBD landscape and examines opportunities and critical issues that arise when applying statistical and data mining approaches to BBD and its implications.

3.2.7 2018

According to Harteis et al (2018) preventing humans from committing errors is a crucial aspect of man-machine interaction and systems of computer assistance. In their work they use eye-tracking technology and automated face recognition to analyse / test persons' emotional reactions and cognitive load during a computer game and learning through trial and error. Results show a positive correlation between learning and emotions and that gaze behaviour and facial expressions inform about the errors that follow.

Chan et al (2018) use an approach to profiling brand image using functional magnetic resonance imaging. They compare consumers' brain responses during passive viewing of visual templates (photos depicting various social scenarios) and brain responses during active visualizing of a brand's image, and then they generate individual neural profiles of brand image that correlate with the participant's own self-report perception of those consumer brands. This neural profiling demonstrates the potential of using pattern analysis of neuroimaging data to study multisensory, nonverbal consumer knowledge and experience.

Fredriksson (2018) discuss big data in the theoretical light of organizational knowledge creation and decisionmaking in organizations. The findings suggest that creating new information and knowledge out of big data, and its use as support for decision-making in organizations, would enhance the quality and increase trustworthiness in decision-making. Goul (2018) addresses the importance of big data and predictive analytics on operations and manufacturing management and their utilization for capability building, and how this capability affects cost and operational performance.

Guha and Kumar (2018) study the digital footprints of consumers to understand and predict consumer behaviour (especially in the areas of cloud computing, internet of things and smart city, predictive manufacturing and 3-D printing and smart healthcare) and the associated challenges.

3.2.8 2019 - 2020

Bleidorn and Hopwood (2019) use machine learning in psychological science to predict human behaviour through personality traits. Machine learning approaches to personality assessment have focused on the associations between social media and other digital records with established personality measures. This research aims to expand the potential of machine learning approaches to personality assessment by embedding it in a more comprehensive construct validation framework.

Constantin et al (2019) build a model to train and validate an artificial neural network to forecast the following year's value of economic sentiment using values of several economic indicators. Research on predicting European Economic Sentiment Indicator (ESI) using artificial neural networks is a starting point, with work on this subject almost inexistent, the reason being mainly that ESI is a composite of five sectorial confidence indicators and is not thought to be an emotional response to the interaction of the entrepreneurial population with different economic indicators.

Canhoto and Clear (2020) point out that artificial intelligence (AI) and machine learning (ML) may save money and improve the efficiency of business processes, but these technologies can also destroy business value, sometimes with grave consequences. They propose a new framework by which to map the components of an AI solution and to identify and manage the value-destruction potential of AI and ML for businesses.

Knox et al (2020) examine visions of 'learning' across humans and machines in a near-future of intensive data analytics. Building upon the concept of 'learnification', practices of 'learning' in emerging big data-driven environments are discussed in two significant ways: the training of machines, and the nudging of human decisions through digital choice architectures.

Steinberg (2020) introduce the possibility that, in the future, firms will be able to use big-data analysis to discover and offer consumers their individual reservation price (i.e., the highest price each consumer would be willing to pay, given their preferences and available income). This can generate some interesting benefits, such as a better situation in terms of equality of both welfare and resources, as well as increased social welfare. However, these benefits are countered by considerations of relational equality. This article takes up the market-failures approach as its basis to demonstrate what is wrong with using big data to personalize prices.

4. Discussion and Further Studies

From the systematic literature review undertaken and the bibliometric analysis done using VOSviewer and R programming, four emergent research areas were identified, namely, the use of big data for business efficiency, artificial swarm intelligence (through knowledge management and decision-making), personalized engagement marketing (customer/people connection) and the feeling economy (communicating with and for people), that are linked with the key issues of this paper.

Going back to the VOSviewer graph if we apply and x axis (current state of research) and y axis (from past to future solutions) it seems that we are moving from an information era, regarding the usage of Big Data, AI and machine learning (hard issues) towards an era of the understanding of human behaviour and knowledge creation (soft issues).

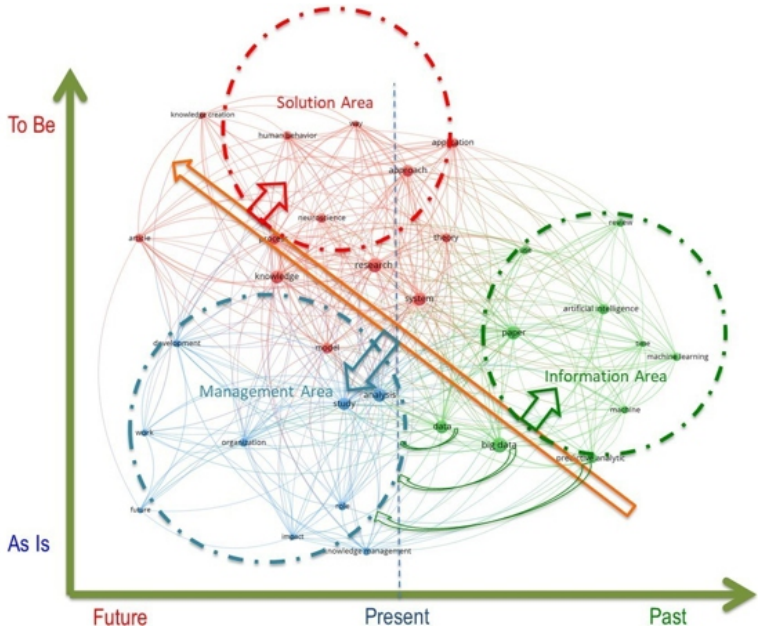


Figure 8: From Information to Management towards Knowledge Creation

Kumar, Yogesh and Dwivedib (2020) point out some interesting research questions addressing this field of research, amongst them, are some we consider relevant for understanding the challenges this field of research pose, namely:

- How can big data-driven research be used to explain digital service or technology adoption, usage, and impact behaviour?
- How can user engagement or disengagement can be measured and explained based on big data analytics?
- How can we develop typology of users or organizations based on user generated content in forums, social media and platforms?
- How can we explain relationships between organizations and other stakeholders (organizations, individuals, customers, suppliers, government, etc.) based on online content in platforms and e-markets and their impacts on engagement or disengagement?
- How can we model adverse impacts of disruptive technologies like artificial intelligence, blockchain, internet of things based on usage behaviour or user generated content?
- How can theories be developed to explain grand socio-political problems and challenges of like pandemic management, sustainable development goals, political harmony, etc.?

The journey over the past 20 years of research demonstrated that we have started on managing data, moving forward to having information that was transformed into intelligence. Intelligence can then be transformed into knowledge. But managing knowledge is no longer sufficient, since now we possess technologies that allow us to create knowledge from knowledge, so we are moving towards a fuzzier understanding of the human behaviour. In summary we are moving from data-driven organizations towards the feeling economy (from hard issues such as analytics towards soft issues such as people).

4.1 Organizational Efficiency (data-driven)

Artificial intelligence helps the predictive ability of organizations (Davenport et al, 2020). AI has recently become popular because it provides a cheap way to make predictions about complex problems based on examples in historical data that a company might already have. This is possible through machine learning (ML). ML is a key issue of this paper, as is defined as "a set of methods that can automatically detect patterns in data, and then use the uncovered patterns to predict future data, or to perform other kinds of decision making under uncertainty" (Murphy, 2012).

