Knowledge Requirements Fulfillment Analysis

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The knowledge spectrum organizes a large amount of information about knowledge, dividing intelligent behavior into its cognitive elements. By providing a concise way to describe organization knowledge requirements and resources, the spectrum supports their cataloging, measurement, and analysis. Obtaining information about knowledge requirements begins with a few simple queries. Business process managers would be asked to identify the maps that guide the performance of the processes that they manage. The dialogue that enables the definition of knowledge requirements, the creation of business process knowledge requirements (BPKR) trees, and the creation of employee knowledge profiles is described. The levels and branches of a BPKR tree and the information stored in BPKR trees is explained. Using several examples from information systems, the value of business process knowledge requirements (BPKR) trees is illustrated. How these trees support the conduct of knowledge requirements fulfillment analysis (KRFA) is described. Although simple, the examples will demonstrate that KRFA should enable firms to better match knowledge requirements and resources. A prototype system for KRFA is briefly described.

Keywords: knowledge management, knowledge spectrum, cataloging knowledge resources, knowledge resource allocation

INTRODUCTION

Stewart (2002) stated that knowledge management requires the continuous auditing of organizational intellectual capital and the mapping of existing knowledge resources. In response, Randles, Miller, and Blades (2011) proposed that the knowledge spectrum provided a framework for defining and assessing organization knowledge requirements and knowledge resources. This paper extends their work, focusing on business process knowledge requirements (BPKR) trees, employee knowledge profiles, and knowledge requirements fulfillment analysis (KRFA).

A BPKR tree represents a business process. The stages of a business process are represented by the level 1 branches of a tree. These branches represent the behavioral-cognitive characteristics of the process providing one aspect in a systematic effort to define organization knowledge requirements. The effort continues through an explication of the technical skills performed at each business process stage.

A dialogue between managers of a firm and the knowledge spectrum is described. This dialogue enables managers to define their business process knowledge requirements and begins with just a few simple queries. Primarily about maps. However, other information also emerged from the knowledge spectrum, such as - the internal maps that guide intelligent action are composed of indicators and rules. From this spectrum information, a query was generated - what are the indicators and rules which comprise the map?

The requirements gathered through the described dialogue would be stored in BPKR trees and used to develop BPKR queries. BPKR queries would be used to establish a dialogue with the firm's knowledge workers. This dialogue would enable knowledge workers to catalog their possession of business process knowledge more precisely. Several simple examples of KRFA are presented. Although simple, the examples demonstrate that even the skeletal view provided by the level 1 and 2 branches of a BPKR tree can be used to create useful employee knowledge profiles. Furthermore, the examples illustrate what one might expect to learn from an analysis of employee knowledge profiles.

A prototype system for KRFA is described. Development of the system is not a daunting task. The strength of the proposed system is its foundation – the knowledge spectrum which provides a concise way to describe organization knowledge requirements and knowledge resources. Two other tools: the cognitive force equations and the knowledge modeling tool - moment models - have been developed. These tools complement KRFA and are discussed in brief in the paper's closing remarks. The paper ends with a brief discussion of the relationship between this research and AI.

LITERATURE REVIEW

The telemedicine research of Randles and Thachenkary (2002) fostered the engine and vehicle analogy of Randles and Fadllala (2004). In the 2004 analogy paper, knowledge chemistry was introduced, and the knowledge spectrum of Randles, Blades, and Fadlalla (2012) was considered its first tool. Based on this telemedicine and knowledge management research, Randles, Miller, and Blades (2011) introduced KRFA, and this research and its foundation topics are introduced in the literature review.

Telemedicine Research

The telemedicine research of Randles and Thachenkary (2002) focused on telemedicine's impact on diagnostic confidence. According to these researchers, diagnostic confidence was an emotion that preceded intelligent action and was related to the size of a physician's knowledge gap. To test the validity of the four-stage model, Randles and Thachenkary (2002) studied the video recordings of teleconsultations and conducted telephone interviews with the consulting physicians. Their study revealed an average change in diagnostic confidence of 40% for teleconsultations conducted to make diagnoses and an average change of 18% for teleconsultations to confirm diagnoses. This indicated that diagnostic confidence was inversely related to the size of the physician's knowledge gap. Furthermore, the research indicated that the successful processing of information and provision of explanations increased diagnostic confidence (Randles and Thachenkary, 2002).

The Engine/Vehicle Analogy and the Knowledge Spectrum

By weaving concepts from the decision making, information systems, telemedicine, cognitive psychology, and epistemology literatures, the four-stage model of Randles and Thachenkary (2002) linked each stage to a specific knowledge type, form of insight, and diagnostic milestone. Using concepts from engine mechanics, which are well-understood physical systems, Randles and Fadlalla (2004) introduced the engine and vehicle analogy. The analogy suggested that different knowledge types were used to extract value from information, resulting in insight. This insight culminated in action which produced new insights. Thus, systematic action, and the analogy provided a description of the process of information dissipation, which was not well understood.

