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Empowering Data Mining Sciences by Habitual Domains Theory, Part II: Reaching Wonderful Solutions

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Abstract

In the Part I of this paper, we presented the main concept of the proposed comprehensive decision model based on Habitual Domains theory, the concept of wonderful solution for solving challenging decision problems that we called decision making in changeable spaces problem (DMCS). In this Part II of the paper, we complete the construction of the model and show that it is operational and effectively empowers DMs in facing challenges. For this purpose, we present the mental principles "7–8–9 principles" that can be used to restructure decision parameters so that new solutions or alternatives could emerge. Then we provide procedures for finding wonderful solutions as sequences of the 7–8–9 principles by solving optimization in changeable spaces (OCS) problems, a new paradigm in optimization. Finally, we present applications of the model to post data mining analysis and decision making. In fact, the proposed model can be used in any area involving decision making and knowledge discovery such as management, politics, health care, technology and research.

Keywords Post data mining · Habitual domain · Competence set · Wonderful solution

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1 Introduction

In Sect. 3.4, Part I of the paper, we have mentioned ten factors (five decision elements and five decision environmental facets) that play a crucial role in real-world decision-making, including decision making in post data mining. Most of the existing decision models do not incorporate all the ten factors in a systematic way, especially, the psychological aspects, the external information input and the allowable time for solving a decision problem. Moreover, most of these models are generally Von Neumann-Morgenstern utility function based [9], and their solutions are computed as solutions of optimization problems when the objective function and constraints satisfy some analytical properties like continuity and convexity. These structural and conceptual constraints limit the application scope of utility function-based decision models to challenging real-world problems such as post data mining decision-making (see Problems 2.1–2.4. Sect. 2, Part I of the paper). In the sequel, for ease of presentation, we will use “Part I” instead of “Part I of the paper” to refer to any part of Part I; the same applies to Part II of the paper). The proposed model in this paper systematically incorporates human psychology and considerably enlarges the scope of application of decision theory to real-world decision-making.

In Part I, we gradually constructed part of the proposed comprehensive descriptive and prescriptive decision-making model based on Habitual Domains theory. To make it easy to understand for a wide audience, we first presented the fundamentals of Habitual Domains theory consisting of the Habitual Domain, the eight hypotheses, H1–H8 and the Human Behavior Mechanism (HBM). Then, we presented ten parameters that affect the decision-making process. Finally, using this background, we introduced the concept of wonderful solution as a solution to the most difficult and challenging decision-making problems, the decision making in changeable spaces (DMCS) problems.

The main contribution of this Part II is to completes the construction of the decision model and show that it is operational. For this purpose, we present the 7–8–9 mental principles of deep knowledge that allow the DM to restructure a decision-making problem so that wonderful solutions could emerge. Then wonderful solutions are expressed as solutions of a new type of optimization problems that we call Optimization in Changeable Spaces (OCS) problems, in the form of sequences of 7–8–9 principles. The OCS is a significant departure from the traditional optimization paradigm. Indeed, it is based on the concept of competence set (see Sect. 4, Part I), which is the projection of the DMs’ Habitual Domain onto the decision-making problem at hand, “optimality” is defined in terms charge level (mental tension) of the DMs and its solution, the wonderful solution, is express in terms of 7–8–9 mental principles (operators).

Further, we construct procedures for finding wonderful solutions for two general OCS types of problems, covering and discovering. Finally, as an illustration of its operational power, we apply the proposed model to post data mining analysis and decision-making Problems 2.1–2.4 of Sect. 2, Part I. It turns out that in addition to finding wonderful solutions, the model can also be used to analyse and explain failure in a decision-making problem.

The Part II is organized as follows. In Sect. 2, we present the 7–8–9 principles (mental operators) that will be used to construct wonderful solutions. In Sect. 3, we present optimization in changeable spaces problem and provide procedures for its resolution in case of covering and discovering problems. Section 4 shows how the proposed model empowers DMs in facing challenging decision-making problems, particularly in post data mining analysis and decision making. The last section concludes the paper.

2 Reaching Wonderful Solutions

In the Problem 2.1, Sect. 2, Part I, we have seen that post data mining analysis may not produce a wondeful decision or solution. Most of the time, mindset, cognitive limitations, group thinking, etc. make the DMs focus on a set of habitual, standards, conventional or mainstream solutions, which may not be satisfactory or even lead to poor outcomes. Indeed, such solutions may become inadequate or obsolete in a changing environment. To reach wonderful solutions, the DM needs to change his way of thinking about the decision problem to expand his set of decisions by finding new, creative and more interesting alternatives or options. In this section, we will see how Habitual Domain theory can help DM expand his Habitual Domain (HD) in order to reach wonderful solutions. Yu [12] has introduced twenty-four principles that can help expand Habitual Domains. The use of these principles in the framework of Habitual Domain theory provides a systematic way to reach wonderful solutions in a decision-making process. In [5], we provide effective applications of this new approach to decision-making in different areas of human activity such as economics, management, supply chain, geopolitical problems, family and social interactions, etc. Particularly, the twenty-four principles can empower post data mining analysis to reach wonderful solutions.

2.1 The 7–8–9 Principles of Deep Knowledge for HD Expansion

In the introduction of this section, we have mentioned that when a DM cannot solve a problem, he needs to effectively expand his HD. There are two key factors in Habitual Domains expansion. External information and self-suggestion. The interaction with the environment is essential to acquire new relevant and important information. When this new information is adequately processed and analysed, it generates new ideas, methods, concepts, etc. Thus, the DM needs to be equipped with effective mental processing principles that would allow him to integrate new information with the existing one to create new knowledge to solve decision problems. In this section, we present twenty-four principles that can be used to expand DM's HD, the ***7–8–9 principles of deep knowledge for HD expansion*** (shortly the *7–8–9 principles*). The DM may use them to expand his HD to be able to effectively solve his decision-making problems and reach wonderful solutions in post data mining analysis. These principles are simple, understandable, and operational. When frequently used, they become part of the DM's HD core (see Sect. 4.1.1, Part I) and a powerful tool for effective and efficient DMCS problems solving. The 7–8–9 principles are divided into three groups: the *seven empowering operators*, the *eight basic methods for HD expansion* and the *nine principles for deep knowledge*.

2.1.1 Seven Empowerment Operators

The seven empowering operators listed in Table 1 are mental operators related to the functioning of our mind. They can open our minds, make us think positively about events that affect our duties and life, be goal oriented, better interact with other people and explore the environment. When we repeatedly use them, they would become strong and powerful circuit patterns in our brain and help us expand and enrich our HD in ways that help us achieve our goals and others' and solve our DMCS problems. We first list them, then discuss the first briefly, the others are self-explanatory. For more details, we refer the reader to [12].

$\mathbf{U_1}$. This is the principle of uniqueness and pricelessness of each human being. From this principle, we can derive two important principles, self-respect and respect of others, for managing our lives and relations with other people at all levels, such as family, group, organisation, society and between nations. Many real-life management problems are rooted in misunderstanding and disrespect. From self-respect and respect other, we can also derive ethics.

Using U_1, a DM can significantly change the ten decision parameters X_t, F_t, $\boldsymbol{F_t}$, D_t, I_t, PS_t, ST_t, PL_t, UN_t and AL_t of a DMCS problem (Sects. 3.4.1 and 3.4.2, Part I). For instance, let us consider Problem 2.1 in Sect. 2, Part I. As Japan was in 1930 recession, the Matsushita Company's sales dropped to a very low level that threatened its existence. The common reaction of companies' managers to such situations is to lay off employees to reduce labour cost to save the company. The set of alternatives of the management reduces to a single strategy $X_t = \{\text{lay off employees}\}$. However, Matsushita did not want to implement such a conventional (habitual) way of reducing costs. Considering the respect of employees who dedicated part of their lives to the company as essential, by applying the principle U_1, he worked hard to expand the set of alternatives, X_t to reach a better solution. He finally found an original wonderful solution that saved both the jobs and the company at the same time.

Table 1 The seven empowering operators

U_1. Everyone is a priceless living entity. We are all unique creations who carry the spark of the divine
$\mathbf{U_2}$. Clear, specific and challenging goals produce energy for our lives. I am totally committed to doing and learning with confidence. This is the only way I can reach the goals
$\mathbf{U_3}$. There are reasons for everything that occurs. One major reason is to help us grow and develop
$\mathbf{U_4}$. Every task is part of my life mission. I have the enthusiasm and confidence to accomplish this mission
$\mathbf{U_5}$. I am the master of my living domain. I take responsibility for everything that happens in it
$\mathbf{U_6}$. Be appreciative and grateful and don't forget to give back to society
$\mathbf{U_7}$. Our remaining lifetime is our most valuable asset. I will enjoy it fully and make a 100 percent contribution to society in each moment of my remaining life

Later, in Sect. 4, we will describe in detail Mastushita's solution within the framework of our model.

2.1.2 Eight Basic Methods for Expanding HD

The eight basic principles, as listed in Table 2, through self-suggestion and external information input, can enable us to generate new ideas, new concepts and, consequently, to expand our HDs.

As most of the principles V_1 –V_8 are known, we discuss briefly V_3 and V_4. It is important to note that their application depends on the individual's Habitual Domains and situations.

2.1.2.1 V_3. Active Association By association with other situations, people, events, physical phenomena, etc., we may acquire new knowledge or deeper insight regarding a situation, a person or group, an event, a physical phenomenon, etc. thereby expanding our Habitual Domain. The following are some ways people, events, etc. can be associated: (1) *causal relationship*, (2) *mutually competitive relationship*, (3) *mutual enhancement,* (4) *hierarchical relationship* and (5) *the true state and its appearance*.

2.1.2.2 V_4. Changing the Relevant Parameters Any event, decision problem, or situation involves some parameters that can be partially or completely controlled. Changing these relevant parameters in a problem or situation can help us better understand it and generate new knowledge for its effective resolution. Interest and tax rates are examples of relevant parameters to manage the dynamics of a country's economy.

2.1.3 Nine Principles for Deep Knowledge

The nine principles for deep knowledge, as listed in Table 3, not only allow us to understand and expand our HDs but help us on how to use our own HDs and other people's HDs to solve our problems as well.