4.2 Artificial Swarm Intelligence (ASI)

Schools of fish, flocks of birds and ants' colonies demonstrate collective intelligence, since they are

capable of making decisions that go beyond the knowledge of individuals in the group (Sulis, 1997). According to Sulis, individuals within the group base their decisions on self-organized local interactions with group members. Mimicking nature for understanding organizations is not new. The emergent decision-making process found in honeybee swarms provides a powerful analogue for how human brains make complex decisions and allowed ASI to enable groups of networked humans to function as a unified intelligence (Rosenberg, L., 2016). This field of research can be found at the top quadrant of Figure 8. "ASI draws from the methods of achieving collective intelligence found in biological swarms to enable human groups to form a single emergent intelligence" (Metcalf et al, 2019, pp. 85).

4.3 Personalized Engagement Marketing

Personalization is often presented and studied alongside customization, as they are related concepts, although differing in application (Kumar, et al; 2019). Personalization derives from the business strategy (based on data collection from individual preferences) whereas customization originates from the customers preferences (for example you can customize a car, choosing the colour and specific features). According to Kumar and colleagues (2019, p. 151) "firms are able to leverage individual customer information and AI technology to provide curated products and services. The AI technology can facilitate real-time learning and help managers improve customer value proposition over time. Such a strategy of curated products that provide increasing value to customers will form the basis of customer retention and sustainable competitive advantage". The step forward will be using the knowledge gained through AI to trace profiles of human behaviour and predicting more precise preferences.

4.4 The Feeling (Emotions) Economy

"The Feeling Economy is an economy in which the total employment and wages attributable to feeling tasks exceed the total employment and wages attributable to thinking or mechanical tasks" (Huang et al, 2019, pp. 44-45). According to these authors in the emerging of the Feeling Economy, the interpersonal, empathetic, feeling tasks of a job, such as communicating with people inside and outside the organization, establishing and maintaining interpersonal relationships, and selling to or influencing others, tend to be more important than thinking tasks and mechanical tasks, for both employees and consumers. Huang and colleagues add that this Feeling Economy will fully overtake the Thinking Economy (jobs that require analysing data and making decisions) by the year 2036.

Main challenges derived from this are: (1) understanding the nature of future jobs and the required skills, (2) considering that humans and machines must collaborate as a "team", (3) anywhere-anytime interaction with internal and external consumers addressing their emotional needs.

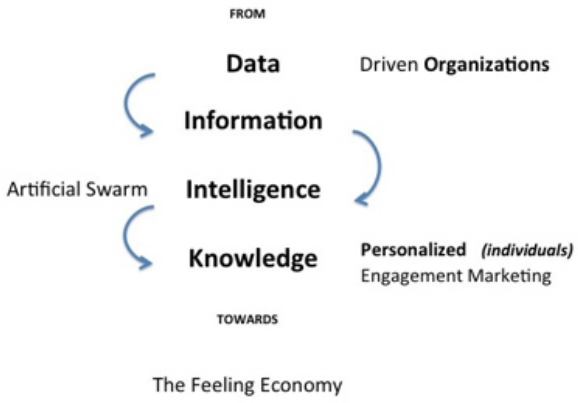


Figure 1: The Journey from Data to People

There are many challenges for researchers in this field. Deep Learning, a key technique used by most AI systems, and the study of the human brain (emotion versus reason) are inherently black boxes, making it very complicated to fully comprehend. Also, there is a fear, that, in a similar manner as the automation of manufacturing processes
has resulted in the loss of blue-collar jobs, the rising use of AI will result in less need for white-collar employees and even high-qualified professional jobs, resulting in a resistance for adopting ASI. Nevertheless, researchers have demonstrated that ASI addresses the limitations associated with group decision-making, amplifying the intelligence of human groups, and facilitating better business decisions. Also, the use of AI, machine learning and neurosciences, pose unique ethical, legal, and philosophical challenges that will need to be addressed.

5. Conclusions

The research conducted by the authors included a systematic and bibliometric literature review, of the past 20 years on the study of knowledge management related to artificial intelligence, machine learning and the understanding of human behaviour through neurosciences approaches. The research showed the past, present and future of this field of research and the linkages between the different terms that were reviewed.

The paper achieved the proposed goal by mapping what is known about the key issues and "understanding how artificial intelligence and machine learning applied to human behaviour has been treated regarding predictive analytics and human organizational behaviour analysis".

The main limitation of the study lies in the information sources considered. Papers were selected from B-On and WoS databases, and as such, grey literature was not included, thus many interesting studies may be omitted.

The main conclusions of the study were that we are moving from business efficiency (data-driven organisations) towards business efficacy by using knowledge to create knowledge. Knowledge that occurs from managing information (hard issues) towards knowledge that evolves from the understanding the collective (swarm) and individual intelligence, through the application of neurosciences tools, towards knowledge creation within the feeling economy.

The human being is quite complex and makes decisions that are not always rational, often influenced by emotional or situational factors. Assuming that AI and Machine Learning are based on rational models, are these methods the best tools for predicting human behaviour? Also based on AI and ML's ability to analyse and sort a lot of information, namely in the digital relationship between people and organisations, are these the best tools to anticipate, manage and generate organizational knowledge?

Further studies should be developed in this field of research addressing the questions posed along this research article, especially empirical works focussing the journey from data to people.

Acknowledgments

This research work is financed by national funds through FCT – Foundation for Science and Technology, I.P., under the project «UIDB/04005/2020».

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New Collaboration through Artefact-Mediated Interaction with a Joint Knowledge Base

Marco Bettoni1 and Eddie Obeng2

1Steinbeis Consulting Center Knowledge Management and Collaboration, Basel, Switzerland

2Pentacle Virtual Business School, Beaconsfield, Buckinghamshire, United Kingdom

ABSTRACT

Collaboration is changing and increasingly emerging as what we call "New Collaboration", a knowledge-based and community-oriented way of working together (especially digital, online collaboration). Unfortunately, organisations use only a small percentage of the potential of New Collaboration. One main reason for this is that they do not understand that New Collaboration is based on knowledge sharing and requires the individual knowledge of the collaborators to be integrated into a shared knowledge structure, a so-called Joint Knowledge Base (JKB). This concept of a Joint Knowledge Base as the tacit knowledge structure which is constructed, shared and maintained during collaboration, emerged during the course of our previous work and became more and more prominent as a key to collaboration. When a group interacts, the JKB functions as an interaction bridge, and this is why it is a key to collaboration. In this paper, we will revise and elaborate in more detail our concept of a JKB and explain its role in artefact-mediated interaction. First, we will explain the main characteristics of New Collaboration and summarise them based on a concise definition. Secondly, we will introduce the concept of a Joint Knowledge Base, explore the role of social negotiation in constructing it, define the JKB as a distributed knowledge structure, discuss the problem of obstacles which hinder its development and suggest how to solve it by means of gaining deeper insight into the complexity of the involved processes (communication, interaction). And next we will further develop this solution by introducing the concept of boundary artefacts and describing their implementation as tools for artefact-mediated interaction by means of a systematic approach. Finally, we will explain this systematic approach and show how boundary artefacts and artefact-mediated interaction work in practice during meetings performed on a commercially available collaboration platform where they contribute to the construction of a JKB.