The engine and vehicle analogy of Randles and Fadlalla (2004) presented specifications for four knowledge blends, which rely on three types of pragmatic knowledge. Each knowledge blend was designed to fuel a different form of knowledge combustion, and each form of knowledge combustion permitted the attainment of a different form of insight. Furthermore, each knowledge blend required the application of a different cognitive force to permit its combustion, and the authors proposed that their fuel and force specifications must be satisfied for the effective dissipation of information. In developing these fuel and force specifications, an alternate knowledge management approach (knowledge chemistry) was proposed.

The foundation of the knowledge spectrum was the engine and vehicle analogy of Randles and Fadlalla (2004) which described three forms of insight and seven knowledge types (declarative knowledge, rules, signals, maps, technical knowledge, semantic knowledge, and structuring causes). These knowledge types and forms of insight were placed on a continuum according to their explicitness, technical feasibility, and ability to generate cognitive force (Randles, Blades, and Fadlalla, 2012).

To support the reader's understanding of KRFA, the knowledge types of the knowledge spectrum are now described. Drawing from Eysenck and Keane (1990), Randles, Blades, and Fadlalla (2012) defined **declarative knowledge** as the knowledge of *knowing that* (such as knowing that a specific diagnostic procedure should be conducted). With respect to **rule-based knowledge**, numerous examples were provided, such as Weick and Bougon (1986), who stated that predictive and associative knowledge were a collection of rules for processing information, and Covington (1998) who described pragmatic rules as rules of knowing what to say when.

Dretske (1988) defined the triggering cause as a summary form of knowledge that signals the presence of an external event. These **signals, alarms, or indicators** represent another type of internal mental model. The lower-level knowledge types just described are simple knowledge types. They serve as the raw materials from which more complex knowledge types are built (Randles, Blades, and Fadlalla, 2012).

Dretske (1988) stated that the third knowledge type controlling intelligent behavior was a map, attached to a belief that guides one's actions. According to Randles and Fadlalla's (2004) specifications of knowledge blends, **map-like knowledge** is a long-chain structure of facts that must be recalled or formulated, and Randles, Gardner, and Allison (2022) refined this definition, stating that maps are composed of a small number of rules and signals.

Drawing from Polanyi (1966), Randles, Blades, and Fadlalla (2012) stated that tacit knowledge has a component that is technical, which is the knowledge of how to do something, and is also referred to as procedural knowledge (Fetzer and Almeder, 1993). **Technical knowledge** resides in the mind and the body (Polanyi, 1966) and is placed in the middle of the knowledge spectrum establishing a broad boundary between tacit and explicit knowledge types (Randles, Blades, and Fadlalla, 2012).

Finally, Dretske's (1988) **structuring cause** is positioned as the most tacit and powerful pragmatic knowledge type on the knowledge spectrum. The structuring cause is highly dependent on semantic knowledge. Its role is to generate an explanation that motivates action. This requires a deep analysis and the identification of relevant strings of thought. Often, these strings of thought seem unrelated on the surface but are connected at a deeper level (Randles, Blades, and Fadlalla, 2012).

BPKR Trees: Cataloguing and Analyzing Knowledge Resources

Because the knowledge spectrum provides a common framework for categorizing and describing organizational knowledge requirements, it can support efforts to match requirements and resources. To define requirements, knowledge spectrum information would be used to establish a dialogue with a firm's business process managers and the requirements information would be stored in BPKR trees. Furthermore, the requirements information collected from business process managers would be used to establish a dialogue with the firm's knowledge workers enabling employees to create their knowledge profiles (Randles, Miller, and Blades, 2011).

As a first step in resolving misunderstandings between managers and knowledge workers, an analysis of their understanding of business process knowledge requirements could be conducted. Furthermore, employee knowledge profiles, business process knowledge requirements, and business process work schedules would be integrated and analyzed to assess knowledge resource allocation as well as to conduct forecasts of the availability of business process knowledge for various scenarios (Randles, Miller, and Blades, 2011).

KNOWLEDGE REQUIREMENTS FULFILLMENT ANALYSIS

Although grouped by titles such as program analyst, software engineer, or data analyst, the employees within each category possess different knowledge and skills. For KRFA, obtaining a precise, in-depth catalog of knowledge resources begins with the creation of business process knowledge requirements (BPKR) trees. Next, the three levels of branches of a BPKR tree are described as is the dialogue to create BPKR trees. Primarily, this dialogue focuses on the internal maps that guide intelligent behavior.

BPKR Trees and Their Three Levels of Branches

In developing an example of a BPKR tree, the information systems development process was first considered. However, this process was too general. There are different types of information systems with different knowledge requirements. Furthermore, each stage of the information systems development process: logical design, physical design, and implementation can be decomposed into sub-stages. Minimally, an organization's information systems development process would be described using at least twelve BPKR trees. Probably, thirty.

Table 1 provides a broad view, presenting the level 1 branches of two BPKR trees (logical design and maintenance) of a cargo transport management system (CTMS). The stages of a business process are represented by the level 1 branches of a BPKR tree. For example, the process – logical design – has four stages: planning, modeling, model walk-through, and design sign-off. The level 1 branches represent the behavioral-cognitive aspects of a process, and each stage requires one of four forms of knowledge combustion (framing, formulation, hypothesis testing, or profound explanation). Planning achieves the formulation form of knowledge combustion. It is guided by an insight achieved in a previous stage. A plan is created while action is delayed. With respect to the modeling stage, at each step of the modeling exercise, hypotheses are tested. Decisions are made. Similarly, model walk-through is a step-by-step task, illustrating the hypothesis testing form of knowledge combustion, again.