W_1–W_9 can help us expand our Habitual Domain and better evaluate and understand people, situations and problems. Some of them may seem obvious and well-known. However, if people use them repeatedly and can retrieve them

Table 2 Eight methods for expanding and enriching HDs

V_1. Learning actively
V_2. Projecting from a higher position
$\mathbf{V_3}$. Active association
$\mathbf{V_4}$. Changing the relevant parameters
$\mathbf{V_5}$. Changing the environment
$\mathbf{V_6}$. Brainstorming
$\mathbf{V_7}$. Retreating in order to advance
$\mathbf{V_8}$. Praying or meditating

Table 3 Nine principles of deep knowledge

W_1. The deep and down principle
W_2. The alternating principle
$\mathbf{W_3}$. The contrasting and complementing principle
$\mathbf{W_4}$. The revolving and cycling principle
$\mathbf{W_5}$. The inner connection principle
$\mathbf{W_6}$. The changing and transforming principle
$\mathbf{W_7}$. The contradiction principle
$\mathbf{W_8}$. The cracking and ripping principle
$\mathbf{W_9}$. The void principle

whenever they are needed, they would have a real advantage in their lives. The principles W_1–W_9 are presented briefly. More details are in [12].

2.1.3.1 W_1. Deep and Down Principle When our charge structure is high in a challenging situation or problem, only ideas with a strong circuit pattern occupy our attention. The following figure illustrates this statement.

As Fig. 1 shows, when the charge is at level B (bold horizontal line), the set of ideas that can be activated is represented by the two thin segments in the Potential Domain (horizontal axis). When the charge level increases to the level A (dotted line), the set of ideas that can be activated considerably reduces to the two bold segments in the Potential Domain.

Ideas with weak circuit pattern (Hypothesis H1) cannot capture our attention as they cannot be retrieved. This fact can be detrimental in problem solving as good solutions may have weak circuit patterns making them difficult to catch our attention. The question that arises is: How to make it possible to retrieve ideas with weak circuit pattern (see Hypothesis H1, Sect. 3, Part I)? The answer is

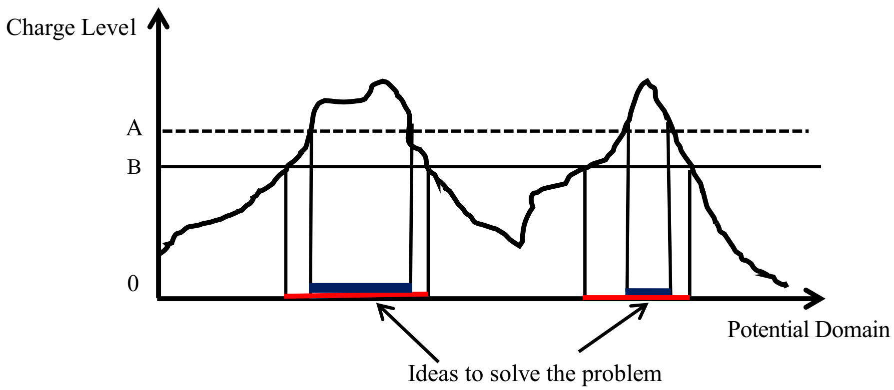

Fig. 1 The deep and down principle

to lower our charge structure so that ideas with weak circuit patterns could be retrieved. To achieve lower levels of charge structure, we need to relax and calm down.

2.1.3.2 W_2. The Alternating Principle Generally, our assessments, evaluations, solutions, statements, actions, and behaviour related to a problem or situation are based on certain beliefs or assumptions. An assumption which is always imposed or always left out will lose its value as an assumption. The alternating principle is simple: Sometimes we must omit or change our combined assumptions so that we can create new ideas from different sets of assumptions. W_2 is a very powerful Habitual Domain expansion tool that can produce significant results in discovery and the change processes in socio-economic activities and scientific research.

2.1.3.3 W_3. The Contrasting and Complementing Principle Many aspects, principles, activities, etc. of human life and nature are represented in the form of complementarity and contrasting pairs. For example, good and bad, internal and external, existence and non-existence, strong and weak, empty and no-empty, man and women, etc. When we deal with events and ideas, we can expand our related Habitual Domain by identifying their contrasting and complementing events or ideas. For instance, by contrasting its poor performance with the performance of a leading company, a poorly performing company can identify what is wrong in its processes and plan their improvement.

2.1.3.4 W_4. The Revolving and Cycling Principle Biological, business, and physical processes share the revolving and cycling principle. Biological organisms are born, grow to reach a maturity state, then decline and ultimately die. In business, a product has a lifecycle consisting of four stages: introduction, growth, maturity, and decline. Companies and businesses follow a similar process. The evolution of an individual, business, or company is a succession of successes and failures. W_4 can help us expand our Habitual Domain with respect to the dynamics and evolution of an entity.

2.1.3.5 W_5. The Inner Connection Principle This principle refers to the building of strong connections with other people. By strong connections we mean knowing the core of their Habitual Domain including their life goals, what they like and what they dislike, character, belief system, etc. This would make it possible to predict their behaviour and interact with them in such a way that would help us achieve our goals and their goals as well.

2.1.3.6 W_6. The Changing and Transforming Principle Every living or non-living system can be described by some parameters through perception and abstraction. When these parameters change significantly, they transform and change the system. For instance, when a central bank drastically increases the interest rate, a macroeconomic parameter, the economic growth slows down as people and businesses borrow less. It is important to note that the changing and transforming principle includes all mathematical operation and transformations used in all sciences.

2.1.3.7 W_7. The Contradiction Principle Generally, to solve a problem, we start with assumptions then go for the analysis and finally we draw a preliminary conclusion. Before claiming that the conclusion is final, it would be wiser if we evaluate our conclusion. One approach to assess whether our conclusion is correct is to apply the contradiction principle. The basic idea of the principle is to use a different approach or perspective to the problem to find some event or information that contradicts our earlier conclusion. If such an event or information is found, we must review the whole decision process from assumptions to the conclusion to discover where the flaw is and address it. The discovery of the flaws and the revision process can significantly expand our HD.

2.1.3.8 W_8. The Cracking and Ripping Principle Looking at human beings, organisations, businesses, and countries as systems, we can say that they are not perfect with respect to structure and/or functionality. They all have some weaknesses. If we want to destroy any system in an effective and efficient way, we can rip open its crack lines for they are its weakest points. Similarly, if we want to protect a system, we need to hide the cracks from external threats and fil them up or repair them. This principle can be a valuable tool in competitive and conflict situations as in war, politics and business competition. Using W_8 expands our HD for effective problem solving.

2.1.3.9 W_9. The Void Principle This principle reflects the fact that the outside of our HD is not empty. This is because we have the tendency to use our own HD to deal with events and problems and think that nothing really exists outside it. This is an easy and efficient, but improper way to deal with events and situations. Such behaviour could be detrimental because other people's HDs exist and can affect us. Moreover, we lose opportunities to get help from other people to help us achieve our goals.

Let us now summaries this section. The brief explanation of some of the 7–8–9 principles shows that the main objective of their use is to expand our HD and direct our attention. As the dynamics of HD is described by the eight hypotheses H1–H8, the application of the 7–8–9 principles is closely related to these hypotheses, especially, H7 and H8. As one way to release charge, the DM uses active problem solving through hypothesis H7, the 7–8–9 principles can be considered as tool for charge release. External information input is an essential element in changing our HDs, therefore, the principle V_1, active learning, is the operational expression of the Information Input hypothesis, H8. The principle V_3, active association, is also an operational expression of the Analogy/Association Hypothesis H4. The deep and down principle, W_1, is strongly related to the Goal Setting and State Evaluation Hypothesis H5 and Charge Structure and State Evaluation Hypothesis H6. Indeed, the effect of this principle is to decrease the charge, which may result in changes in goal setting and attention allocation. As the ten decision parameters $\{X_t, F_t, \boldsymbol{F}_t, D_t, I_t, \mathrm{PS}_t, \mathrm{ST}_t, \mathrm{PL}_t, \mathrm{UN}_t, \mathrm{AL}_t\}$ (see Sect. 3.4, Part I) are part of the Actual Domain, they can be changed or restructured by the 7–8–9 principles for solving DMCS problems. For an effective use and application of the 7–8–9 principles in decision-making problem solving, the DM may first apply them to determine as accurately as possible the above ten decision parameters. He may then apply them to restructure these parameters when needed to find an acceptable or wonderful solution to the decision problem. In the next section, we see how 7–8–9 principles can be used to solve DMCS problems and empower DMs in post data mining analysis and decision-making.

3 Empowering Data Mining Sciences by Habitual Domain Theory

Data mining significantly contributed to big data management for knowledge extraction to support decision-making in many areas of human activities that generate big data such as e-commerce, health care and government services [1, 7]. The success of data mining methods has attracted more researchers who extended them and developed new ones. These efforts enlarged data mining application scope and improved its accuracy.

However, studies on second-order data mining, that is, how the extracted knowledge is used by organization's DMs to formulate a course of actions, solve problems or gain competitive advantage are scarce and lack a systematic approach [8]. The output of data mining algorithms is an essential part of the decision process, but it is not enough to make good decisions as the DM's cognitive limitations, behaviour, mindset, the psychological state and competence may lead to inefficient use of data mining results and ultimately to poor quality decisions. There is an abundant literature on companies' failure in post data mining analysis and decision-making.

The best example is Nokia company's failure in the smart phone era [2] (see Problem 2.2 in Sect. 2, Part I). Nokia strategic management foresaw the coming major shifts in mobile phone technology and related software developments to meet the growing customers' preferences and desires for more internet related applications. These strategic insights into the future of mobile phone technology where not realized at the operations level. Instead, Nokia managers and analysts segmented the market into 8 segments and aimed at making phones for each segment instead of focusing on common preferences. This strategy consumed all the resources of the company and prevented it from investing in changing its competence set to acquire the capabilities to develop new software platforms to shift from previous generation of mobile phones to smart phones that have computer-like applications such as games, banking, social media, etc. They kept on hanging on design and user friendliness and did not share their operating system, Symbian, with other companies to maintain the company's leadership, while the key issue was to have an open platform to allow developers to add applications, which was done by others by developing other systems such as Android system.