Keywords: new collaboration, knowledge sharing, joint knowledge base, boundary objects, artefact-mediated interaction

1. Introduction

The business world in which we are living today is a world of volatility, uncertainty, complexity and ambiguity (VUCA). It is a new world which changes faster than we can learn and where business outputs "depend on a wider and wider range of knowledge, skills, values, technologies and competences" (Obeng 1997, pp.3-9).

In order to be successful in this new world, collaboration must adapt and change. In previous work, we proposed a knowledge-based and community-oriented understanding of collaboration which we called New Collaboration and described based on three models: a system model (Bettoni et al., 2016), a presence model (Bettoni et al., 2018) and a hierarchical process model (Bettoni and Obeng, 2020) called the "Pyramid of New Collaboration". This pyramid model of collaboration requires the individual knowledge of the collaborators to be integrated into a shared knowledge structure, a so-called "Joint Knowledge Base" (JKB). For doing this it is essential to understand how the JKB enables collaboration and specifically how the JKB is constructed and maintained. This is our main research question here. A better understanding of this aspect of knowledge sharing will contribute to raising awareness of the fact that a JKB plays an essential role in collaboration and to taking this seriously.

Secondly, it will help to understand how the interwoven process between knowledge sharing and collaboration works. Last but not least, it can help to understand group learning (and group work in general) not only as a form of knowledge acquisition (cognitive process) and participation in a social community (social process) but also as collaborative knowledge creation (Paavola et al., 2004). Therefore, the aim of this article is to revise and elaborate our concept of a JKB in more detail. Our results define the main characteristics of New Collaboration, specify the role of social negotiation in constructing the Joint Knowledge Base, define it as a distributed knowledge structure, identify obstacles which hinder its development and suggest how to solve this problem by means of communication and interaction. We furthermore introduce the concept of "boundary artefacts", describe their implementation as tools for artefact-mediated interaction and show how this has been implemented on a commercially available collaboration platform. The article ends with a discussion and conclusions, including limitations and implications for further research.

2. Literature Review

Our research is highly innovative, in fact the aforementioned main topics, i.e. "process model of collaboration", "shared knowledge structure" and "knowledge-based collaboration" are missing in the academic and business literature on collaboration and knowledge sharing. This can easily be checked by doing an internet search as well as by analysing literature review articles. A systematic literature review of state-of-the-art functionalities in knowledge sharing mechanisms provides a representative example (Navimipour & Charband, 2016). The research topics identified in this review have not changed since the beginning of knowledge sharing research in the 1990s: motivation for sharing knowledge, impact of good practice and job satisfaction, cultural influences, strength of social ties, explicit knowledge vs. tacit knowledge, trust, empowerment, leadership style, leadership behaviour, impact of IT (platforms, etc.), exchange relationships with co-workers, social interaction, sociocultural factors (like trust, shared goals,

shared language and collaboration). Thus, the literature focuses mostly either on outcomes or on "external" aspects as conditions for successful outcomes. As a result, we can conclude that there is practically no literature about how knowledge sharing actually proceeds or the steps of its process. Notice moreover that collaboration is considered only to be a factor influencing knowledge sharing and never as a factor affected by it, like in the seminal work by Roschelle and Teasley (1995) which started the investigation into the role of knowledge sharing in collaborative problem solving in a fundamentally new way, which has never been followed up by other researchers.

Recent surveys show that, in order to cope successfully in the VUCA world, organisations should develop collaborative cultures, embrace collaborative practices (IDC, 2016, p.42) and invest in collaborative business models (Dufft, 2017, p.11). Unfortunately, the business and education world seem to largely ignore the fact that collaboration, in the wake of the spread of knowledge-intensive work (Smith, 2002; Bettoni, 2000), has also changed and is increasingly emerging as a new way of working and learning together which we call "New Collaboration". Surveys about the application of digital collaboration in business show that e-mail (which promotes divergent interaction) is still considered to be the most important collaboration tool (Roten et al., 2016, pp.3-4). But New Collaboration requires a completely different type of interaction: convergent interaction. Hence, considering and applying e-mail as the main collaboration tool clearly indicates that New Collaboration is still going unnoticed or at least is not well understood and not sufficiently put into practice.

Stoller-Schai, a pioneer of e-collaboration research, recently defined collaboration as "the direct and mutually influential active confrontation of two or more people, oriented towards common goals, to solve or master a task or problem" (Stoller-Schai, 2021). While this is very good as a generic definition, let us look more deeply at the aforementioned "task or problem". In the VUCA world, more and more groups are facing knowledge-intensive tasks which are judgmental rather than intellective (have a demonstrably correct solution), complementary (require abilities, skills, knowledge of different people) rather than conjunctive and unitary (cannot meaningfully or efficiently be divided into subtasks and assigned to different group members) rather than divisible (for these categories see: Laughlin, 2011). And for these tasks they need New Collaboration.

3. Methodology

To answer our main research question (how is the JKB constructed and maintained, see above), we take a Systems Thinking approach, a way of thinking which enables to better understand and design complex issues. Systems Thinking requires (Haberfellner, 2002; Vester, 2007):

1. the systemic definition of concepts. We define four new concepts in this way: a) new collaboration, b)

1. the systemic definition of concepts. We define four new concepts in this way: a) new collaboration, b) joint knowledge base, c) artefact-mediated interaction, d) boundary artefact;
2. the use of these concepts in the context of a holistic view;
3. the use of systemic models. We describe two such models: a) distributed knowledge structure, b) bicyclic knowledge conversion;
the use of holistic, interconnected thinking. We have applied this in two cases: a) system of boundary artefacts, b) QUBE New Collaboration.

4. Results

After defining the main characteristics of New Collaboration, we specify the role of social negotiation in constructing the Joint Knowledge Base. We then model the JKB as a distributed knowledge structure, thus clarifying the issue of its existence; we identify obstacles which hinder its development and suggest how to solve this problem by means of a model which combines communication and interaction. We further introduce the concept of "boundary artefacts", describe their implementation as interaction tools and demonstrate how our theory works in practice by showing its implementation on a commercially available collaboration platform.

4.1 New Collaboration: Concept, Definition, Process

If we want to fully exploit New Collaboration, we need first of all to become aware of its emergence and secondly to better understand its structural and dynamical complexity. This requires a clarification of our concept of New Collaboration, a description of its essential elements (structure) and a model of how New Collaboration unfolds (method, process).

Successful groups are increasingly collaborating in this new way: they work together on a knowledge-intensive, judgmental and complementary task without splitting it. And because the task (the unit of work) is not split, the related knowledge needed during the performance of the task must also form a unit and be maintained as a unit. For this reason, New Collaboration requires the individual knowledge of the collaborators to be integrated into a shared knowledge structure. This essential "Rule of Unitary Group-Knowledge" can be concisely stated as: IF the group-task is unitary, THEN group-knowledge should be unitary.

In this sense, we say that New Collaboration is knowledge-based. Moreover, the practice of constructing and maintaining this task-related knowledge as a shared knowledge structure requires that the group's members accept fair terms of collaboration, like reciprocity or mutuality (Rawls, 1971; 2001). Against this background, group collaboration has three relevant dimensions: (1) the mutual

engagement of the group in a conscious, continuous effort to pursue (2) a joint enterprise (shared tasks) which, over time, leads to the development of (3) a shared repertoire (symbols, words, concepts, stories, ways of doing things, routines). Since these are the three dimensions of practice in Wenger's community of practice model (Wenger, 1998, pp.72ff), it is in this sense that we say that New Collaboration is community-oriented. The aforementioned characteristics of the concept of New Collaboration are summarised in the following definition (adapted from Bettoni et. al., 2016; Bettoni, 2017):
New Collaboration is a way of working together at a complementary and unitary task without splitting it, thereby concurrently practicing fair terms of collaboration and being mutually engaged as a community for constructing and maintaining a Joint Knowledge Base as a basis for accomplishing that task.