The behavioral-cognitive description provided through the level 1 branches of a BPKR tree is one part of the requirements definition. Through explication of a stage's technical skills, knowledge requirements can be described in greater depth. Table 2 presents a BPKR tree for the process - logical design of a CTMS, presenting the level 1 branches (stages), the level 2 branches (technical skills), and the level 3 branches (tools) of the tree. The table shows that the modeling stage requires three technical skills: process modeling (branch 2.1), data modeling (branch 2.2), and logic modeling (branch 2.3). Furthermore, it shows that each skill requires a tool. For example, the process modeling task uses the tool - data flow diagrams. As shown in Table 2, this tool is represented by the level 3 branch (2.1.1) which extends from the level 2 branch (2.1 - process modeling). Another example of the relation between task and tool is the level 2 branch (2.2) depicting data modeling task and the level 3 branch (2.2.1) depicting the tool - entity relationship diagram.

A Simple Dialogue to Create a BPKR Tree

In discussing knowledge chemistry and knowledge blends, Randles and Fadlalla (2004) stated that intelligent behavior was supported by four sets of cognitive processes: pre-semantic, semantic, pragmatic, and technical. The pragmatic and technical processes are the focus of this research, and the dialogue to obtain information about them begins with just a few simple queries. Primarily about maps. For example, the knowledge required to develop a set of data flow diagrams was defined by a systems analyst who was guided by the following dialogue - *the conduct of a technical skill requires maps,* and, from this spectrum information, a query was generated that asked - *which maps guide the development of the data flow diagrams*.

Other information also emerged from the knowledge spectrum, such as - *the internal maps that guide intelligent action are composed of approximately a dozen indicators and rules*. From this spectrum information, a query was generated - *what are the indicators and rules that guide the creation of the context diagram*. While a simple question, when asked repeatedly about different maps, a great amount of valuable information can be collected. By looking just beyond job titles and technical skills, at maps, signals, and rules, an organization can refine its definition of knowledge requirements.

The creation of a data flow diagram is an iterative process that begins with the creation of the upper-level diagrams: context diagram, diagram 0, diagram 1, diagram 2, and diagram 3. From responses to spectrum queries, information regarding branch 2.1.1's knowledge requirements was obtained and stored in the branch's requirements nodes. As Table 3 shows, the development of the context diagram, diagram 0, and several lower-level diagrams is guided by three maps, and the simple query: *What are the indicators and rules that guide the creation of the lower-level diagrams*, elicited the following rules. Each diagram should have the same level of complexity. There should be a maximum of five and a minimum of three processes per diagram, and, for a process with a complex internal logic, the subdivision (explosion) of the process should stop when the process has one input and one output data flow.

A tool can direct the performance of a technical skill or might only support its conduct. The process modeling tool - data-flow diagrams – directs the process modeling task specifying its steps, rules, and states. Because the tool directs the task, it is of primary importance in describing the branch's knowledge requirements. Consequently, the requirements nodes of this level 3 branch (branch 2.1.1) would possess most of the requirements information for the process modeling task (branch 2.1).

In addition to knowledge regarding use of the tool, knowledge about organization processes (process knowledge) is also required to develop data flow diagrams (process models). The requirements for this process knowledge would be obtained by repeating the previous dialogue (described in Table 3) but only concerning maps. These requirements would be stored in the requirements nodes of branch 2.1 – process modelling. As depicted in Table 4, a simple query about maps reveals that the creation of data flow diagrams requires seven additional maps of organization processes.

The creation of the context diagram and diagram 0 requires a map (Map 1) that is like a list that would identify each of the external entities sharing information with the firm. For each of the listed entities, a general description of the shared information would also be provided. Map 2 is a slight modification of Map 1. For each Map 1 entity, the lower-level process sending or receiving the information (front-end, core, or back-end) is appended. Map 3 identifies the front-end sub-processes: marketing, sales, and customer service while Map 4 (core) identifies the core sub-processes: production, inventory control, human resources, and accounting.

Table 4 illustrates that the collection of BPKR information does not have to be as detailed as shown in Table 3. In Table 4, a summary description of the map's contents is provided, rather than the map's indicators and rules. While it is easy to envision uses where the more detailed approach (demonstrated through Table 3) is appropriate, in most cases only a summary description of the contents of each map is required, as shown in Table 4.

Examples of Knowledge Requirements Fulfillment Analysis

From a definition of knowledge requirements, the process moves to cataloguing employees' possession of the required knowledge. This is done through use of requirements information which is stored in the requirements nodes on the branches of BPKR trees. Tables 3 and 4 illustrate how queries about internal maps can produce detailed or summary definitions of business process knowledge requirements. This requirements information would be used to generate BPKR queries which would enable employees to communicate their possession of business process knowledge.