Thus, Nokia failure is rooted in management behavior, which can be explained by Habitual Domain Theory and the use of 7–8–9 principle could help avoid it. Indeed, the principle V_4 "Changing the relevant parameters", suggests that the management needs to identify the relevant parameters in its business and change them according to the evolution of its environment. Basically, a mobile phone can be characterized by two parameters, hardware and functionality (software). Nokia management focused on the hardware and almost ignored the improvement of functionality. Nokia management ignored the principle W_4" The revolving and cycling principle" by not incorporating in its strategic planning the end of keypad phones era and the coming of the new era of touch screen and smart phones with computer-like functions.

In terms of Habitual Domains, one can say that Nokia's Habitual Domain was rigid and trapped in a domain characterized by a "matrix organization" that was dedicated to hardware development and market supplier relationship with its customers. Unfortunately, Nokia could not get out of this domain on time. An illustration of this rigidity is the fact of not sharing with others its operating system, Symbian. By doing so, Nokia management overestimated its competence set as it could not develop new and useful mobile phone applications to satisfy its customers growing desires for more multimedia and internet applications to retain them. The management ignored the principle W_9 "The void principle", thinking that Nokia is the absolute leader and it can do everything related to mobile phone. Not sharing its operating system with others, gave the competitors the opportunity to use the principle W_8 "The cracking and ripping principle", which consists in focusing on cracks (weaknesses) of some entity and make them wider to ultimately rip it. We will complete the analysis of this failure once the model building is completed.

Model Building In this section, we present a formal model for solving DMCS problems in general, and particularly, post data mining decision-making. The model is based on the 7–8–9 principles and competence set. Its solutions are expressed as sequences of 7–8–9 principles, especially, the wonderful solution. To start with the model building, we construct the mental operators' space, denoted *CM*.

For presentation convenience, we denote the set of the 7–8–9 principles $\{U_1,\ldots,U_7, V_1, \ldots,V_8, W_1,\ldots,W_9\}$ (see Sect. 2.1) by $M=\{M_1, M_2,\ldots, M_{24}\}$. These principles can help generate new ideas and effectively expand the DM's competence set to solve problems. Mathematically, they can be thought of operators that transform ideas into other ideas or create new ones. Thus, the domain of these operators is the Ω_1-space of all the knowledge and skills that the whole humanity has reached so far. It is a time dependent set. The operators $M_1, M_2,\ldots, M_{24}$ are set-to-set functions with domain Ω_1-space and range Ω-space, where Ω-space is the space of all the knowledge and skills that the whole humanity has reached so far and the knowledge and skills it will reach in the future. Thus, for any subset A of Ω_1-, $M_i(A) \subset \Omega$ for any operator M_i in M. The Ω-space is not a set in the traditional sense because its boundaries and dynamics are unknown. The Ω_1-space is of a similar nature. In the decision-making process, the DMs may apply the 7–8–9 principles individually at sometimes or use a sequence of them at some other times; an individual principle may also be repeatedly applied in some period.

A finite compound of principles $M_{i(1)}oM_{i(2)}o \ldots oM_{i(s)}$ from M is called *ideas generating operator* or *IG-operator*. Here the symbol "*o*" indicates the sequence in which the principles from the set M are used. For any part A of the Ω_1-space, the DMs could generate new ideas by the operation $M_{i(1)}oM_{i(2)}o \ldots oM_{i(s)}(A)$ that we call *ideas generating operation* or *IG-operation*. Let us denote by

$$CM = \left\{M_{i(1)}oM_{i(2)}o \ldots oM_{i(s)}/M_{i(j)} \in M, \quad j = 1, 2, \ldots, s, s \text{ positive integer}\right\} \tag{3.1}$$

the set of all *IG*-operators based on *M*. Let *H* and $CS^t(E)$ be an *IG*-operator and the DM's competence set related to a decision making problem *E*, at time *t*, respectively, and let $G_s(E)$ be the set of DM's life goals affected by the problem *E*, at time *s* at the end of implementation of the operator *H*.

In this section, for ease of presentation, we will use the notation $ch(H(CS^t(E)))$ to represent the charge structure $ch\left(G_s(E)\right)$ at time *s* as defined in the formula (4.1) of Part I. This notation makes sense as the competence set is a projection of the DM's Habitual Domain onto the problem *E*. Recall also that we use the words charge, charge level and charge structure as meaning the same thing. When we deal with the same problem *E*, we further simply denote $CS^t(E)$ by CS^t, omitting to mention the problem *E*. Now we can derive the general competence set based Optimization in Changeable Space (OCS) problem from the general DMCS problem (4.1) of Part I, as follows

$$\begin{aligned} &\text{red ch } \left(H_t(CS^0)\right) \\ &\text{subject to } H_t \in \Sigma, \quad \mu\left(H_t\right) \le AL_t \end{aligned} \tag{3.2}$$

where "*red*" means reduce, CS^0 is the initial competence set of the DM for solving *E*, *t* is the current time, which can also represent the current stage or step in the decision process, Σ is the set of all mental operators that the DM can use to solve the problem *E*, H_t is the chronologically ordered sequence of all operators applied in the process of solving the problem *E* up to the current time *t*. For instance, if the *IG*-operators *H* and H' have been applied sequentially, and currently H'' is being applied, then $H_t = H''oH'oH$. Here, for simplicity, we assume that the DM uses or applies operators in a sequential way. The expression $ch(H_t(CS^0))$ is the charge level of the DM, at time *t*, related to the new DM's competence set $H_t(CS^0)$ resulting from implementing the mental operator H_t. The operator H_t is from the set Σ of mental operators. AL_t is the perceived allowable time at the current time *t*. Indeed, the perceived allowable time is a decision parameter that depends on the external information input and on the evaluation of the DM as explained in item (v) of Sect. 3.4.2. of Part I, therefore, it may change over time.

It is important to note that basically H_t is a mental operator, but its implementation could lead to two results: (1) new ideas that change DM's competence set without any material action (change of DM's mind), (2) new ideas that change DM's competence set and requires material or real-world operations (new skills, training, assets, resources, capabilities, etc.). The changes of type (1) do not require time or material resources, while the implementation of H_t in changes of type (2) require time, resources and real-world actions or operations such as building infrastructure, training, negotiations, etc. Therefore, here, and in the sequel, $\mu\left(H_t\right)$ is the duration of the transformation of the given competence set by the operator H_t, including the time spent for finding H_t itself, and when H_t requires some material or real-world changes, $\mu\left(H_t\right)$ includes also the time the operations take to realize the required real-world changes. We assume that the resolution process starts at time $t=0$. The initial time can be any time t_0.

Note that to accommodate human creativity, the set Σ could be the set of all mental operators that the humanity used in the past and that it will use in the future. Therefore,Σ could be a dynamic set with unknown boundaries and without any specific known mathematical structure.

A solution to the problem (3.2) at some evaluation time t is an operator $H_t \in \Sigma$ that reduces the DM's initial charge level $ch(CS^0)$ to an *acceptable low* level or to an *insignificantly low* level $ch(H(CS^0))$ at time t. The absolute minimum level of the charge function $ch(.)$, i.e. no charge, is reached when the goal functions perceived states or levels coincide with their ideal states or levels for all the goals affected by the problem E (see Hypotheses H5 and H6 in Sect. 3.1, Part I). In real-world decision problems, such a level is rarely reached for there is always room for improvement as the ideal levels of goal functions can be changed by self-suggestion.

When the decision problem can be expressed as an optimisation problem in the form of a mathematical programming problem with deterministic parameters as linear programming, quadratic programming, etc. an optimal solution could be reached. However, an optimal solution may not be a wonderful solution as the set of feasible solutions may not contain one, and optimization techniques do not include restructuring of the decision parameters so that new solutions emerge, including wonderful solutions. The following is a formal definition of a solution to the problem (3.2) that we have derived from Definition 4.1. in Sect. 4 of Part I.

Definition 3.1 There are two types of solutions to the problem (3.2).

1. An operator $H_t \in \Sigma$ is said to be a **wonderful solution** to the problem (3.2) at current time t, if $\mu(H_t) \le AL_t$ and the DM perceives that by finding H_t and implementing it, when necessary, his charge level has been **substantially reduced** from an **initial high level** $ch(CS^0)$, at time $t=0$, to an **insignificant low level** $ch(H_t(CS^0))$, at time t, thereby relieving his pain and frustration and making himself happy.
2. An operator $H_t \in \Sigma$ is said to be an **acceptable solution** to the problem (3.2), at current time t, if $\mu(H_t) \le AL_t$ and the DM perceives that by finding H_t and implementing it, when necessary, his charge level has been reduced from the initial level $ch(CS^0)$ to an **acceptable low level** $ch(H_t(CS^0))$, at time t.

Remark 3.1 The difference between Definitions 4.1 in Sect. 4, Part I and Definition 3.1 is that the latter explicitly involves the mental operators from Σ, including the 7–8–9 principles and *IG*-operators from *CM*, which make it more operational. As mentioned above, the time $\mu(H_t)$ includes also the duration of the operational implementation of H_t, when it requires real-world changes.

In the sequel, we will limit ourselves to the set of *IG*-operators from *CM* only [see (3.1)], that is, we assume that $\Sigma = CM$, without loss of generality, as *CM* is a very large set. To obtain operational procedures for solving DMCS problems, we make the reasonable assumption.

Assumption 3.1 When ideas, knowledge, skills or resources are acquired, they are not lost in the future, that is, the sequence of competence sets CS^t is non-decreasing. This can be written formally $CS^t \subset CS^{t'}$ for all t, t' such that $t < t'$.

This assumption is consistent with the HD hypotheses H1, Circuit Pattern Hypothesis and H2, Unlimited Capacity Hypothesis.

3.1 Covering Problem

We have mentioned the covering problem in Sect. 3.5 of Part I. One can formally define it in terms of competence set as "how to transform a given competence set CS^0 into a set that contains a needed or targeted competence set CS." In fact, at any time, the competence set is just a projection of the DM's Habitual Domains onto the decision problem; hence, it has a Potential Domain, an Actual Domain, Activation Probabilities and a Reachable Domain. At any time, the competence set of DMs may include part (or all) of the decision parameters, skills, and resources needed to solve the decision-making problem. The process of transformation from one competence set to another can occur when the Actual Domain or the Reachable Domain is expanded to deeper parts of the Potential Domain or some new ideas are acquired from outside of the DM's Habitual Domains. To realise such transformation, the 7–8–9 principles of deep knowledge (see Sect. 2.1) are very useful. In this paper, the *IG*-operators that are derived from these principles will be used as tools of competence set transformation and expansion.