This definition has its roots in the seminal work by Roschelle and Teasley (1995) which investigated collaborative problem solving almost 25 years ago. In our process model "Pyramid of New Collaboration", we have modelled this type of collaboration by means of a breakdown structure similar to the "Work Breakdown Structure" (WBS) of project management; it is a hierarchical decomposition with seven layers, where each layer specifies the means that enable the process in the upper layer, and all the layers together implement the whole collaboration process. With this approach, collaboration (the highest level) is based on knowledge sharing (the 6th level) as the essential means which enables collaboration. This aspect, new collaboration being knowledge-based, is perhaps the main difference from traditional collaboration and requires us to elaborate our concept of a JKB in more detail.

4.2 Joint Knowledge Base

The term Joint Knowledge Base (JKB) indicates the shared knowledge structure which is constructed and maintained during collaboration on a unitary task (new collaboration). According to Roschelle and Teasley (1995, p.76), collaborators interact through language (conversation), physical action and combinations of words and action. During these collective activities, each collaborator contributes their unique knowledge (Fig.1) to the group work and from this interactive process, shared knowledge elements emerge, the building bricks of the JKB.

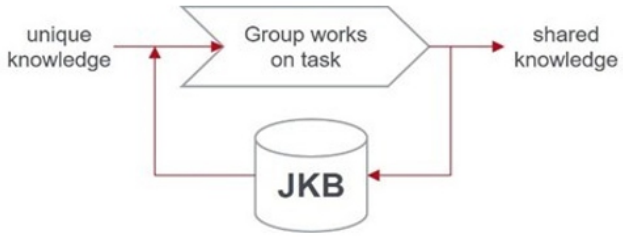

Figure 1. Group working on a unitary task – the JKB as an interaction bridge

The JKB collects and organises these knowledge elements into a system. Thanks to this, it can function as a basis for accomplishing the shared task on which the group is working and can also be seen as a control unit regulating the interaction, a bridge between shared and unique knowledge (interaction bridge), an essential condition for the possibility of successful collaboration. In our Pyramid Model of New Collaboration (Bettoni and Obeng, 2020), Knowledge Sharing is placed immediately below it, at level six, as the fundamental activity which enables New Collaboration (the highest level). It is here where collaborators construct and maintain the Joint Knowledge Base. In order to do this and organise the knowledge elements into a system they must interact in new ways described at the underlying levels five and four, called "Negotiation of Meaning" and "Co-Construction of Knowledge" (Bettoni and Obeng, 2020, p.167).

4.2.1 From IKB to JKB: Negotiation of Meaning

Before entering the JKB, any knowledge element must have been previously constructed by an individual group member (collaborators) and be part of their Individual Knowledge Base (IKB). The IKB is not merely storage for knowledge elements; in line with Immanuel Kant's definition of knowledge ("A system of compared and connected mental constructs", Kant, 1781/1787, A97, own translation), we conceive it as a knowledge system which plays a role in basic cognitive functions such as assimilation and accommodation (Piaget, 1936). Thus, an IKB is much more than simply a repository and contributes a greater functionality to cognition than just a memory system. It is hence important to understand how a knowledge element of an IKB can become part of the JKB so that it can be considered as "shared". In order to be accepted as constitutive parts of the JKB, knowledge elements must be evaluated as meaningful by the group. The meaning that they must have is not simply a specific relationship between a sign and a reference (lexical meaning) or a grand principle of reason or ethics (philosophical meaning). They must make sense to the group in practical ways, especially in relation to the professional experience of each group member. This is why the knowledge elements can enter the JKB only if they successfully pass through a "sensemaking" process called a negotiation of meaning: an interactive process which comprises two highly interlinked activities, participation and reification (Wenger, 1998), and which is the first of the two main components of cognitive presence (Bettoni et al., 2018). In short: any element of an IKB of any group member must go through a process of group cognition and can enter the JKB only as a socially negotiated result of this process.

Participation must be about something, some content, ideas, proposals; and reification also must be of something. So, what we need here in first place is to produce relevant content, hence to be creative and skilled in constructing (producing or modifying) knowledge elements. Thus, the core process

underlying and enabling the negotiation of meaning is the co-construction of knowledge, the second main component of cognitive presence. It comprises skills like: (a) shared language, (b) shared content / storage, (c) co-planning, (d) co-solving, (e) cowriting (Bettoni et al. 2018, p.1137).

4.2.2 The JKB as a Distributed Knowledge Structure

During the course of the co-construction of knowledge, each collaborator builds and maintains in their mind their own individual knowledge base so that, within a group, we have as many IKBs involved as there are collaborators. But the overall shared goal of working with the other collaborators on the same shared task leads to the emergence of areas within the individual knowledge bases which mutually converge (and resonate). When the negotiation of meaning succeeds, this leads to the emergence of knowledge areas in each individual which converge and resonate among the group members: the elements of these areas can then be considered as "shared" knowledge elements. Thus, the Joint Knowledge Base does not exist in a single place and is not constructed outside the minds of the collaborators. There is no single, integrated knowledge base that grows outside of them; instead, a JKB is a distributed knowledge structure made of the converging parts found within the individually constructed knowledge bases (Fig. 2).

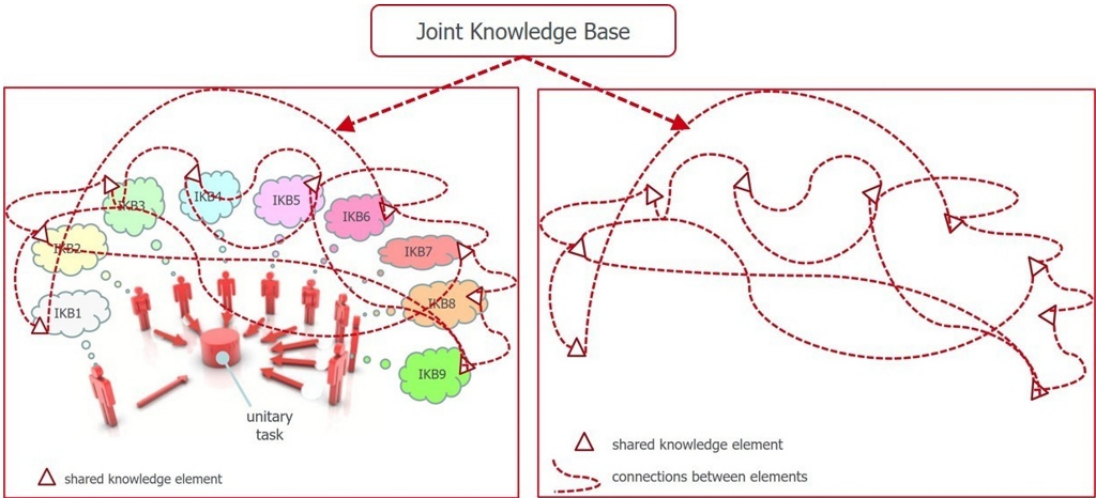

Figure 2: Joint Knowledge Base as a distributed structure (one shared element, all group members).