The BPKR information obtained through BPKR queries would be used to create employee and organization knowledge profiles which would be used to conduct KRFA. KRFA is described next through several simple. As it will be shown, even the skeletal views provided by the level 1 and 2 branches of the BPKR trees depicted in Tables 1 and 2 can be used to create useful knowledge profiles.

Example 1. Table 5 depicts the employee knowledge profiles of Analyst A and B for several different processes. This profile information provides an explanation of events that occurred years ago when an inexperienced programmer (Analyst A) and a programmer/analyst with five years of experience (Analyst B) were assigned to the logical design of a cargo transport management system.

The task required the translation of a transport procedures manual into computer program specifications. In three months, Analyst A had developed specifications for fifteen programs while Analyst B struggled with the task. As depicted in Table 5, Analyst B did not possess the knowledge required to develop program specifications (branch 2.4), although competent in many other areas. For example, regarding the planning involved in the logical design of an information system (branch 2.1), Analyst A had little confidence (50%) while Analyst B was moderately confident (70%). The same is true for process and data modeling (branches 2.2 and 2.3). Analyst A indicates only a 70% and 65% confidence level surpassed by Analyst B in each case. Conversely, while novice in many areas, Table 5 indicates that Analyst A was well prepared to translate a cargo transport manual into computer program specifications (branch 2.4) with Analyst A being highly confident (90%) and Analyst B a little less confident (80%).

Example 2. To perform complex business processes, many knowledge requirements must be satisfied. Through KRFA employees with complementary skills can be identified when forming teams. As depicted in Table 6, Analyst A and B formed a complementary team that enabled them to successfully complete many projects over several years. This was done in the following manner.

Because Analyst A was adept at the design of information systems, this analyst would immediately begin software design. For logical design and the development of the logical model, Analyst A was 95% confident while Analyst B was 85% confident. Similarly, regarding coding Analyst A was 95% confident while Analyst B was 85% confident. Using existing (tested) code, Analyst A would quickly create, test, and debug a program with the greatest functionality. Instead of design and coding, Analyst B would complete the documentation and make presentations regarding the just completed project. For these tasks, Analyst B was 90% confident (script writing and visual presentation) while Analyst A was 80% and 70% confident.

Finally, using Analyst A's code as template, Analyst B would create several other programs bringing each to 80% completion. The computer programs were completed by Analyst A while Analyst B would develop a test plan and create the test files for systems testing. For these tasks Analyst B was better suited. Regarding the development of a test plan (branch 3.1) Analyst B was 95% confident while Analyst A was 80% confident. Similarly, regarding the development of test data (branch 3.2) Analyst B was 95% confident while Analyst A was 80% confident. This example illustrates that an analysis of employee knowledge profiles can enable managers to assign employees to the tasks they do best.

Example 3. The next example comes from the computer services industry where several firms competed for contracts to process insurance claims. As Table 7 suggests the firm that won the contract had the lawyers necessary to steer the firm through the proposal process and a skilled government relations staff to manage the contract. Founded by a person with a strong computer science background, the firm had an experienced team of IT professionals who could capably modify and operate the firm's claims processing software. As depicted in Table 7, a veteran team of technical specialists and technical writers were also available to develop the proposal.

The firm was making a low, break-even bid to assure winning the contract. Unfortunately, there was one critical weakness in the composition of the team. No economic consultants were asked to study the cost of operating in a rapidly growing metropolitan area. The bid was based on the cost of living of the city headquartering the firm and was made too low. Rather than breaking-even significant losses were incurred. Alternately, through a definition of knowledge requirements, the need to conduct competent economic analyses might have been recognized. Under advisement of an expert economist, the bid would have been raised 20%; the contract still won, and the firm's break-even strategy successfully implemented.

While simple examples, examples 1 and 2 illustrate what one might expect to learn from an analysis of employee knowledge profiles. Example 3 suggests that the definition and analysis of organization knowledge requirements might serve as a management tool. The authors believe the failure to fulfill critical knowledge requirements is the cause of many business catastrophes. The conduct of KRFA might enable organizations to avoid them.

A Prototype System

Over an entire career, a knowledge worker would input information regarding twenty processes and twenty technical skills through their dialogue with the KRFA system. This would occur over short spans of time (less than an hour) several dozen times over an entire career. By cataloguing their possession of business process knowledge, employees would communicate their skills and value. By going beyond processes and stages and describing skills, maps, signals, and rules, a deeper understanding of organization knowledge requirements is obtained. This requirements information would enable organizations to perform in depth analyses regarding the fulfillment of requirements, as well as forward looking analyses concerning the availability of workers to satisfy them.

This paper has provided several simple examples of knowledge requirements fulfillment analysis. Most assuredly, implementation of the proposed system would reveal more interesting cases. However, the examples show that knowledge spectrum information can be used to establish a dialogue with business process managers and knowledge workers. Through this dialogue information to support KRFA and other forms of knowledge forecasting would be created. Although only a concept, the development of the proposed system is not daunting. When resources are available development of a prototype system will begin.

The proposed system would use existing technologies in novel ways. Its strength is its foundation – the knowledge spectrum. By providing a concise way to describe organization knowledge requirements and knowledge resources, the knowledge spectrum supports their effective cataloging, measurement, and analysis. If implemented organization wide, a directory of business processes would be provided allowing knowledge workers to access specific branches of BPKR trees. For example, a knowledge worker could select a technical skill from the menu, which would begin a dialogue that would guide the knowledge worker's entry of information regarding the selected skill.