First, from the general OCS problem (3.2) we derive the general covering problem as follows

$$\begin{aligned} &red\, ch(H_t(CS^0)) \\ &\text{subject to } CS \subset H_t\left(CS^0\right), \quad H_t \in CM, \quad \mu\left(H_t\right) \le AL_t \end{aligned} \tag{3.3}$$

where CS is the needed or targeted competence set to be covered. CS is a simplification of the concept of competence set discussed in Sect. 4.1 of Part I, assuming that: (1) the needed competence set $CS^*(E, t)$ and the perceived competence set $CS^t(E)$ coincide (the DM perceives correctly what is needed to solve the problem), (2) this competence set is constant, and (3) the decision problem E is known. The other parameters are the same as in the problem (3.2) with $\Sigma = CM$. The difference between the general OCS problem (3.2) and the covering problem (3.3) is the addition of the constraint $CS \subset H_t\left(CS^0\right)$ that expresses the covering of the needed or targeted competence set CS by the DM's competence set after implementing the *IG*-operator H_t. In the process of finding the operator H_t, the DM tries his best to reduce the residual charge as much as possible by using the least resistance and/or avoidance justification principle (see Sect. 4 of Part I). From Definition 3.1, we derive the following definition of a solution to (3.3).

Definition 3.2 There are two types of solutions to the Problem (3.3).

1. An IG-operator $H_t \in CM$ is said to be a **wonderful solution** to the problem (3.3) at the current time t, if $\mu(H_t) \le AL_t$ and $CS \subset H_t(CS^0)$, and the DM perceives that by finding H_t and implementing it, when necessary, his charge level has been **substantially reduced** from his **initial high charge level** $ch(CS^0)$ to an **insignificant low charge level**,$ch(H_t(CS^0))$, at current time t, thereby relieving his pain and frustration, and making himself happy.
2. An IG-operator $H_t \in CM$ is said to be an **acceptable solution** to the problem (3.3) at the current time t, if $\mu(H_t) \le AL_t$ and $CS \subset H_t(CS^0)$, and the DM perceives that by finding H_t and implementing it, when necessary, his charge level has been reduced from his initial charge level $ch(CS^0)$ to an **acceptable low charge level,** $ch(H_t(CS^0))$ at current time t.

Similar remarks and comments made on Definition 3.1 can be made on acceptable and wonderful solutions and the time $\mu(H_t)$ of Definition 3.2. Next, from the covering problem (3.3), we derive some very important special cases depending on which goal function(s) (see Hypothesis H5 in Sect. 3.1 of Part I) the DM focuses on.

3.1.1 Covering Time and/or Cost

Assume that the covering problem is feasible, i.e., there exists at least one *IG*-operator that can lead to *CS* covering within the perceived allowable time. Then the *covering time reduction* problem can be formulated as follows.

$$\begin{aligned} & red\ \mu(H_t) \\ & \text{subject to } H_t \in CM, \quad CS \subset H_t(CS^0), \quad \mu(H_t) \le AL_t \end{aligned} \tag{3.4}$$

In the constraints of (3.4), the set CS^0 can be replaced by a part of Ω_1-space. As far as the authors know, problems such as (3.2)–(3.4) have not been discussed in literature except in authors' works [4, 5]. The unique feature of this problem is that it involves the mental operator H_t in *CM* that is defined in a domain that is not endowed with some known mathematical structure to be tractable with traditional optimisation methods. Some new mathematical structures are suitable to solve this problem in its general form. This could be a worthy direction of research. A definition of a solution to the problem (3.4) can be derived from Definition 3.2 by deleting the parts related to the charge level $ch(H_t(CS^0(E)))$, and replacing them by appropriate statements for $\mu(H_t)$.

Assume that the DMs can provide an estimate, $c(H)$, of the cost of any *IG*-operator $H \in CM$, then the *covering cost reduction* problem can be formulated as follows

$$\begin{aligned} & red\ c(H_t) \\ & \text{subject to } H_t \in CM, \quad CS \subset H_t(CS^0), \quad \mu(H_t) \le AL_t \end{aligned} \tag{3.5}$$

We leave to the reader the formulation of a solution to the problem (3.5). When the DMs are interested in *time and cost efficiency* at the same time, a multiple criteria formulation is more suitable, we obtain

$$\begin{aligned} & red\{c(H_t), \mu(H_t)\} \\ & \text{subject to } H_t \in CM, \quad CS \subset H_t(CS^0), \quad \mu(H_t) \le AL_t \end{aligned} \tag{3.6}$$

As two criteria are involved in the problem (3.6), the Multiple Criteria Decision Making (MADM) methods [11] can be used to define a solution to this problem, for instance, a solution based on the lexicographic ordering. We also leave this exercise to the reader. The reader may derive more OCS problems from the previous models.

Remark 3.2 It is important to emphasise that the OCS models (3.3)–(3.6) are beyond the traditional and satisficing decision models. Solutions of OCS models are expressed in terms of *IG*-operators that are mental operators and their outcomes are competence sets, while solutions of traditional models are generally represented by numerical values, vectors, matrices or functions and are found by numerical algorithms. Note that algorithms can also be represented by the 7–8–9 principles as special cases. For instance, the "Changing and transforming principle", W_6, is general and includes all mathematical transformations such as the arithmetic operations, matrix operations, integration operations, derivative calculation, geometric transformations, etc.

3.2 Discovering

In this section, we use OCS for solving DMCS discovering problem. The relevance of discovering to DMCS has been mentioned in Sect. 3.5, Part I. Discovering is the transformation of a given competence set CS^0 into a new competence set to solve a problem E with an unknown competence set. In terms of HD theory, discovering contributes to reducing the charge level (see Hypothesis H7 in Sect. 3, Part I) or relieving the pain of some targeted people. Thus, the general OCS problem associated with discovering problem can be formulated as follows

$$\begin{aligned} & red\, ch(H_t(CS^0)) \\ & \text{subject to } H_t \in CM, H_t(CS^0)\backslash CS^0 \ne \emptyset, \mu(H_t) \le AL_t \end{aligned} \tag{3.7}$$

where $ch(H_t(CS^0))$ is the resulting charge level after implementation of the *IG*-operator H_t. It is important to note that although the problems (3.3) and (3.7) look similar, they differ considerably. The difference between the two problems is that in (3.3) the needed or targeted competence set CS is known to the DM, while in (3.7) the targeted competence set is unknown to the DM. Therefore, it does not appear in the constraints of (3.7). The only guide of the DM is his charge level $ch(H_t(CS^0))$. According to Assumption 3.1, $CS^0 \subset H_t(CS^0)$. Then the condition $H_t(CS^0)\backslash CS^0 \ne \emptyset$ in (3.7) means that H_t should lead to a new competence set that is larger than CS^0 by achieving some significant progress in the discovering process. A definition of acceptable solution and wonderful solution can be derived from Definition 3.2 by deleting the constraint $CS \subset H_t(CS^0)$.

Here, it is important to make a distinction between the problem E or objective of the DM and the competence set he needs to solve E. The DM knows the former but may not know the latter. For instance, an inventor knows his invention problem, say constructing an airplane that could cover the distance from Europe to USA in 1 h, but he may not know the competence set needed to achieve this invention at the initial stage. By contrast, a student enrolling in a university knows his problem or objective, say to become an engineer, and knows the competence set needed to achieve this objective, namely, to successfully go through the corresponding well-known curriculum. OCS problems similar to (3.4)–(3.6) can also be formulated for the discovering problem. We leave this extension to the reader to explore.

3.3 General Procedures for Solving Covering and Discovering Problems

In this section, we provide procedures for solving DMCS covering and discovering problems. These procedures are presented in an algorithmic way to make it possible to transform them into computer programs. For a practical use of these procedures, we make the following assumption.

Assumption 3.2

(i) The DM is aware of the 7–8–9 principles of deep knowledge and the possibility to combine them to solve decision problems. In terms of HD, this means that we assume that the 7–8–9 principles and the set of their combinations CM are part of the DM's Reachable Domain, RD (see Sect. 3.1, Part I).
(ii) The DM uses the principle of active problem solving (see Sect. 4, Part I) in both covering and discovering processes. He may from time to time and for a limited period use the avoidance justification principle (Sect. 4, Part I) as a strategy to achieve his goals later, that is, adjust his goals to meet reality for a period. In other words, we assume that the DM does not give up the pursuit of his goals as long as the perceived allowable time, $\mathrm{AL_t}$, has not been reached.

Moreover, the presented procedures find ***acceptable solutions*** to DMCS problems. Similar procedures for finding ***wonderful solutions*** can be easily derived from these procedures, one need just to replace "acceptable low level" by "insignificant low level", with respect to charge level and "acceptable solution" by "wonderful solution", accordingly. The same goes also for the outcomes of the procedures. The first procedure solves the general covering problem (3.3). We first present it briefly in an informal way in three general steps.

Step 1 (Identification) Identify the problem to be solved, E, the needed or targeted competence set CS and the initial competence set CS^0 including the decision parameters X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, $\mathrm{PS_t}$, $\mathrm{ST_t}$, $\mathrm{PL_t}$, $\mathrm{UN_t}$, and $\mathrm{AL_t}$ at time $t=0$.

Step 2 (Comparison of the current competence set CS^t with the targeted competence set CS) If CS is not covered by CS^t and/or the DM's charge level is not at an acceptable low level, go to Step 3. Otherwise, his current competence set covers the targeted competence set within the allowable time and the charge level has reached an acceptable low level. Stop, and the problem is solved.

Step 3 (Expanding the current competence set $\boldsymbol{CS^t}$ *to cover the needed or targeted competence set CS)* Find an *IG*-operator *H*, the implementation of which could help expand the DM's current competence set CS^t to a new competence set that contains additional elements of *CS* that did not belong to CS^t. Return to Step 2. The loop between Step 2 and Step 3 continues until the covering takes place and the DM charge level is at an acceptable low level or the DM runs out of time.

Procedure 3.1 (*General Covering Problem*) *Step 1* Assume that a decision problem *E* is given. Identify the needed or targeted competence set *CS* to solve *E*. This includes all the necessary skills, knowledge, know-how, capabilities, attitude, resources, etc. to effectively solve *E*.