It is in this sense that we speak of a "joint" knowledge base: the JKB is the distributed system connecting and comparing all those individual knowledge elements whose meanings converge and fit across group activities. Thanks to this, the JKB enables meaningful conversation, action and interaction in relation to the purposes which emerge, step by step, during collaboration on a shared task. Any JKB is bound to the specific group of individuals who interact: when one individual is missing or a new one arrives, then the JKB changes. The fact that two or more individual knowledge elements are seen as converging does

not necessarily imply that they precisely overlap or match in all their parts and across all the individual knowledge bases of the group members. It is sufficient if they are fit for the purposes in hand. In this sense, we should speak more precisely of taken-asshared rather than shared knowledge elements (Cobb, 2000, p.166).

4.2.3 Knowledge Sharing Obstacles

When collaborating in this way, the JKB can grow and step by step become more and more representative of the group's knowledge. But due to the complexity of communication and interaction, co-constructing such a representative JKB is not easy to achieve! When people engage in conversations and debates for contributing knowledge elements and negotiating their meaning, they will encounter many obstacles. Two of the main obstacles (also called "semantic boundary", Carlyle, 2002) are:

1. the meaning of messages cannot be just transferred by communication;
2. interpretations of messages are often different.

The first obstacle exists because meaning does not travel; it must be (and always is) actively constructed. Heinz von Förster called it The Hermeneutic Principle: "The hearer, not the speaker, determines the meaning of an utterance" (Förster and Glasersfeld, 1999, p.13). The second obstacle exists because differences in experience and background among participants have created different experiential worlds (Glasersfeld, 1991, 2007) and these lead to different conceptualisations and interpretations which, on one hand, may be a source of creativity but on the other, can create social dilemmas and conflicts (Du Chatenier et al., 2009).

These intrinsic obstacles allow us to recognise something very important for collaboration: that plain conversation is an intrinsically limited resource when it comes to constructing a JKB. We know this very well from conventional meetings: they are very often not only unproductive and a waste of time (Kello, 2015) but also last too long, mostly because the collaboration and knowledge sharing are not working as they could and should when the meeting only uses plain conversation and debate (Bettoni and Obeng, 2020). Thus, as a next step, we need to solve this problem with the intrinsic limits of conversation.

4.2.4 Bicyclic Knowledge Conversion

Conversation is a complex process, but since language is learned without effort (in childhood), that process unfolds hidden behind a "veil of simplicity" (in analogy to the "veil of ignorance", Rawls,

2001), that we put on step by step during the course of our language skills development, until we reach the highest level, that of unconscious competence (Flower, 1999). By looking behind this veil, we can see how, during conversation, a knowledge base is built and maintained by several element-related activities which are performed on the knowledge elements during a circular, recursive process.

The four main activities are:

1. introducing new elements (through assimilation or accommodation);
2. modifying existing elements when divergence arises during collaboration;
3. detecting divergence across collaborators by monitoring ongoing interpretations of knowledge elements and comparing them with the intended interpretations to determine whether these fit;
4. last but not least, rectifying intended interpretations when there are conflicts (meanings do not fit).

If we want to solve the aforementioned problem of the intrinsic limits of conversation, then the complexity of communication and interaction involved in such knowledge sharing activities should be taken seriously. To this aim, we have developed a model of bicyclic knowledge conversion between a subjective self and another person, indicated by "Self" and "Other" (Fischer and Herr, 2019). The model is called "bicyclic" because it combines two main ways of recursive, coordinated interacting (Fig. 3): a communication (lower half of the diagram, based on Glanville, 2007) and a co-action (upper half of the diagram).

Since we focus on knowledge conversion in our model, in constructing it we used the SECI model of knowledge conversion (Nonaka and Takeuchi, 1995) and the IECS basic knowledge sharing model (Kharabsheh et al., 2016) as sources of inspiration. But differing from the SECI model, in our model the interaction process begins by explicitly considering two individuals, each with their own individual knowledge base (explicit and tacit knowledge) and looks at how knowledge conversions proceed first within each single person and then between them. More precisely, typical bicyclic knowledge conversion starts within the individual and proceeds as follows (Fig. 3, left side):

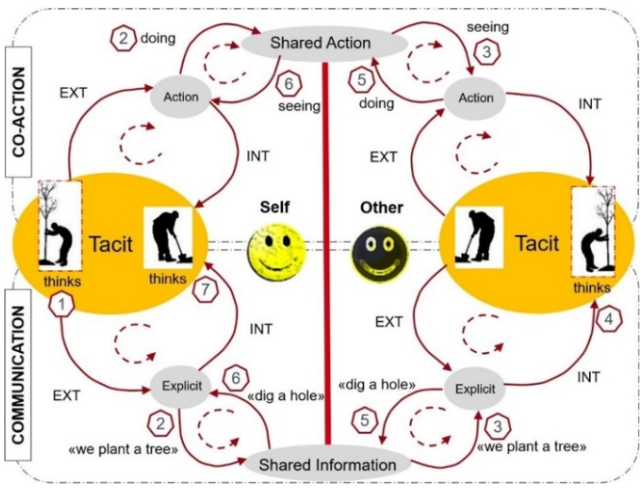

Figure 3: Bicyclic knowledge conversion between the Self and Other.

1. First, the model considers two knowledge conversions by the Self, from tacit to explicit (acronym EXT) and from explicit to tacit (acronym INT). EXT means "knowledge externalisation" (to document, to express) whereas INT means "internalisation" (to learn, to understand).
2. These two knowledge conversions form a loop internal to both individuals, indicated in the diagram with a circular arrow (dashed line). This loop can eventually lead to some thoughts related, for example, to planting a tree, indicated in the diagram - within the tacit knowledge base - by the silhouette of a person holding a young tree.
3. In a third step, the model looks at the knowledge conversion from explicit to explicit called "combination", which in our case is seen as an exchange of information in the sense of a conversation between two individuals.
4. At the same time, we also look at knowledge conversion from tacit to action, depicted in the upper part of the diagram.
5. An interactive knowledge conversion between Self and Other begins with the conversation depicted in the lower part of the diagram but is interlinked with the process of co-action.

- Step 1: Mrs Self thinks of planting a tree.
- Step 2: She says "we plant a tree" and, at the same time, the action of catching, moving and holding the tree begins.
- Step 3: Mr Other hears "we plant a tree"; this is the only information transferred. Meaning is not transferred, so what does this sequence of words mean? If there were no action, interpretation could be difficult and lead to misunderstandings. But Mr Other sees what Mrs Self is doing.
- Step 4: He understands correctly what Mrs Self said and contributes a complementary idea, for example by thinking that the tree needs a hole.
- Step 5: He says "dig a hole" and begins to do it.
- Step 6: Mrs Self hears "dig a hole". Again, if there were no action, interpretation could be difficult. But Mrs Self also sees what Mr Other is doing.
- Step 7: She understands correctly what Mr Other said and contributes a complementary idea, for example by thinking of a combination of her holding the tree and Mr Other digging a hole: they fit and so the collaboration is successful.