The system would be flexible. Queries could be designed that only require a simple answer to an in-depth question. For example, from the requirements nodes of the healthcare benefits software maintenance tree, specifically the level 1 branch - analysis stage, the level 2 branch - the technical skill (computer software programing), and the level 3 branch - the tool (programming language XX), the following requirement could be specified. *The task requires the analysis of 30 programs and 30 thousand lines of code written in the computer programming language XX, regarding employee healthcare benefits*. Analysts would only be required to provide a simple answer regarding how confident they are about fulfilling this requirement.

The BPKR trees' level of detail would be determined by the managers and knowledge workers who create them. The managers and workers would select specific maps for explication of their rules and signals. For many processes, such detail is not required. However, when assessing controller's knowledge of air traffic control, information regarding each blip and line on an air traffic control screen seems essential.

In addition, the envisioned system would support project managers. For example, the system could support a project manager's selection of 15 analysts to develop data flow diagrams. To select the team, the project manager would identify available analysts who know how to use the tool - data flow diagrams using the proposed system. Of this pool of analysts, an analysis of their process knowledge would be performed by the project manager. The analysts who use the tool best and possess knowledge about the required organization processes would be selected for the team.

Internal maps are the cornerstone of KRFA. One of the reasons for this is that maps serve as an intermediary between learning (which creates the maps) and intelligent behavior (which requires the maps). When employee knowledge profiles are created, employees would be asked to specify how they gained their expertise (how they acquired their internal maps). Was it through academic study, work experience, and/or personal experience? This profile information could be used by business process and human resource managers to evaluate employee claims of possession of required business process knowledge.

Using KRFA, managers will be able to better allocate knowledge resources and better ensure the fulfillment of critical requirements. For risk managers, the fulfillment of critical requirements is of great concern and KRFA should be useful. KRFA warrants further research by researchers from many sciences. These sciences include knowledge management, human resource management, project management, and risk management as well as the library and information sciences.

CLOSING REMARKS

Over two decades ago, an analysis of one hundred video recordings of medical diagnostic teleconsultations was conducted. Through their dialogue and actions, the strengths of physicians (patient history) and specialists (specialized knowledge of illness) emerged. The explanations of specialists began halfway through the teleconference, prompting the physicians to make queries and the specialists to provide more in-depth explanations. These dialogues revealed a great deal about knowledge and supported the creation of the knowledge chemistry approach.

Across three decades of research, a common theme has emerged. Capture the explanations of knowledge workers involved in critical processes. The provision of maps and explanations through HTKB technologies was described by Randles, Blades, and Fadlalla (2008). HTKB technologies would establish timing mechanisms using pragmatic rules which would control what is said when. The authors suggested that knowledge intense organizations conduct audio and video analysis and develop HTKB technologies for critical processes. Through HTKB technologies organizations would gain greater congruence in the conduct of critical processes, would have greater access to specialty knowledge, and would become increasingly more scientific.

From the perspective of knowledge chemistry, maps are paramount. Unfortunately, efforts to map knowledge can be difficult. Lenat and Feigenbaum (1991) recognized this unfortunate characteristic of knowledge and articulated an important principle of knowledge. If a computer program is to perform a complex task, it must know a great deal about the world it operates. Furthermore, in unexpected situations, an intelligent agent must be capable of falling back on increasingly general knowledge. Lenat and Feigenbaum suggested that AI research slowly hand-code a large, broad knowledge base. However, the authors recognized that this was an unpalatable task that would entail personal centuries of hard knowledge-entry work.

The task is not so foreboding for advocates of the knowledge chemistry approach. While there is no escaping the painful fact about mapping knowledge - hard work is necessary, for knowledge chemistry, a large, broad knowledge base is not required. Rules, signals, and maps are the components of HTKB technologies. The intelligent agents who process HTKB information provide the broad knowledge.

For over a decade, this research has focused on developing the tools of knowledge micro analysis. The cognitive force equations have been completed, and, except for the development of supporting graphics, the knowledge modeling tool - moment models - is complete. A moment model has several levels. The first level provides a static view. The second and third levels (the pragmatic and conceptual levels) provide a dynamic view of knowledge interactions on a timeline of several minutes. The second level of a moment model focuses on knowledge types. The third level focuses on insights. Together, the second and third levels of a moment model reveal the means (knowledge types) and ends (forms of insight) of intelligent behavior.

Randles, Miller, and Sayeed (2017) proposed that problem space maps, information processing rules, and pragmatic rules were critical in performing complex technical skills. Their development would serve as a stepping-stone toward replication of complex technical skills. An incremental approach has been proposed in which researchers would study complex skills and create Dretske’s internal maps for use by machines. By focusing on the development of maps, an intermediary, specialized function would be performed. Knowledge chemistry would support AI. In alliance, AI might rapidly advance to the creation of machines. that perform complex human skills.