Step 2 Identify the DM's initial competence set CS^0. This includes all the skills, knowledge, know- how, capabilities, resources, etc. related to *CS* that the DM has really acquired and the ten decision parameters $\{X_0, F_0, \boldsymbol{F}_0, D_0, I_0, \mathrm{PS}_0, \mathrm{ST}_0, \mathrm{PL}_0, \mathrm{UN}_0, \mathrm{AL}_0\}$, when F_0, $\boldsymbol{F}_0$, are not available, determine the goal functions (see Sect. 3.1, Part I) that the DM focuses on.

For ease of presentation, let us denote time by *t*, the *IG*-operator solution of the problem by *H**, the counter of *IG*-operators used in the resolution processes by *p* and the set of *IG*-operators used by Γ. We set the initial values of these parameters as follows.

$t=0$ the starting time, $H^*=ID$ (identity or do-nothing operator), $p=1$ and $\Gamma = \emptyset$.

Step 3 The DM compares *CS* with CS^t, then

- If $CS \subset CS^t$ and the DM believes that $ch(CS^t)$ is an *acceptable* low charge level, an acceptable solution is reached that is the current *IG*-operator *H**. Then stop, the problem is solved.
- If $CS \not\subset CS^t$, go to Step 4.
- If $CS \subset CS^t$ and $ch(CS^t)$ did not reach an *acceptable* low level, go to Step 6.

Step 4 Test $t \le \mathrm{AL_t}$, if no stop, the covering problem is infeasible for the DM.

Otherwise, analyse CS^t including X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, $\mathrm{PS_t}$, $\mathrm{ST_t}$, $\mathrm{PL_t}$, $\mathrm{UN_t}$, and $\mathrm{AL_t}$, then select an appropriate *IG*-operator *H* from the set *CM* of the *IG*-operators such that the expected new competence set $H(CS^t)$ resulting from the implementation of *H* satisfies

$$\left(H\left(CS^t\right)\backslash CS^t\right) \Uparrow CS \neq \emptyset, ch\left(H\left(CS^t\right)\right) less\ than\ ch\left(CS^t\right) \text{ and } t + \mu(H) \leq AL_t \tag{3.8}$$

The first relation in (3.8) means that the DMs' new competence set $H(CS^t)$ would have more common elements with *CS* than CS^t. In other words, the DMs would acquire additional elements from the needed or targeted competence set *CS* that were not in CS^t before implementing *H*. The relation $ch(H(CS^t)) less\ than\ ch(CS^t)$ expresses the fact that the DMs' charge level has decreased by implementing *H*. This means that the DMs consider or perceive the expansion of CS^t by adding the newly acquired elements from *CS* through operator *H* as significant. Here, it is important to note that the inclusion $CS^t \subset H(CS^t)$ is valid thanks to Assumption 3.1. This inclusion means that the DMs do not lose previously acquired knowledge, skills, etc. from *CS*.

Step 5 Monitoring the implementation of *H*.

The DM implements *H* and monitors the process, if he sees that *H* will not be completed within the perceived allowable time $\mathrm{AL_t}$ or it will not produce the expected results, he stops implementing *H*. Let Δt be the time spent in finding *H* and implementing it up to the stopping moment. Set $t = t + \Delta t$ then CS^t is the acquired competence set at the stopping time, go to Step 3. Otherwise, let $t = t + \mu(H), CS^t = H(CS^t), H^p = H, \Gamma = \Gamma \cup \{H^p\}, H * = H^p oH *$, and $p = p + 1$, go to Step 3.

Step 6 Test $t \le \mathrm{AL_t}$, if no stop, the process cannot further decrease the charge level.

Otherwise, analyse CS^t including X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, $\mathrm{PS_t}$, $\mathrm{ST_t}$, $\mathrm{PL_t}$, $\mathrm{UN_t}$ and $\mathrm{AL_t}$, then select an appropriate *IG*-operator *H* from the set *CM* of the *IG*-operators such that the expected new competence set $H(CS^t)$ resulting from implementation of *H* satisfies

$$ch\left(H\left(CS^t\right)\right) less\, than\, ch\left(CS^t\right) \quad \text{and} \quad t + \mu(H) \le AL_t \tag{3.9}$$

Go to Step 5.

Let us now explain how the Procedure 3.1 works steps by step.

– Step 1 is devoted to the problem definition and identification of the corresponding competence set *CS* that will be the DM's targeted set for covering.

– In Step 2, the DM determines his own competence set for solving the decision problem at the beginning of the covering process, $t = 0$. Moreover, the DM initialises different counters that will be used in the procedure to present its outcome in a convenient way. These are the time *t*, the counter *p* of the *IG*-operators used in the procedure, the *IG*-operator solution H^*, which is the ordered sequence of the *IG*-operators used up to the end of the procedure, and Γ the set of used operators up to the end of the procedure.

– In Step 3, the DM assesses the covering progress by comparing his current competence set to the targeted competence set. Three cases may occur.

Case 1 His competence set covers the targeted competence set *CS* and his charge level $ch(H(CS^t))$ is at an acceptable low level; the covering process is successfully completed.

Case 2 His competence set does not cover the targeted competence set *CS*, the covering process is not completed. The process continues in Step 4, where the DM analyses his current competence set CS^t including X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, $\mathrm{PS_t}$, $\mathrm{ST_t}$, $\mathrm{PL_t}$, $\mathrm{UN_t}$ and $\mathrm{AL_t}$ for possible revision and/or update in the light of the new information input, if any, and/or self-suggestion. The first thing the DM does in this exercise is to check where he is with respect to the updated perceived allowable time $\mathrm{AL_t}$. If the current time has reached the perceived allowable time, the covering process stops even if it is not completed. Otherwise, the DM still has an opportunity to expand his competence set by using the basic 7–8–9 principles or their combinations. He must find an *IG*-operator *H* in *CM* to acquire additional new elements from the targeted competence set and, at the same time, decrease his current charge level. Moreover, the implementation of H should be within the perceived allowable time. All these actions and constraints are represented in (3.8).

Next, the DM goes to Step 5, which is devoted to the implementation of H. As mentioned above, the *IG*-operator H may be a mental operation that does not necessitate physical resources or action; it can be implemented immediately. However, it often happens also that H requires a process that involves human and material resources and may succeed or fail as it could be exposed to all kinds of resistances, uncertainties and risks. Therefore, the DM must monitor the implementation of H. In case he sees that H cannot be completed successfully or cannot produce the expected results stated in Step 4, during its implementation, the DM must stop its implementation, then go back to Step 3. In case the implementation of H is completed successfully, the DM updates the counters, then return to Step 3.

Case 3 The DM achieves the covering $CS \subset CS^t$, but he is not satisfied with the charge level $ch(CS^t)$. This may occur if the last *IG*-operator used to cover the last uncovered part of CS generates high costs, continuous damage to the environment, etc. He may want to improve the quality and/or performance of the covering process. Then he goes to Step 6. In Step 6, the DM needs first to check where he is with respect to the perceived allowable time. If the time is up, the procedure stops. If no, he needs to analyse the current competence set including the ten decision parameters X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, PS_t, ST_t, PL_t, UN_t and AL_t, for possible revision and/or update in the light of the new information input if any and/or self-suggestion. If he still has time, he starts the search for an *IG*-operator H that is implementable within the perceived allowable time, and at the same time can decrease his charge level. This fact is expressed in the relations (3.9). Here, it is important to note that, according to Assumption 3.1, we have $CS \subset H(CS^t)$ after the implementation of H, that is, the covering of CS is maintained. Next, the DM goes to the Step 5 for the implementation of H. Then he returns to Step 3. He continues this cycle until the procedure ends in Step 3, 4 or 6.

Note that the comparison of the current competence set CS^t of the DM with the targeted competence set CS and the assessment and update of the ten decision parameters X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, PS_t, ST_t, PL_t, UN_t and AL_t in Steps 4 and 6 are performed with Hypotheses H1-H8 (Sect. 3, Part I). The search for an *IG*-operator H to enlarge the current DM's competence set to cover new elements from the targeted competence set CS and/or reduce the charge level is conducted using the Hypotheses H6, H7 and H8, and the 7–8–9 principles.

In real-world covering problems, the DM may or may not succeed in covering the needed competence set of a problem within the perceived allowable time. In case covering is completed, the outcomes of Procedure 3.1 are as follows. (1) The duration of the covering, the last value of t, and the last value of the counter p of the *IG*-operators used in the procedure; (2) The set Γ of the *IG*-operators used to cover CS; (3) The acceptable solution found at the end of the procedure, $H^* = H^p o H^{p-1} o \ldots o H^1$; (4) The final competence set, $CS^t = H * (CS^0)$. Note that this competence set contains CS. It could also be larger than CS.

In case the covering is not completed, Procedure 3.1 outcomes are: (1) The duration of the process, which is the stopping time t, (2) The set Γ of the *IG*-operators used in the covering process, (3) The *IG*-operator H^* and (4) the competence set $CS^t = H*(CS^0)$ reached at the stopping time *t*. Thus, the DM has the necessary data and information to continue the process if a favourable change in the decision problem or in his environment occurs later.

Remark 3.3 Procedure 3.1 has three ways of stopping. The first is at Step 3, if $CS \subset CS^t$ and the charge level $ch(CS^t)$ is at an acceptable low level, the covering is completed. The second is at Step 4, if $t > \mathrm{AL_t}$ the covering process is not completed within the perceived allowable time, the DM may accept the covered part of *CS*. He may also wait for a change in perceived allowable time to continue the covering process or consider changing or extending the perceived allowable time as a DMCS problem per se. The third way the procedure can stop is at Step 6, if $t > \mathrm{AL_t}$, which is like the previous way. Thus, the failure of the covering process is essentially determined by the perceived allowable time (recall that the DM uses the active problem-solving principle). However, the causes of failure of the covering process can be many. One may categories them into three major classes. The first is the lack of accurate and adequate information during the covering process. The second is the DM's HD including his psychological states, skills, knowledge, and capabilities to manage the process. This includes how he uses the 7–8–9 principles of deep knowledge. The third is the availability of resources to implement the decisions and strategies, including human and material resources.

3.3.1 Discovering Procedure

Discovering problems can be of different types: (1) Discovering at the individual level, (2) discovering at the group level (includes family and organisation levels), (3) discovering at the society or nation level, and (4) discovering at the humanity or global level. We provide a procedure for discovering at the most difficult level, humanity or global level. The reader may develop similar procedures for the other levels.

Procedure 3.2. (*Discovering Problem*) This procedure finds acceptable solution to (3.7).

Steps 1 Identify precisely the problem *E* to be solved.

Step 2 It is like Step 2 of Procedure 3.1.

Step 3 Is $ch(H(CS^t))$ an *acceptable low* charge level? If yes, the discovering process is completed.

Step 4 Test $t \le \mathrm{AL_t}$, if not stop, completing the discovering process is infeasible for the DM within the allowable time. Otherwise, analyse CS^t including X_t, F_t, $\boldsymbol{F}_t$, D_t, I_t, $\mathrm{PS_t}$, $\mathrm{ST_t}$, $\mathrm{PL_t}$, $\mathrm{UN_t}$ and $\mathrm{AL_t}$, then select an appropriate *IG*-operator *H* from the set *CM* of the *IG*-operators such that the expected new competence set $H(CS^t)$ resulting from implementation of *H* satisfies

$$H\left(CS^t\right)\backslash CS^t \neq \emptyset, ch\left(H\left(CS^t\right)\right) less\ than\ ch\left(CS^t\right) \quad \text{and} \quad t + \mu(H) \le AL_t$$

and the DM's new competence set $H(CS^t)$ would have more insight into the discovering problem *E* than CS^t. In other words, the DM would acquire additional valuable information on solving the discovering problem that was not available in CS^t before implementing H. The decrease in the DM's charge is an indication that he made some significant progress in the discovering process.

Step 5 Monitoring the implementation of H. It is like Step 5 of Procedure 3.1.

In case the discovering process is completed, the outcomes of the Procedure 3.2 are as follows. The discovering process time t, the last value of p, the number of IG-operators used in the procedure, the set Γ of the IG-operators that were completely used in the discovering process, the obtained acceptable solution $H^* = H^p \, oH^{p-1} o \ldots oH^1$ and the final competence set, $CS^t = H * (CS^0)$.

In case the discovering process is not completed, the outcomes are like in the case the procedure is completed. This latter differs from the former in two points. (1) The value of t is the stopping time before the completion of the procedure and (2) the obtained IG-operator H^* is not an acceptable solution. A similar procedure can be formulated for finding a wonderful solution of the problem (3.7). One needs just to replace "acceptable low level" by "insignificant low level" in Step 3 and "acceptable solution" by "wonderful solution" in the outcome of the procedure if it is completed.

Remark 3.4 The major difference between Procedures 3.2 and 3.1 is that the latter does not involve a known targeted competence set as in covering process and its outcomes are uncertain. Indeed, in the discovering process often the DM has a clear objective or problem, for instance, a doctor works hard to discover a vaccine for some deadly disease, however he does not know precisely the targeted or needed competence set. The discovering process stops when (1) the DM achieves the objective, which is equivalent to say, when his charge is released, or (2) the process has reached the time limit AL_t. One can similarly formulate procedures for discovering problems when the DM considers time and/or cost as important criteria.

It is important to mention that real-world decision problems generally involve both covering and discovering processes. They are ***dis/covering*** problems. For example, during a covering process, the DM may fall in a decision trap, which means that he must use a discovering procedure to find a way out. In such cases, the DM may use both covering and discovering procedures.

4 Empowering Decision Makers for Challenging Problems Solving: An Application to Post Data Mining Analysis and Decision-Making

In this section, we illustrate how wonderful solutions can be reached in post data mining analysis and decision-making stage of challenging problems when the proposed model is used. And in case of failure in facing challenging problems, what aspects of the model where not properly implemented or missing. We present four applications. The first one is about how Matsushita company could survive a crisis and prosper without laying off employees (Problem 2.1, Sect. 2, Part I). We formulate the post data mining decision-making problem as an OCS discovering problems of the form (3.7), then solve it by the Procedure 3.2. As a result, we obtain Matsushita's solution as a wonderful solution. The other three applications are realted to Problems 2.2–2.4 of Sect. 2, of Part I. Problem 2.3 represents a temporary failure, while Problems 2.2 and 2.4 represents an irreversible failure. They are briefly presented because of space constraints.

Problem 4.1 Let us go back to the Problem 2.1., Sect. 2, Part I (*Breaking through crisis to prosperity by Matsushita*). The problem was effectively solved by Matsushita after many days of thinking deeply, retreating, meditation and prayer. In a meditation, Matsushita noticed that it is generally easier to sell a product to friends and relatives than to unknown people. On average, each employee has at least 5 to 10 relatives and 5 to 10 good friends, and each of the relatives and friends also has from 5 to 10 relatives and good friends, and so on. Through this channel, Matsushita Company could create a large pool of potential customers. Thus, Matsushita discovered a "gold mine" in a crisis time.

Matsushita called for a corporate meeting that all employees must attend. Employees were nervous and highly charged as the situation was worsening and other companies were firing their employees in large numbers. They were expecting similar decisions. Matsushita said: our company is in serious difficulties, almost all our products are piling in inventory as sales are decreasing, if things continue in this way, it may not survive. We could just like other companies lay off employees to survive. However, in our company, we are not going to fire employees and/or cut down their salaries or benefits. Instead, I will ask all the employees in production department to work only half day, and in the other half help the company to sell our products, that is, to become sales agents of the company.

The idea is to sell the company's products to relatives and friends of relatives. As each of the employees has relatives and friends and each of his relatives has his relatives and friends, and so on, it is possible to reach a considerable number of customers. Moreover, by adopting this strategy, product acceptance would be higher because of family relationships and friendship, which would substantially increase the company's sales. The employees cheered Matsushita and enthusiastically embraced the strategy and promised to do their best to sell company's products, electrical and electronic products. In 2 months, the inventory level decreased substantially to reach a point where more production was required. The company produced more and more and became more prosperous.

Let us now show that Matsushita's decision problem of finding a solution that can save both the company and the employees is a DMCS problem. Denote the problem by E. We first describe the decision elements and environmental facets realted to E (see Sect. 3.4, Part I), $\{X_t, F_t, \boldsymbol{F}_t, D_t, I_t, \mathrm{PS}_t, \mathrm{ST}_t, \mathrm{PL}_t, \mathrm{UN}_t, \mathrm{AL}_t\}$ at the initial time $t=0$. The involved DM is Matsushita Company management headed by Matsushita.

- The set of alternatives, X_t, consists of all measures that are conventionally used to mitigate the problems of dramatic decrease in sales or demand.
- The set of criteria, F_t, could be the time and cost efficiency and effectiveness of a decision or measure taken to save the company.

- The set of outcomes, $\boldsymbol{F}_t$, would be the performances of decisions and/or measures with respect to the criteria F_t.
- The set of preferences, D_t, is the set of preferences of the DM over the outcomes $\boldsymbol{F}_t$.
- The information input, I_t, is the internal and external information that the DM receives or solicits about what happens in the company and about the recession from all possible sources.
- The psychological state of the DM, PS_t, is represented by DM's charge level.
- The stages of the decision problem, ST_t, are the period before the corporate meeting where Matsushita announced the solution to the problem and the period starting from this meeting to the end, where the solution was successfully implemented.
- The set of players, PL_t, consists of the Matsushita management and the employees as the main players, and any other concerned people.
- The set of unknowns, UN_t, consists of all the factors or parameters, hidden or known, that can affect the situation and are not under the DM's control as the behaviour of markets and consumers. The DM may be unaware of some of them.
- AL_t, is the allowable time to find a solution to the problem and implement it. It is the time left before the company goes bankrupt. It is not known exactly but it is short given the crisis.

Obviously, the difficulties lie in X_t, I_t, PS_t, PL_t, UN_t and AL_t. Indeed, the set of alternatives X_t does not contain a viable solution as Matsushita did not want to use conventional measures to cut down costs by laying off employees. Since the problem is a consequence of recession, information input, I_t, could vary very quickly and unpredictably as the situation evolves quickly and unpredictably in such turbulent times. As the DM did not see a satisfactory solution and the situation was worsening internally and externally, he was in a highly charged psychological state, PS_t. The employees as a group are a major player in this problem. However, the set of players, PL_t, may change unpredictably as the crisis enfolds. As the problem occurs during recession, the DM would not be able to control many external factors and even some internal factors as the recession deepens. That is, the dynamics of the set of unknowns, UN_t, is highly unpredictable. Finally, the perceived allowable time becomes highly uncertain and short as the situation worsened and no solution is found. From this analysis, it appears that X_t, I_t, PS_t, PL_t, UN_t and AL_t are changeable spaces. Therefore, the problem faced by Matsushita is a DMCS problem. It is a dis/covering DMCS problem as it involves discovering a solution to the problem in stage one, then a covering problem in the implementation stage.

Next, we solve the DMCS problem E as an OCS problem. Its resolution process will follow the main steps of the Procedure 3.2 without mentioning them in detail because of space constraints. As Matsushita did not know the needed competence set of the problem a priori, the discovering OCS problem (3.7) is appropriate

$$red\, ch(H_t(CS^0)) \quad \text{subject to } H_t \in CM, H_t\left(CS^0\right)\backslash CS^0 \neq \emptyset, \mu\left(H_t\right) \leq AL_t \quad (4.1)$$

where H_t is the *IG*-operator used up to time *t* and *CM* is the set of *IG*-operators (3.1). Matsushita must discover the needed competence set that would consist of solutions, resources and capabilities, including their application process that will help him bring his current high level of charge to an acceptable or insignificant low level. $\mu\left(H_t\right)$ is the time needed to find H_t and implement it and AL_t is the perceived allowable time at time *t*.

Construction of the Solution Now we proceed to the construction of an acceptable or wonderful solution of *E* as an *IG*-Operator (see Sect. 3). In the first stage, the fact that, since the very beginning, Matsushita did not want to lay off employees to solve the problem of the company implies that he activated or used the principle $\mathbf{U_1}$ "Everyone is a priceless living entity. We are all unique creations who carry the spark of the divine" of the 7–8–9 principles (see Sect. 2.1.1), which is an expression of deep respect for his employees. This principle has a strong circuit pattern in his brain and it is in the core of his Habitual Domain, that is, it is almost certainly activated whenever the corresponding stimuli are present or occur. However, refusing to implement the conventional solution of labour force reduction increased his charge level, as he did not have a ready alternative solution. To allow more ideas to surface and explore his Potential Domain, he used the "Deep and down principle", $\mathbf{W_1}$. Being guided by the principle $\mathbf{U_1}$ in his analysis of the situation, he understood well the problem, the dramatic drop of the demand for his company's products is due to the economic recession not the employees. Then applying the "Contradiction principle", $\mathbf{W_7}$, he concluded that a solution to the problem is to boost the sales in a recession context not the conventional and easy solution consisting of laying off employees to reduce costs. This operation can be represented as follows

$$CS^1 = H^1\left(CS^0\right), \quad \text{with } H^1 = \boldsymbol{W}_7 o \boldsymbol{W}_1 o \boldsymbol{U}_1$$

The new competence set does not cover the needed competence set, but the charge of the DM is lesser as he has discovered a new approach to the problem, looking for a strategy to boost sales that is different from the conventional one, lay off employees. In terms of charge level this can be expressed as follows

$$ch\left(H^1\left(CS^0\right)\right)\, less\, than\, ch\left(CS^0\right)$$

However, the new charge level has not reached an acceptable level. Estimating that he still has time to solve the problem and encouraged by the progress in solving it, he continued in the same direction looking for a concrete strategy to boost sales. Here, a new marketing strategy need to be discovered. As inventory level was high, the company did not need all the employees in the production process the whole day, which makes them an idle human resource that can perform other tasks. Observing this, Matsushita used the "changing and transforming principle", $\mathbf{W_6}$, to discover the idea of transforming the employees into salesmen during the second half of the day after working in the first half in the production process. With this idea, the company could reduce inventory and production at the same time. This idea looked interesting, but Matsushita needed to find a way to make it effective in a recession and fear context. He again used the “Deep and down principle”, $\mathbf{W_1}$, to explore deeper parts of his Potential Domain.

As the employees are unexperienced salesmen and the company has no financial means to implement a costly marketing strategy, Matsushita used “The inner connection principle”, $\mathbf{W_5}$, that is reflected in family relations and friendship. Indeed, family relations and friendship make it easier for the employees to promote the company’s products. Moreover, the family members and friends of Matsushita employees would be more receptive to them and willing to buy the proposed products, if they need them, thanks to the strong relationships that exist between them. Matsushita also believed that an employee is a human resource that has unlimited capacity to learn to do a task when he/she is fit to do it (Circuit Pattern Hypothesis, H1 and Unlimited Capacity Hypothesis, H2). Thus, using the three principles $\mathbf{W_6}$, $\mathbf{W_1}$ and $\mathbf{W_5}$, he could formulate the marketing strategy mentioned above. We can summaries this operation as follows.

$$CS^2 = H^2\left(CS^1\right), \quad \text{with } H^2 = \boldsymbol{W}_5 o \boldsymbol{W}_1 o \boldsymbol{W}_6$$

The new competence set CS^2 contains the new marketing strategy. However, it does not provide Matsushita the competence to solve the problem. He needs to discover more about the needed competence set to solve the problem. The charge level related to CS^2 is much less than the charge level related to CS^1, that is,

$$ch\left(CS^2\right) much\ less\ than\ ch\left(CS^1\right)$$

However, the new charge level has not reached an acceptable or insignificant low level as another challenge is ahead, the acceptance and implementation of the new strategy. Matsushita had to present the strategy to the company members for endorsement and action. Theoretically, Matsushita found a good solution to the problem as it would boost the sales and reduce the inventory since the employees would work only half day indoors and turn into sales force in the other half of the day. Moreover, it does not involve a significant cost. As stated above, Matsushita has discovered a gold mine.

The challenge faced by Matsushita is how to exploit this gold mine. Referring to the HBM (see Fig. 3.1 and its explanation, Sect. 3, Part I), he needs to understand his own charge structure and the employees’, then find a way on how to reduce these fear-related charges and create charge and drive for his strategy. Thus, he needed to find a way on how to inspire his employees to enthusiastically accept his solution and implement it. Using the “Deep and down principle”, $\mathbf{W_1}$, to explore his Potential Domain, Matsushita concluded that the best way to achieve full support of employees is to invite them to a corporate meeting to inform them on the company’s status and present his strategy.

In the second stage, he called all the company members for the corporate meeting. Here also, he applied the principle $\mathbf{U_1}$ mentioned above, as consulting them and getting their support and approval is a sign of respect. The employees were highly charged as the fear of being fired was high (Charge Structure and Attention Allocation Hypothesis, H6) because job is related to many life goals as security, wealth, family sustenance, respect from others, social status, etc. He first described the difficult situation in which the company was and concluded that if nothing is done, the company will close. In order to make the employees receptive to his strategy, he had to reduce their charge level by proposing something that could reduce their fear or make it disappear (Discharge Hypothesis, H7). Then Matsushita announced that there will be no lay off and no reduction of benefits. Naturally, this announcement has significantly dissipated the fear of the employees and made them look forward with great interest for his strategy on how to achieve this objective, which may seem unrealistic in recession context. He then further explained in detail his strategy to save the company and the jobs (External Information Input Hypothesis, H8). The employees shouted "*banzai*" (long life) to Matsushita. They embraced the idea and showed enthusiasm and commitment to it.

The employees accepted Matsushita's strategy because it had the potential to release their charge created by the fear of being fired and it would save the company as well. *It is a wonderful solution*. Thus, Matsushita strategy eliminated the charge related to job loss fear and created a high charge or drive for its implementation. It has also created an atmosphere of trust between Matsushita and the employees. Moreover, it increased significantly the confidence of employees; by the "Principle of social comparison", a behavioural tendency, the commitment to the strategy became even stronger as no employee would feel comfortable if he/she does not commit to it, while the others do. Matsushita's solution is comprehensive and multidimensional in the sense that it relates to psychological aspects such as motivation, trust and confidence, and competence change and improvement as it turned production employees to sales force and marketing agents. This step can be formally summaries as follows.

$$CS^3 = H^3\left(CS^2\right), \quad \text{with } H^3 = \boldsymbol{U}_1 o \boldsymbol{W}_1$$

where the new competence set,CS^3, includes the commitment of the employees to implement Matsushita's strategy. This is a great progress in the discovering of the needed competence set to solve the problem. However, CS^3 does not completely solve the problem. The charge level related to CS^3 is much less than the charge level related to CS^2, that is,

$$ch\left(CS^3\right) less\ than\ ch\left(CS^2\right)$$

However, this new charge level has not reached an acceptable low level.

As stated above, the strategy was successfully implemented. Matsushita turned the atmosphere of fear and stress into an enthusiastic and promising one. In terms of Habitual Domain, the strategy has moved the perceived states of many life goals such as wealth (employment), social status and family protection to their ideal states, the fear of being fired has disappeared.

Moreover, it has also re-set a higher ideal value to some goals as wealth accumulation (Goal Setting and State Evaluation Hypothesis, H5). In implementing the process, Matsushita and the employees used the 7–8–9 principle “Inner connection principle”, $\mathbf{W_5}$, to sell the company’s products to relatives and friends. Indeed, in a short period, 2 months, Matsushita Company prospered, and employees benefited from it. Thus, Matsushita’s strategy has solved the problem of the company. One can formally describe this last step by the following relation

$$CS^4 = H^4\left(CS^3\right), \quad \text{with } H^4 = \boldsymbol{W}_5$$

where the new competence set,CS^4, includes the needed competence set. At this step, we can say that the last operation has reduced the charge level to an *insignificant low* level $ch(CS^4)$ Moreover, it solved Matsushita’s problem within the allowable time. We can say that Matsushita has found a ***wonderful solution*** (see Definition 3.1) to the company’s problem as it has reduced both his and employees’ high charge level to an insignificant low level because it has saved the company and the employees’ jobs and made the company prosper in a very short time in a recession period, which is very rare in business. The final competence set CS^4 includes the unknown needed competence set

$$CS^4 = H^*\left(CS^0\right),$$

where $H^* = H^4oH^3oH^2oH^1 = \left(\boldsymbol{W}_5\right)o\left(\boldsymbol{U}_1\boldsymbol{o}\boldsymbol{W}_1\right)o\left(\boldsymbol{W}_5\boldsymbol{o}\boldsymbol{W}_1\boldsymbol{o}\boldsymbol{W}_6\right)o\left(\boldsymbol{W}_7\boldsymbol{o}\boldsymbol{W}_1\boldsymbol{o}\boldsymbol{U}_1\right)$ is the *IG*-operator solution of the OCS problem (4.1), CS^4 is the last competence set. It includes Matsushita’s strategy, the commitment of his employees to it and its implementation process. The solution H^* is a wonderful solution as mentioned above.

Remark 4.1 The above analysis of the DMCS faced by Matsushita is an illustration of how a repeated use of the 7–8–9 principles can facilitate reducing significantly the DM’s charge level as to reach a wonderful solution of DMCS problems. We hope that the analysis and resolution of the Problem 4.1 initiated the reader to the use of the 7–8–9 principles in solving DMCS problems. It is important to note that the final solution H^* of the Problem 4.1 is a good sketch of the complete solution as it captures the essential steps of the decision-making process.

Problem 4.2 Let us go back to Problem 2.3 in Part I of the paper (*Amazon’s displaying of the different prices for the same product*) [3, 10]. Let us first describe the problem in terms of Habitual Domains theory. Once the customers discovered the differential pricing strategy (Hypothesis H8), they felt that it is un injustice (Hypothesis H5), therefore, their charge level increased sharply (Hypothesis H6) to a level that required immediate actions (Hypothesis H7, discharge). The company was bombarded by complains. As a result, the company’s charge level went high as well as the situation started to damage its reputation, which would lead to customers loss.

The company’s management faced the challenge of reducing the charge of its customers swiftly and effectively. Let CS^0 be the competence set of Amazon management when the problem was recognized as important. And let CS be the targeted competence set, that is, a set that contains a course of actions that brings down the charge level of the affected customer and maintains the loyalty of the others. In fact, what created this problem is that Amazon management ignored the 7–8–9 principle $\boldsymbol{U}_1$ by displaying different prices for the same product. The affected customers' outrage made Amazon's management activate this principle from their Potential Domains to their Actual Domains (see Diagram 3.1, Sect. 3, Part I). Having $\boldsymbol{U}_1$ in Actual Domain, an apology and compensation become the only way out of the situation. The apology would reduce the charge of the affected customer and maintain the loyalty of the other customers, and the compensation would further reduce the formers' charge to a satisfactory level. Therefore, a ***satisfactory solution*** was reached $H^* = \boldsymbol{U}_1$ and the new competence set $CS^1 = \boldsymbol{U}_1\left(CS^0\right)$ contains the apology and compensation.

Problem 4.3 Let us go back to Problem 2.4. in Sect. 2, Part I, (*The failure of the Canadian government automated Phoenix pay system*). According to the report [6], in 2009, the Canadian federal government started the Transformation of Pay Administration Initiative, with the objectives: (1) realize $70 million in annual savings, (2) centralize the pay operations by replacing the 40-year-old Regional Pay System that relied on staff's expertise and experienced long delays in processing pay of many employees. This initiative led to the Phoenix pay system, more than half of the federal government's 290,000 public servants have experienced pay problems, causing significant anxiety, stress and hardship. Instead of realizing the intended objectives, the government will incur approximately $2.2 billion in unplanned expenditures. By any measure, the Phoenix pay system has been a failure.

Due to space constraint, we will give a brief analysis of this case. The failure is ongoing as the problem has not been solved. As concluded in the report [6], Phoenix did not fail due to unforeseen events or challenging circumstances. Nor did it fail due to a single error or mistake. Rather, it failed due to a series of avoidable, poor management decisions, including:

1. Removing critical pay processing functions from the system;
2. Failing to simplify pay rules before developing a new system;
3. Failing to appreciate the complexity of the human resources to pay process;
4. Selecting an off-the-shelf system that required extensive customization and was not integrated with human resources systems;
5. Failing to align human resources practices with new pay system;
6. Failing to test the system through a pilot project;
7. Ignoring repeated warnings from employees, unions, IBM, and an independent report that the system wasn't ready;
8. Providing inadequate training to compensation advisors, human resources staff, and employees;
9. Laying off experienced compensation advisors and reducing the total number of advisors before implementing the new system;
10. Failing to put in place an appropriate governance and oversight structure; and
11. Reacting slowly to problems after implementation.

From Habitual Domain theory perspective, the Phoenix problem can be divided into two problems that occurred at two phases, design and implementation phases: (A) The inadequacy of Phoenix to manage the pay system and (B) the lack of competence of human resources staff to operate Phoenix. The problems A and B can be formulated as two covering problems of the form (3.3), respectively as covering problem A and covering problem B. Problem A is related to Phoenix as an information technology system and reflects the question: Does Phoenix achieve its objective of managing the pay system in an effective and efficient way? In terms of competence set, this question can be reformulated as follows. Does the set of competences that Phoenix equips human resources staff with cover the competence set needed to manage the pay system in an efficient and effective way?

Covering problem B expresses the question: Assuming that Phoenix is adequate to manage the pay system, do the human resources staff master the needed skills to operate Phoenix effectively and efficiently? In terms of competence set, this question can be reformulated as follows. If the functionalities of Phoenix cover the needed competence set to manage the pay system adequately, do human resource staff's competence set integrate the needed skills to operate Phoenix effectively and efficiently?

Now we can use the Procedure 3.1 to analyse the Phoenix problem and explain it in terms of the proposed decision model. For the covering problem A, the covering process did not take place at all according to failures (1)–(7). Indeed, the Step 2 of Procedure 3.1 recommends performing an initial evaluation of the competence set C^0 that would the human resources staff acquire by mastering Phoenix operations. Then testing whether this competence set covers the needed (targeted) competence set C to manage the pay system effectively and efficiently should be performed in Step 3. Once, initial evaluation and testing is done, if covering does not take place, the dynamic covering process continues improving the human resources staff competence set until the covering is complete (Steps 3–6). A pilot project or study is an adequate way to have the initial evaluation, failure (6) indicates that it has not been done. The failures (1)–(5) show clearly that Phoenix would not be adequate to manage the complex pay system and the pilot project would have revealed this fact. Moreover, according to (7), Phoenix managers did not believe that performing the covering A is necessary. In the covering process, the managers certainly ignored one *major player* (see Sect. 3.4.2 of Part I) in this challenging problem, the 390, 000 employees that the Phoenix would directly significantly impact as compensation is fundamental in the relation employer-employee.

In fact, the managers' attention (Hypothesis H6) was more focused on getting the Phoenix completed to achieve government's objectives within the allowable time AL_t. The honourable minister of Public Services and Procurement argued that the government did not have a choice and had to move forward with the Phoenix pay system, since there were no longer enough people to manage the old system. This situation was created by failure (9), which means that budget cuts were given the priority over the 390,000 employees. In terms of Habitual Domain theory, this means that the managers ignored the 7–8–9 principle $\boldsymbol{U}_1$, in this case, respect to the 390,000 government employees. In other words, the activation probability of $\boldsymbol{U}_1$ from managers' Potential Domain to their Actual Domain was not strong enough to activate it. In fact, many of the 7–8–9 principles (see Sect. 2) were not activated in the covering process. We mention two more as an illustration. First, the deep and down principle $\mathbf{W_1}$. Indeed, the managers ignored the high level of charge expressed by the numerous complains of employees that had pay problem and pay centre staff that experienced problems in implementing Phoenix. The managers were "victims" of the "Void principle" $\mathbf{W_9}$. They believed that their Habitual Domain is the only one that exists, ignoring warnings of the employees, unions, IBM, and an independent report from Gartner that the system was not ready, according to failure (7).

As for covering problem B, an Analysis by Procedure 3.1 provides the following insights. The reported problems and damages caused by Phoenix implementation mean that the covering process of the covering problem B was not completed. The failures (8) and (9) can be explained by saying that Phoenix managers started with a very bad initial (approximation) competence set CS^0 of the human resources staff with respect to the targeted competence set CS, which is the set of needed skills to master the use of Phoenix. Indeed, the failures (8) and (9) show that the human resources staff were not ready to operate the system, especially, (9) made their competence set worse as they lost crucial competencies. The failures (10)–(11) are related to control, monitoring and progress evaluation. In Procedure 3.1, each time there is a change in t the covering competence set CS^t, there is an evaluation test of what is achieved in terms of covering the targeted competence set CS as shown in Step 3. There is also time monitoring through testing whether the remaining time is enough to complete the covering in Steps 4, 5 and 6. Failures (10) and (11) show that these monitoring and control steps were almost completely absent.

Problem 4.4 Let us go back to Problem 2.2. in Sect. 2, Part I, (*The failure of Nokia*). We have analysed this failure by the 7–8–9 principles in the introduction of Sect. 3. In terms of Procedure 3.1, Nokia's problem was a covering problem as there was a major shift of customers' preferences from keypad phones to touch screen phones with computer-like functionalities. Nokia's competence set CS^0 covered almost perfectly the old needed competence set, CS, needed to satisfy customers in the era of keypad phones, however, with the major shift in customers' preferences, a new competence set, $\overline{CS}$, was needed. Nokia failed to cover this competence set by expanding its competence set CS^0 in Step 3 as the covering process was not completed within the allowable time, AL_t (the beginning of the new era of smart phones). This failure is due to its management Habitual Domain rigidity that we explained by the non-activation for use of the 7–8–9 principles $\mathbf{V_4}$ "Changing the relevant parameters", $\mathbf{W_4}$ "Revolving and cycling principle", $\mathbf{W_9}$ "Void principle" and $\mathbf{W_8}$ "Cracking and ripping principle" in the introduction of Sect. 3.

Remark 4.2 From the analysis of Problems 4.1–4.4 by the proposed model, the following insights are worth mentioning. Matsushita succeeded in reaching a wonderful solution in facing his challenge by applying the relevant 7–8–9 principles, especially, upholding the principle $\boldsymbol{U_1}$ and properly applying the steps of Procedure 3.2. In contrast, Amazon management, ignored the principle $\boldsymbol{U_1}$ when it implemented the price differentiation strategy. However, it activated this principle within the allowable time AL_t (the time before reputation damage becomes irreversible). It succeeded in saving long term reputation by apology and compensation, which are powerful means of charge reduction. The Phoenix managers failed for ignoring the relevant 7–8–9 principles, especially, $\boldsymbol{U}_1$ and the “void principle” $\boldsymbol{W_9}$, and not properly applying the Procedure 3.1. Nokia failed dramatically by ignoring the relevant principles $\mathbf{V_4}$, $\mathbf{W_4}$, $\mathbf{W_9}$, and $\mathbf{W_8}$. Thus, this analysis shows that if DMs integrate the 7–8–9 principles in their HDs’ core (they are automatically activated when the stimuli are present) and properly apply Procedures 3.1–3.2, the model can considerably empower them in facing challenges.

5 Conclusion

I the Part I of this paper, we have pointed out that researches on the final and essential stage of post data mining analysis and decision-making are rare. This stage needs a theoretical framework to reach better decisions. To contribute to this area of research, we have introduced a systematic way to analyse post data mining outcomes to reach *wonderful solutions* for action. The model we propose is based on Habitual domain Theory. Part II provides a framework for restructuring decision parameters by the 7–8–9 principles to generate new alternatives in post data mining analysis to reach wonderful solutions and decisions. In this model, the DMs are represented by their Habitual Domain, the dynamics of which is described by HBM (see Fig. 3.1, Sect. 3, Part I) instead of a utility function. Wonderful or satisfactory solutions are found or reached by solving OCS problems using the 7–8–9 principles and are expressed as sequences of these mental principles. Moreover, optimality is psychology based not utility based. *In this sense, this model is general and represents* a *paradigm shift in decision theory*.

In Sect. 4, we have shown that the proposed systematic model can be effectively used in real-world post data mining analysis and decision-making through the Problems 4.1–4.4. These applications show that if DMs integrate the 7–8–9 principles in the core of their HDs and apply the Procedures 3.1–3.2, the model can considerably empower them in facing challenges. In fact, the model can also be applied to pre, during and post data mining stages. For more applications of the model, see [5]. Further, thanks to its generality, the proposed model can also be used, in a similar way, to empower other sciences such as artificial intelligence, technology, health care, management and politics for better decision-making, research and discovery.

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