We see here that, thanks to co-action, interpretations on both sides were correct and conversation has been successful; moreover, thanks to this intertwining of conversation and co-action, a fourth step of knowledge conversion called "socialisation" has also been successfully performed; this is the step in which tacit knowledge is shared between the two individuals by means of integrating the two types of interaction, conversation and physical action. This suggests that the problem with the intrinsic limits of

conversation can be solved if the group collaborates (and constructs the JKB) in a way so as to intentionally make use of both conversation and co-action. 4.3 Artefact-Mediated Interaction with Boundary Objects

Given the previously presented model of a JKB, our next task now consists in suggesting collaborative patterns for group work and business meetings which promote this way of collaborating. Facilitation techniques already answered this question in part a long time ago by adding a specific type of physical action in space to conversation. This approach increases the complexity of leading the interaction, but we know from the practice of facilitation (Wagenaar and Hulsebosch, 2008; Kaner, 2014) that there are lot of tools and techniques (which can be easily learned) which help skilled facilitators in coping with this complexity of leading. Complex interaction methods, if appropriately facilitated, best fit with the complexity of the co-construction process, thus enabling the group to interact in a much more efficient and much more effective way.

A knowledge café, which requires dialogue rules, a specific venue with tables (each for 4 or 5 people), a facilitator with the skills to chair the session, a powerful question, a relevant introduction, small group conversations, etc. is a good example of such a complex interaction method (Sharp, 2019; Gurteen, 2021). Physical action is implemented mainly by means of the session's assembly changes (from plenary to small groups, from group to group 3 times then back to plenary) but can also include notes taken by all participants on large shared sheets at the tables.

Another example is storytelling: in this method, the physical action comes with the chain and flow of events which make up the story; we find it in the central conflict of the story as well as in its resolution. What we have here is merely a described and imagined physical action but it is there as a new dimension which increases the opportunities for activating the imagination, stimulating further thinking, creating tacit knowledge, helping to rediscover meaningfulness and orientation, awakening emotions, creating cohesion and strengthening memories. Among other types of stories, fairy-tales are particularly suited to fostering collaboration because they bring and hold together individuals and their (tacit) experiences through references, metaphors and analogies which can easily be assimilated (Bittel and Bettoni, 2014).

4.3.1 Artefact-Mediated Interaction

When conversation and physical action on an object (in space) are combined into one single group activity, we obtain a new type of interaction, which we call object-mediated interaction (combinations of words and actions on a shared object), where the physical action is performed on real objects which can be created, moved, modified and transformed in various ways in space. The new dimension which

conversation and the object which is produced step by step over the course of the interaction largely increase the number of choices and hence the opportunities for knowledge co-creation.

When the object is an artefact produced by the group (like, for instance, a list of ideas, a mind map of concepts or a flowchart of a process) and this artefact is made easily visible and accessible for everybody by means of a poster, a whiteboard, a panel or a table, then we speak of artefact-mediated interaction. In artefact-mediated interaction, the physical action performed by the collaborators consists of moving within a shared 3D space, sitting in small groups at tables, gathering in-front of a panel or poster, writing on large sheets or on small cards, fixing them on a panel or wall and then organising them according to a given problem-solving method etc. In doing so, they not only use existing artefacts; they also change or produce one or more of them as a result of their interaction. Such a product could be a set of marketing ideas organised in subgroups, a form for systematically organising information about project progress or a plan of action for training new clients.

When studying collaborative, heterogeneous problem-solving by scientists from different disciplines, Star (1989) recognised the importance of such collaboratively-produced artefacts. In fact, she observed that those scientists, despite their differences, were nonetheless able to successfully collaborate and attributed this to what she called "boundary objects": objects produced during the interaction that enabled those scientists to establish shared context (Star, 1989, p.47) like, for instance, documents, terms, standardised forms and methods, models, maps and other forms of reification (Wenger, 1998, p.105). In order to underline the fact that these objects are produced during the interaction, we will call them "boundary artefacts". They can link communities together by allowing different groups to collaborate on a common task (Wenger, 1998, pp.105ff) but they can also link individuals together by allowing a group to collaborate on a unitary task.

4.3.2 A System of Boundary Artefacts

Although traditional facilitation methods and tools (Kaner, 2014) use boundary artefacts, this alone is not enough to cope with the complexity of the co-construction process and to produce a representative JKB. We need a more systematic approach, which identifies a set of relevant dimensions (like space, time, culture, tools, methods and behaviours, see section 5) and where the whole interaction process is designed around boundary artefacts. Implementation of such a systematic approach exists in the QUBE system, a 3D collaborative virtual environment (3D CVE) of the "virtual world" type (Pentacle, 2015).

On QUBE, a boundary artefact is called PET (abbreviation for Performance Enhancing Tool). A QUBE PET implements a set of knowledge elements on a pinboard, structured in a specific way (see Fig. 4 and 5): this given structure functions as catalyser for the interaction, thus guiding the construction

of shared knowledge elements along clearly defined pathways and making the negotiation of meaning more efficient and effective. Four of the most successful QUBE PETs are Hopes&FearsTM, 5PsTM, StickyStepsTM and RAPIDTM:

- The PET called Hopes&FearsTM (Fig. 4) has a pinboard divided in three fields: on the right, a box for the fears, on the left a box for the hopes and below, a box for ways for overcoming the fears. This is a great way to initiate any new activity with stakeholders, especially if there is lots of uncertainty in the goals or methods. Working with this PET helps with the first steps of inclusion in teambuilding; it contributes to emotionally engaging team members from the start, helping them to define shared goals, agreeing early on what does and does not fall within the scope, agreeing on what are hard and what are soft success criteria, identifying risks and creating the basis for a common project culture.
- The PET called 5PsTM (Fig. 4) provides a way of formulating the essential aspects of a message, task or action. The pinboard is divided in two fields. The box on the left is for the unstructured, spontaneous description of an idea, message or task. The box on the right is structured into 5 fields: Purpose, Principles, People, Process and Performance. Working with this PET helps to avoid misunderstandings and communicate clearly about complex issues, like the core elements of a project, problem or solution. It should be used at milestones when the group needs to reflect on the project, task or action and gain a clearer view of its essential aspects as well as every time a team member or stakeholder receives instructions to act independently.