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APPENDIX

TABLE 1
THE LEVEL 1 BRANCHES OF THREE BPKR TREES CARGO TRANSPORT MANAGEMENT SYSTEM (CTMS)

Process	Level 1 Branches	Stage	Forms of Knowledge Combustion

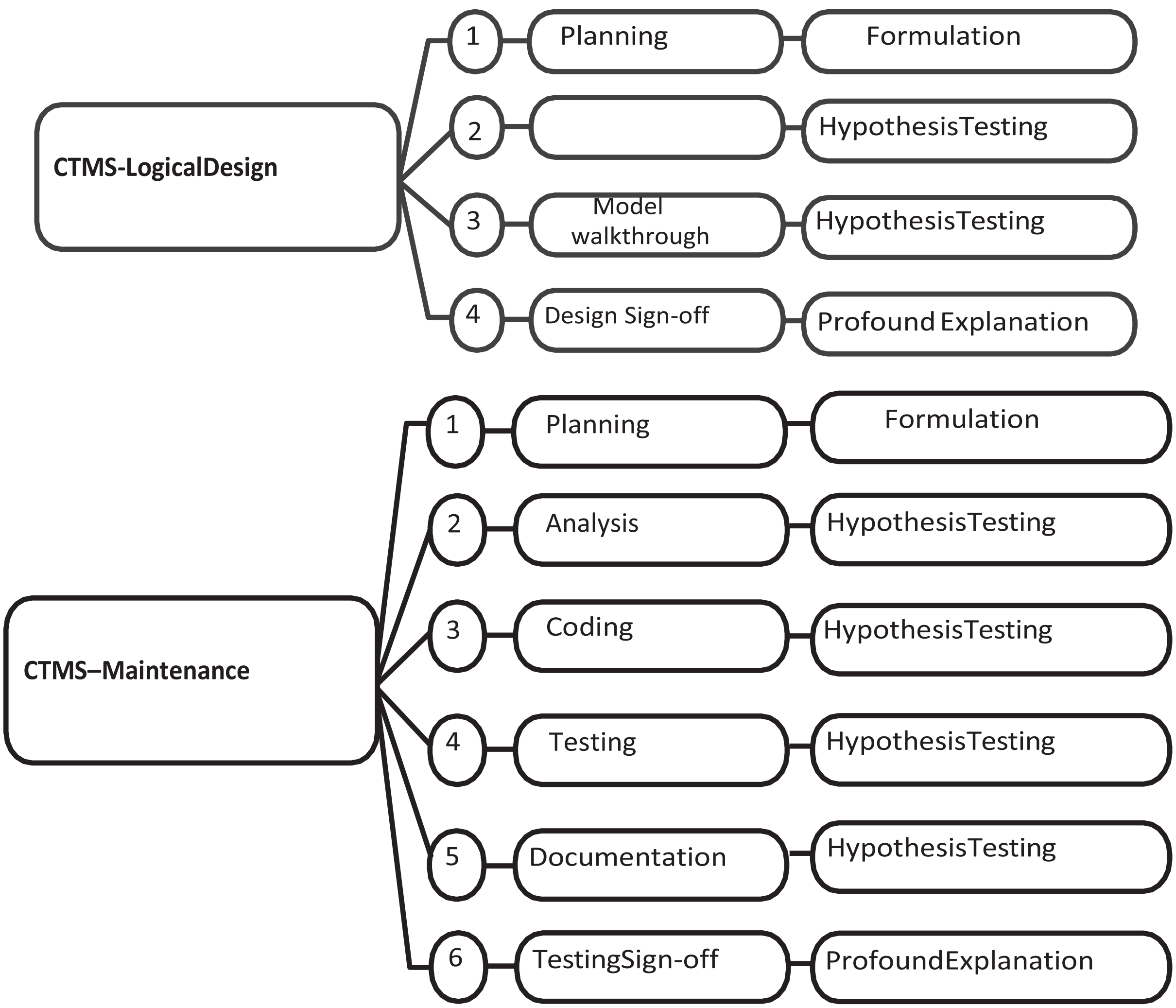

TABLE 2
THE LEVEL 2 AND 3 BRANCHES LOGICAL DESIGN OF CTMS

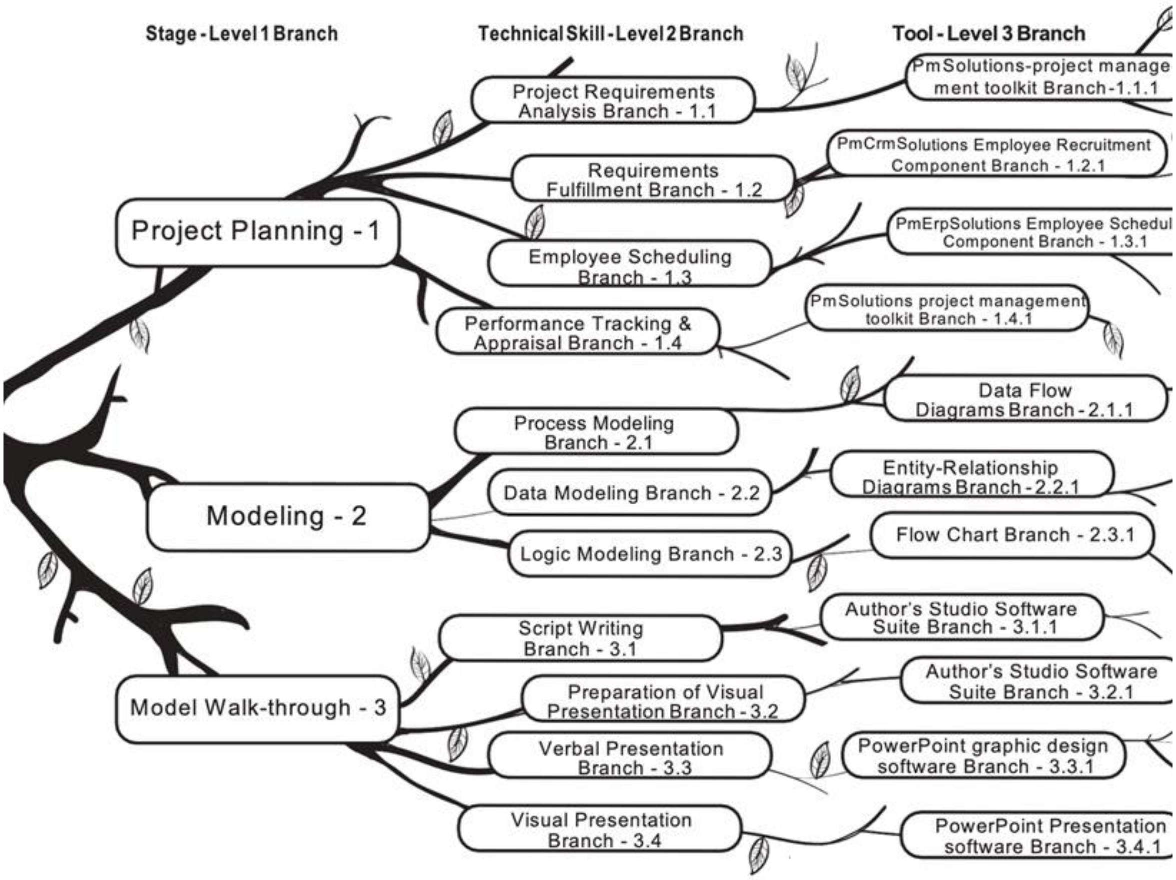

TABLE 3
THE REQUIREMENTS NODES OF BRANCH 2.1.1 PROCESS MODELING USING DATA FLOW DIAGRAMS KNOWLEDGE REQUIREMENTS

What are the maps that guide the creation of data flow diagrams?
• There would be three maps required to guide the development of the data flow diagrams. The first map would guide the creation of the context diagram. • The second map would guide the creation of diagram 0. • The third map would guide the development of the lower-level diagrams. • diagrams.

What are the indicators and rules that guide the creation of the context diagram?
• The names of external entities, data flows, and data stores should be nouns. • Data flows represent data that is moving. • The name of a process should be composed of a noun and verb such as report creation. • The names of data flows and data stores move from the general to increasingly more specific names. • Data flows should flow in only one direction. If the data flow is bi-directional use two data flows.

What are the indicators and rules that guide the creation of diagram 0?
• Process 0 of the context diagram should be exploded into three different processes: process 1 - front end, process 2 – core, and process 3 – back end • Data stores represent data at rest and should only be shown if the data it holds is used by more than one process in the diagram. • When exploding a process into its lower-level sub-processes, all the upper-level inputs and outputs must be accounted for in the lower-level processes (logical consistency). • Data flows must flow through a process to enter an external entity or data store. • Each process must have at least one input and one output data flow.

What are the indicators and rules that guide the creation of the lower-level diagrams?

- **Each diagram should have the same level of complexity.**
- **There should be a maximum of five and a minimum of three processes per diagram.**
- **When exploding an upper-level process into its sub-processes, a breakdown of: input, process, and output or planning, execution, and evaluation is often used.**
- **For a process with a complex internal logic, the explosion of the process should stop when there is one input and one output data flow.**