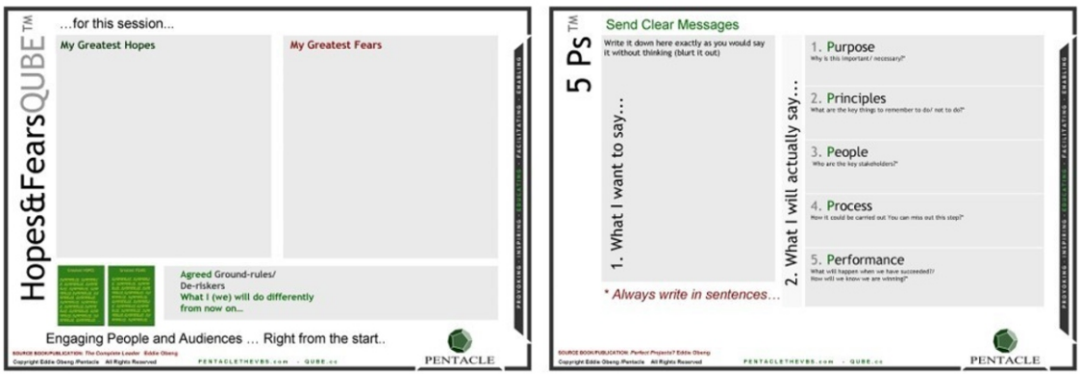

Figure 4: Boundary objects Hopes&FearsTM and 5PsTM

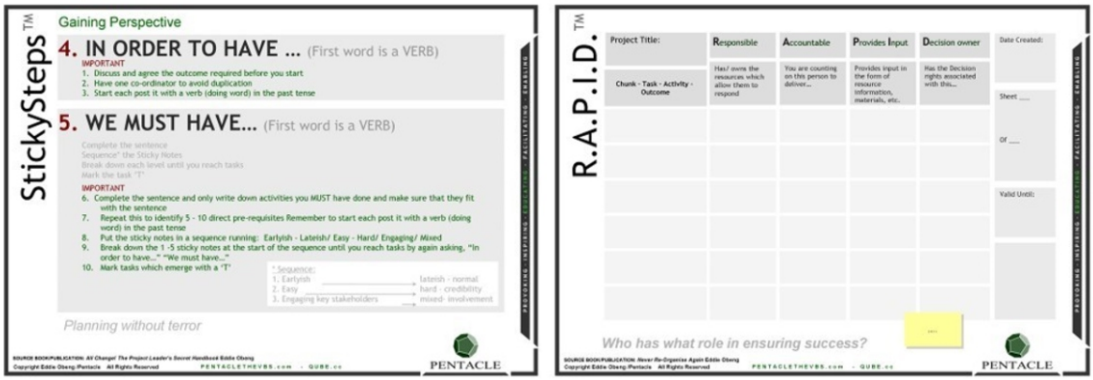

Figure 5: Boundary objects StickyStepsTM and RAPIDTM

- The PET called StickyStepsTM (Fig. 5) displays a simple pinboard with just two areas; a row on the top for expressing the overall goal and a large area below this row for breaking down the overall goal of the action into the means required to achieve it. If one or more actions in this lower area are still too large, the team repeats this step by adding a lower breakdown level; the breakdown continues until you reach tiny little steps (tasks). This PET provides a quick and effective way to plan a project or action whenever they are almost too large to contemplate. This kind of breakdown (goal to action) allows interdependencies between parts of the project, action or task to be dealt with appropriately.

• The PET called RAPIDTM (Fig. 5) is simply a table of tasks (rows) with columns for the different roles (responsible, accountable, contributing and deciding) needed for accomplishing a task; when roles for tasks are assigned to group members, then the facilitator enters their names in the related cells, thus making sure that everyone knows exactly what it is they have to contribute, and in what way. This PET is also very useful for ensuring the interdependence of the activities and people involved on them in a systematic way: this helps to reduce bottlenecks which tend to slow down the pace of execution of a project. It should be used at the end of any team meeting and in general every time the group agrees on tasks for a piece of work in which the group members are involved.

4.4 QUBE New Collaboration

On QUBE, the previously mentioned systematic approach to online collaboration is obtained by designing a meeting around six relevant dimensions, which can also be seen as six relevant components: Physical Space, Time, New Culture, New Tools, New Methods, New Behaviours. Strictly speaking, artefacts-mediated interaction is implemented by means of the 5th component (New Methods) but all the other dimensions also contribute and are necessary for the QUBE New Collaboration:

1.Physical Space on QUBE is supported by a 3D environment (3D CVE) which simulates a business campus with buildings, various types of rooms and other places and provides avatars with which each participant can move around in the rooms, meet other people, sit with them and chat at tables, visit panels, point to items on the walls of the room, walk to other rooms, work at an individual desk, etc.

2.Regarding Time, on QUBE a meeting continuously uses boundary artefacts, in each phase, from begin to end.

3.An example of "New Culture" is the principle of "Write first, talk second" which requires that, for any given topic of discussion, participants must first write their contributions on a panel and then conversation will start based on and referencing those written contributions.

4.An online "New Tool" is, for example, the sticky note facility and the panel on a wall: each participant can create as many sticky notes as they wish, write a text on each and place the sticky note on a panel visible to all the other participants.

5.A "New Method" is, for instance, the so-called "Hopes & Fears" method for collaboratively planning a session.

6.Last but not least, an example of a "New Behaviour" is being fully attentive to what is going on instead of reading e-mails or surfing the internet during the meeting.

Thus, in general, on QUBE, collaboration and the construction of a JKB proceed as a group activity where cognitive, social and leading presence come together at the intersection of these different dimensions and produce boundary artefacts.

4.4.1 A QUBE Session

A typical session on QUBE, for instance a kick-off meeting, begins with session facilitators welcoming the participants as they arrive in the space. Each person in QUBE is represented by an individual avatar, a simple box figure (like LEGO mini figures but gender-neutral) which provides enough of a human form to foster the required level of identification.

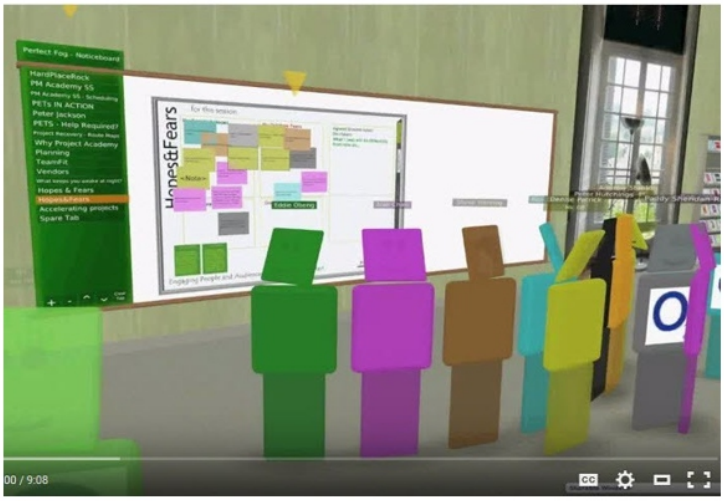

Figure 6: Group at whiteboard with Hopes & Fears PET by Pentacle

Using your avatar, you are able to communicate with other people just as you would in the real world. You can move around in the rooms of a building, physically interact and work shoulder to shoulder, literally brainstorming with many other people by means of whiteboards and sticky notes.

The facilitators welcome each one individually and make sure that they are ready to begin. Then the avatars can visit the virtual collaboration space until the meeting starts. The room has been carefully prepared in advance. The whiteboards, panels, tables and chairs needed during the meeting are available on the walls and on the floor. Some whiteboards display poster tools called PETs (Performance Enhancing Tools), guidelines or procedures about how to accomplish a task described on a poster. PETs can easily be replicated on a whiteboard or wall when needed; each PET is linked with a specific documentation which describes "what is it?", "why do I need it?", "when do I use it?" and "how do I use it?" In this sense, a QUBE PET is a collaboration method and corresponds to what is often called a collaboration pattern in literature (Eppler and Schmeil, 2010). What is special about a QUBE PET is that the collaboration involved is always an artefact-mediated interaction.