- **For a process with an internal logic that is moderately complex, the explosion of the process should stop when there are two or three input data flows and one output data flow.**
- **For a process with a simple internal logic, the explosion of the process should stop when there are two or three input data flows and two output data flows.**
- **The explosion of a process should stop when the internal logic of the process can be described graphically using a one-page flow chart.**

TABLE 4
THE REQUIREMENTS NODES OF BRANCH 2.1 PROCESS MODELING KNOWLEDGE REQUIREMENTS

What are the maps that guide the creation of the data flow diagrams?
Map 1 guides the creation of the context diagram and diagram 0. It is like a short list. Each entry identifies an external entity that sends or receives information from the firm. A general description of the transferred information is also provided.
Map 2 is a slight modification of map 1. For each map 1 entry, the lower-level process that sends or receives the information (front end, core, or back end) is appended. Additional entries are added to the list to identify the data that is transferred between the front end, core, and back-end processes.
Map 3 (front end) identifies the front-end sub-processes: marketing, sales, and customer service. For each of the map 2 front end entries, a more specific description of the transferred information is provided.
Map 4 (core) identifies the core sub-processes: production, inventory control, human resources, and accounting. For each of the map 2 core entries, a more specific description of the transferred information is provided.
Map 5 (back end) identifies the back end sub-processes: warehouse, shipping, and supply chain management. For each of the map 2 backend entries, a more specific description of the transferred information is provided.
Map 6 explodes the marketing process into four sub processes: adv. campaign management, public relations management, event management, and marketing research. For each of the map 3 marketing entries, the sub processes sending or receiving the info are identified, and a more specific description of the transferred information is provided.
Map 7 explodes the sales sub process into four sub processes: sales order, product pricing, product demand forecasting, and sales force management. For each of the map 3 sales entries, the sub processes sending or receiving the info are identified, and a more specific description of the transferred information is provided.

TABLE 5
KNOWLEDGE PROFILES OF CTMS ANALYSTS A AND B APPROXIMATE DATE – JUNE 1ST 1978

Process / Stage / Branch	BPKR Query	EMP. A	EMP. B
Logical Design Planning / 2.1	How confident are you in your ability to plan the design of an information system?	50%	70%
Logical Design Process Modeling / 2.2	How confident are you in your ability to develop process models using data flow diagrams?	70%	80%
Logical Design Data Modeling / 2.3	How confident are you in your ability to develop data models using entity relationship diagrams?	65%	80%
Logical Design Program Specs / 2.4	How confident are you in your ability to develop program specifications using hierarchy charts with narrative?	90%	80%
Logical Design Model Present / 3.3	How confident are you in your ability to make a verbal presentation of the hierarchy charts?	85%	80%
Implementation Coding / 2	How confident are you in your ability to code computer programs using language A?	75%	85%
Implementation Testing / 3	How confident are you in your ability to test computer programs?	80%	85%

TABLE 6
KNOWLEDGE PROFILES OF ANALYSTS A AND B APPROXIMATE DATE - JUNE 1ST 1985

Process / Stage / Branch	BPKR Query	EMP. A	EMP. B
Logical Design Data Model / 2.2	How confident are you in your ability to develop data models using Entity Relationship Diagrams?	95%	85%
Logical Design Logical Model / 2.3	How confident are you in your ability to develop logical models using hierarchy charts with narrative?	95%	85%
Logical Design Walk-through / 3.3	How confident are you in your ability to make a verbal presentation of the hierarchy charts?	95%	85%
Implementation Coding / 2	How confident are you in your ability to code and de-bug computer programs using language A?	95%	85%
Implementation Test Plan Dev / 3.1	How confident are you in your r ability to develop a test plan to test coded computer programs?	80%	95%
Implementation Test Data Dev / 3.2	How confident are you in your ability to create test data and test files for program testing?	70%	95%
Implementation Test Plan Imp / 3.3	How confident are you in your ability to implement a test plan for coded computer programs?	75%	95%
Implementation Documentation / 4	How confident are you in your ability to provide documentation for coded and tested computer programs?	80%	95%
Implementation Script Writing / 5.1	How confident are you in your ability to write a script for the verbal presentation of the programs and test results?	80%	90%
Implementation Visual Present / 5.2	How confident are you in your ability to prepare a visual presentation of the programs and test results?	70%	90%
Implementation Walk-through / 5.3	How confident are you in your ability to make a verbal presentation of the coded programs and test results?	80%	90%

TABLE 7
A COMPUTER SERVICES COMPANY KNOWLEDGE PROFILE OF THE PROJECT TEAM

Process / Task	Knowledge Profile of Project Team	
Government Relations Contract Management	How confident are you in your ability to develop contracts for insurance claims processing?	90%
Government Relations Agency Communications	How confident are you in your ability to communicate with the appropriate members of the insurance claims department?	90%
Government Relations Legislative Communications	How confident are you in your ability to develop and maintain communications with the appropriate members of the legislator?	90%
XX Bidding Proposal Development	How confident are you in your ability to respond to request for proposal for insurance claims processing?	90%
XX Bidding Cost Assessments	How confident are you in your ability to identify the agencies that provide cost of living information about U.S. metropolitan areas?	70%
XX Bidding Cost Assessments	How confident are you in your ability to obtain the cost-of-living information from the identified agencies to support bid pricing?	70%
XX Bidding Cost Assessments	How confident are you in your ability to conduct a comparative study of the cost of living in two different metropolitan areas?	70%
XX Bidding Pricing Strategy	How confident are you in your ability to develop a pricing strategy that is aligned with the firm's overall corporate strategy?	90%
Systems Development Requirements Definition	How confident are you in your ability to identify differences between the firm's system and state XX's requirements?	90%
Systems Development Program Specifications	How confident are you in your ability to specify the required coding changes to implement the state system?	90%
Systems Implementation Software Coding	How confident are you in your ability to code specified changes to the base system using language X?	90%
Systems Implementation Software Testing	How confident are you in your ability to develop a test plan to test the insurance claim processing software developed for state XX?	90%
System Maintenance Software design	How confident are you in your ability to specify the coding changes which are required to State XX's software system?	80%
System Maintenance Software implementation	How confident are you in your ability to code and test the coding changes to State XX's claims processing software?	80%