4.4.2 Problem-Solving Meetings

Regularly scheduled problem-solving and decision-making meetings with a project team are the most important requirement for effective and efficient collaboration (Gordon, 1977). On QUBE, these meetings, called "drumbeats", eventually receive the high level of consideration which they deserve. Within such a drumbeat, we see exemplified how QUBE implements artefacts-mediated interaction: conversation and physical action are combined during a meeting on QUBE to form a mediated interaction in which collaborators produce the aforementioned boundary artefacts (see 4.3.1). A drumbeat starts with a previously appointed coordinator welcoming the team members as they arrive in the project space on QUBE and gather at the central meeting place, called the "home" (leadership presence, social presence). When the group is complete, they walk together to a panel which displays the PET "Hopes & Fears" where the coordinator asks: "what are your expectations and what are you afraid of in relation to this meeting?". Each participant writes their contributions on cards and places them in the hopes or fears area of the panel (Fig. 4, left). Collaboration enabled by this boundary artefact starts within the individual, with the two knowledge conversions of "internalisation" (INT) - when a participant reads the cards that other participants place on the board – and "externalisation" (EXT) – when a participant writes their own contributions on cards and places them on the board, among the others. A team member will then organise the cards in clusters and clarify their meaning with the help of the group, thus beginning the knowledge conversion of "combination". Together the team then needs to discuss what could remove the Fears (social presence) before creating a meeting agenda of steps for making the Hopes a reality (cognitive presence): this will require writing some new cards and placing them on the board as well as putting existing cards in a proper temporal sequence. The knowledge conversion of "socialisation" happens in these card-related actions: pointing to a card when talking about its content, moving cards to put them in a better order, creating clusters or sequences of cards, changing the size of a card, formatting its words, etc.

When the meeting agenda is ready, then the team starts working on the tasks defined in it. PETs like "5 Ps" and "STICKY STEPS" help to clarify the problem and plan some quick wins in the beginning. During the interactions, some specific questions will arise and provide opportunities for starting work in smaller groups. Small groups can move to an area in the same room equipped with chairs and round tables and sit down here when they want to discuss something, for example how to proceed when dealing with the specific question they have selected to work on (cognitive presence, leading presence). Once they have decided this, they can move to another area of the space and gather in front of a huge whiteboard with sections separated by panels. At tables and in front of panels, the group members will only hear each other talking, without noise from other groups (a feature which is quite impossible in a real room). At the end of the meeting, a PET called RAPID will help the whole team to define the next steps and related tasks and plan when and who will accomplish them after the meeting (leading presence, social presence). After that, the team usually gathers in a circle in the middle of the room. Here

the group performs a so-called "spincasting" (social presence): each team member in turn has the opportunity to give brief feedback about the work carried out in the small groups (insight, remarks, questions, learning, etc.).

This structure of a drumbeat meeting in three steps (start in plenary with a teambuilding PET, work in small groups with problem solving and planning PETs, closing the meeting with a planning PET and a plenary feedback) can also be applied during any phase of project work.

5. Discussion

In the VUCA world, the trend is clearly moving towards increasingly knowledge-based work in a fast-changing environment. In order to successfully cope with this evolution, organisations should develop collaborative cultures and embrace collaborative practices. New Collaboration can support this but in order to fully exploit its potential, we need to better understand an essential aspect of knowledge sharing, the Joint Knowledge Base.

To this aim, we have first provided a definition of New Collaboration as a knowledge-based and communityoriented activity where collaborators are mutually engaged in constructing and maintaining a JKB as a basis for accomplishing their unitary task without splitting it. At first sight, this concept of collaboration may seem excessively resource-intensive; imagine, for instance, a research department; what could it mean here, "working together on a unitary task without splitting it"? Of course, researchers should not work all together on every research project and on every work package in a project. There are tasks which were, are and will also in future be better assigned to one individual. But the trend is clearly moving towards increasingly knowledge-based work units (Jacobs, 2019) and because knowledge evolves so rapidly and remains mostly tacit (less time for documenting) due to the high rate of innovation, these tasks tend to be complementary (require the contribution of more than one individual). When problem-solving requires interaction with other people, what you have is often a consulting situation. Sometimes just a phone call or e-mail to one colleague may be enough; but in many cases, you need more time and to involve more than one person. You may need a prolonged, problem-solving interaction with a group and this can seldom be done one-to-one on the phone; it requires a meeting. So, with increasingly knowledge-based, complementary and unitary tasks, the number of (problemsolving) meetings is also increasing. These meetings are critical for any organisation, but most people hate them (so-called "paradox of meetings"). Fortunately, New Collaboration also applies to problem-solving meetings and has recently been proposed as a solution to the paradox of meetings (Bettoni and Obeng, 2020).

The knowledge elements of a JKB are all initially constructed by individual group members and must then go through a process of group cognition (a negotiation of meaning): they can enter the JKB only as a

socially negotiated result of this process. This approach implies that the group must pay great attention to the two components of the negotiation process, participation and reification.

By arguing that participation and reification are both based on and enabled by the co-construction of knowledge, we have in a certain sense shifted the focus to the intrinsic limits of plain conversation as a method for building a JKB, like for instance in conventional meetings. Our model of bicyclic knowledge conversion has enabled us to look behind the veil of simplicity: there we were able to see not only the obstacles which hinder and the activities which contribute to the construction of a representative JKB but also to understand the essential role that physical action can play in overcoming the problem of the intrinsic limits of plain conversation. Based on this, we have proposed artefact-mediated interaction as a solution to this problem and argued for the need of a systematic approach, where the whole interaction process in all its relevant dimensions (like space, time, culture, tools, methods and behaviours) is designed around boundary artefacts. Finally, we were able to show that this way of collaborating is not just theory but already daily practice: the commercially available collaboration platform called QUBE and the tools and culture which it promotes constitute a real-world system which successfully implements artefacts-mediated interaction by means of boundary artefacts (PETs), thus enabling the Joint Knowledge Base to be representative of the group's knowledge and the full potential of New Collaboration to be exploited.

6. Conclusion

Our paper deals with the fundamental issue of a Joint Knowledge Base, which so far was missing in the research literature. Our model of a JKB adds a missing piece to the description and generation of collaborative group interaction patterns (Eppler and Schmeil, 2010). We believe our model to contribute an important aspect to the effort of formalizing collaboration both in virtual and in physical environments, a task that is crucial especially in order to advance the application of digital collaboration. Our research contributes further to a better development of collaboration patterns as "recommendations for how (or how not) to interact" (Wasson and Mørch, 2000), which is essential for promoting innovative, valuable new forms of working together (New Collaboration). Nevertheless, being this the first attempt to address fundamental issues like how a JKB enables collaboration and specifically how a JKB is constructed and maintained, the current version of this attempt has some limitations, which will need to be well investigated in the evaluation of this research and addressed by future work.

First of all, our model of a Joint Knowledge Base is only a rough sketch; further research will be required for investigating: 1) how knowledge areas, which mutually converge and resonate, emerge within many individual knowledge bases; 2) to what degree the meanings need to be consensual and build convergent areas in order to enter the JKB; 3) what indicates the convergence of meanings and how does resonance manifest itself in these convergent areas when meanings do not overlap or match across all the

individual knowledge bases of the group members. Secondly, in mediated interaction, further investigations will have to deal with our interpretation and use of the boundary artefact and clarify how cognitive, social and leading presence come together and contribute to its production. In particular, regarding physical action, we need to develop a model: 1) of what this type of action adds to the interaction when it is performed on cards which can be placed and grouped on a whiteboard; 2) of how physical action influences the motivations, roles and relationships of the participants. Last but not least, the way in which the intertwining of communication and co-action contributes to the knowledge conversion called "socialisation" will require further clarification in future work. This will be important to make it easier to share tacit knowledge in a variety of collaborative situations.

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Notes: