The KM-MCDM interface in decision design: tradeoffs-free conflict dissolution

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Abstract: Concepts of decision design are introduced via Multiple Criteria Decision Making (MCDM), Knowledge Management (KM) and optimisation. Decision-making conflict is defined as the absence of a prominent tradeoffs-free alternative. Because tradeoffs are properties of alternatives (the measured) and not of criteria (the measures), designing an optimal decision involves designing a tradeoffs-free alternative (or its proxy). Decision-making process becomes more important than its outcome: high-quality process assures high-quality outcome, not vice versa. A merger of MCDM and KM into an integrated decision support is outlined. Process-based MCDM paradigm emerges: decision making is neither art nor science – but knowledge-based skill or practice.

Keywords: decision making; decision design; decision process; Multiple Criteria Decision Making; MCDM; optimisation; Knowledge Management; KM; tradeoffs; tradeoffs-free; conflict; conflict dissolution; conflict resolution.

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1 Introduction

Setting a goal is not the main thing.
It is deciding how you will go about achieving it and staying with that plan.
Tom Landry

Decision making and *judgement* are two different processes that should not be capriciously confounded. Reviewing some pop-leadership literature, like Tichy and Bennis (2007), reveals that the distinction is treated as irrelevant in some executive circles.

The use of common language in serious research can be perilous. In the area of *Knowledge Management* (*KM*), the loose reliance on common talk and the lack of a definition of *knowledge* has led to the confusion between knowledge and information and its famous *tautological reduction* (knowledge ⇔ information), which brought KM decades back in its evolution. The same unfortunate looseness typifies the *Tichy–Bennis reduction* (decision making ⇔ judgement). This is further aggravated by their usage of the jargon like *judgement call*, connecting valid concepts from judgement theory with Wall-Street or American-football imagery of a quarterback's or referee's 'calls'.

In the non-pop literature on decision-making, it is crucial to differentiate safely between making *decisions*, passing *judgements* and making *calls*.

Decision making refers to the process of selecting an option or alternative and taking full responsibility for the consequences, i.e., for the action that follows. Any decision making must be followed by action, is rooted in action and can be improved through analysis and experience.

Judgement refers to the process of evaluating or ranking options or alternatives without the subsequent assumption of responsibility for whatever actions, if any, are brought forth by such calls. Judgement, therefore, does not have to be followed by action and is free of responsibility.

When we choose option A as the best, and act to invest our money into it, then we have made a decision and accepted responsibility for the investment. When we declare option A the best and leave the decision up to them, then we have offered a judgement, free of any responsibility.

What then could be a 'judgement call'? We can *make* a decision or *take* a decision, but how do we *call* a decision? Decision making refers to *producing* a decision, decision taking to *accepting* a decision (produced by others) and judgement calling to *announcing* a decision to others, ignoring process, experience or responsibility (Bennis and Tichy, 2007),[1] and expecting (or forcing) *others* to follow or carry it out. It appears that only called-for 'leaders' make judgement calls, but decision makers decide and judges judge.

In this paper, we deal with decision making.

2 Decision-making processes

Management is decision making.
Herbert Simon

The traditional decision-making theory is based on establishing criteria and *assessing* (measuring) options relative to those criteria. Such a 'decision', by itself, changes

nothing. Providing managers with information in the form of symbolic descriptions is next to useless *if* not followed by action. Decision making is not just its informational input, but also a purposeful coordination of action of the entire decision-making process. Action and implementation must follow decisions if they are to have any added value. Decision making without any such responsibility for subsequent action is a mere *judgement*.

It is the responsibility and purpose of decision making to *generate alternatives* leading to action, not just assess and evaluate given alternatives in an action-free context.

Tradeoffs analysis delays or prevents action; it makes decision makers procrastinating or immobile. Only tradeoffs-free alternatives lead to effective action. It is the responsibility of decision-making support to help producing tradeoffs-free alternatives – or their effective approximations or surrogates – for decision makers.

Decision making is a complex process of selecting *criteria* (and their measures), determining *alternatives* (or options) gathering, evaluating and processing *information*, producing and evaluating partial or *intermediate results*, reconsidering criteria, alternatives and information on the basis of achieved results, and repeating (recycling) the process until an actionable outcome (a decision) has been reached. *Coordinating* the entire process refers to the *knowledge* or skill of decision making. Mastered, this complex process can become professionally expedient and routine.

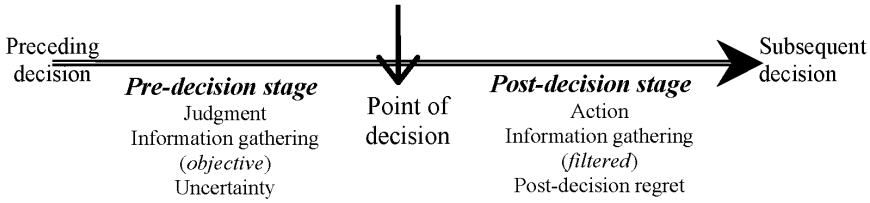
The interface between decision-making knowledge and decision-making information has thus been established: *knowledge refers to the coordination* of decision process (and its cyclical iterations), while *information is one of the inputs* into this process. The difference between process and input (as well as output/outcome) is fundamental and should be clear: any illegitimate confounding of knowledge and information (as well as of decision and judgement) cannot be useful or beneficial. Judgement can be an input into the decision-making process, but not vice versa.

Let us take a closer look at the *decision process* itself.

In Figure 1, we display a simplified scheme of the decision-making process. *Preceding and subsequent decisions* are important as they provide the necessary *context* for the current decision. No decision is an island. Human behaviour and purposes are different at different stages of the process:

- *Pre-decision stage*. Basic information is being gathered, alternatives generated, criteria proposed, etc. Information gathering is mostly objective and unbiased at this stage.
- *Point of decision*. The most desirable alternative is selected and commitment to its implementation declared.
- *Post-decision stage*. Additional information is being gathered, rationalising the decision, reducing post-decision regret, preparing implementation. Information gathering is highly filtered and biased towards the decision taken.

Figure 1 Pre-decision and post-decision stages



In some decision-making cultures (styles, habits), the emphasis is on the point of decision, i.e., the outcome of the process. This is where the decision support (analysis, computation) is most often applied. The process itself is de-emphasised, remains in the background, invisible and not considered important: the final outcome is all that matters. Decisions become points in time, taken out of context, with little or no embedding in the process.

In other cultures, the point of decision is de-emphasised and focus turned towards the process itself. Both pre-decision and post-decision stages are analysed in detail, often partially overlapping and proceeding in parallel. The decision itself is let to be brought forth by the process; it does not serve as a sharp *separator* of the pre- and post-stages, but as their integrating *connector*.

While *outcome-based* decision-making prevails in some western cultures (e.g., the USA), *process-based* decision-making is often practiced in stronger Asian cultures (e.g., Japan). This dichotomy is probably temporary and is not likely to persist. The parallel can be drawn with the worldwide shift from final-outcome orientation to process-based orientation (leading to *process management* in the 1980s) in production organisational paradigms (Zeleny, 2006b, 2007); the reinstatement of the decision process in the centre of attention is similarly crossing cultural boundaries due to the global interaction, communication and cooperation.

The quality of a decision depends on the quality of the underlying process. The better is the process of decision making, the better are the decisions – but not vice versa: better outcome does not imply a better underlying decision-making process.

Learning (and therefore improving) decision-making skills cannot take place through analysing outcomes only. Learning is intimately related to the process and its coordination. Inputs and outputs of the process are information; coordination of the properly structured process implies knowledge. The dominant function of the pre-decision process is *generation of alternatives* (options, ends).

It is precisely the quality and nature of available decision alternatives (their identification, creation, invention or design) that determine the quality of decision outcomes. It is not the criteria, measurement or evaluations that are primary in determining decision quality – it is the configuration of the feasible set of available alternatives.

3 Criteria and tradeoffs

It is very important to realise that there can be no ‘decision making’ with only one criterion or a single objective function. Such a formulation is simply a problem of measurement and search, i.e., a technical problem.

The same has also been recognised by Milton Friedman as follows:

> "An economic problem exists whenever scarce means are used to satisfy alternative ends. If the means are not scarce, there is no problem at all; there is Nirvana. If the means are scarce and there is only a single end, the problem of how to use the means is a technological problem. No value judgments enter into its solution; only knowledge of physical and technical relationships."
> (Friedman, 1962)

According to Friedman (1962), only an *economic problem* is of interest, not a *technological problem* (with a single end). Decision making thus deals with economic problems where value judgements enter into their solutions.

It is quite remarkable to realise that traditional economics (including Friedman's), decision analysis and utility theory (being characterised by a single end or utility function) have so far only dealt with the technological problems in Friedman's sense.

The notion of tradeoffs then derives naturally from Friedman's distinction: there can be *no tradeoffs* in cases of a single criterion: one cannot 'trade off' more for less of the same thing. Consequently, *tradeoffs emerge* only in cases of multiple criteria.[2]

We should emphasise that tradeoffs *emerge*: they are not fixed or natural properties of criteria, attributes or objective functions. *Tradeoffs are imputed* by the set of *scarce means* (see Friedman) and its properties. It would be erroneous to treat tradeoffs as if being the real attributes of specific criteria, objectives or dimensions.

Whether or not there are tradeoffs depends not on alternative ends but only on scarce means. Although no single-criterion situation can have tradeoffs and therefore is not a subject of decision making, not all multiple-criteria cases will be characterised by tradeoffs: tradeoffs emerge or do not emerge on the basis of the means (feasible set of alternatives) configuration. *Tradeoffs are the properties of the means, not of criteria or objectives*.

Yet, statements about criteria, like "there are tradeoffs between cost and quality" or "Cost and quality are conflicting objectives", are often accepted at their face value, as facts of reality.

What are criteria?

Criteria are simply measures or measuring tapes for evaluating (measuring) objects of reality (things, alternatives, options, or strategies). There is a fundamental difference between measures and measured objects. Measuring 'tapes' (length, volume, weight, sweetness, etc.) are quite different from apples, oranges and other items of available alternatives.

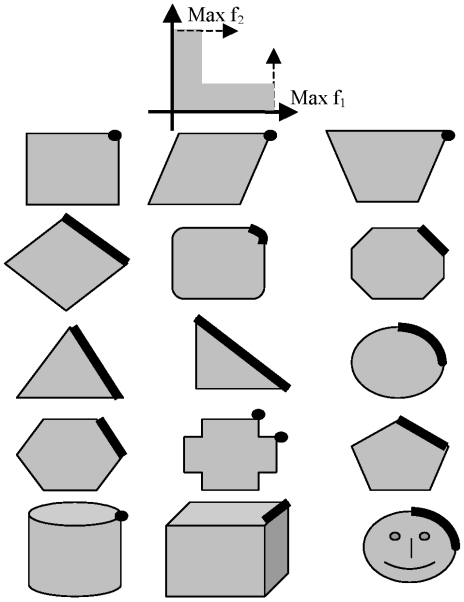
There can be no tradeoffs between measures (or measuring tapes). Measures of cost and quality do not produce tradeoffs, the set of evaluated (measured) choices (alternatives, options) does. It is the configuration (size, shape and structure) of the feasible set (the measured 'object' of alternatives, options and strategies) that is capable of producing or bringing forth any tradeoffs.

In Figure 2, we are looking at two 'conflicting' objectives, f_1 and f_2, to be both maximised over the changing array of feasible sets. The point of the picture is to show that conflicts, tradeoffs or any other forms of relationship between criteria or objectives are not inner attributes of the measures, but are external attributes of the objects they measure, in this case feasible sets, but also any sets of means, constraints, designs, etc.

It is quite apparent that also the tradeoffs boundary and its shapes, like the non-dominated set, Pareto-optimal solutions, efficiency frontier, productivity frontier,

etc., are the properties of the set of options (objects of measurement), and not of the set of measures (criteria of measurements). This is significant because to truly maximise an objective function(s), one has to optimise the feasible set; the rest is a mere valuation.

Figure 2 Optimality and Pareto-optimal solutions are the function of the feasible set – not of the criteria or objectives themselves



Observe that the identical pair of functions (multiple criteria or evaluation measures) engenders tradeoffs boundaries of different shapes and sizes, including the *no-tradeoffs cases*.

Because different configurations of means (different feasible sets) give rise to different solution configurations (different tradeoffs or non-dominated sets), the question of securing the best or optimal decision faces a real challenge:

Any decision can undoubtedly be improved through changing the configuration of means (reshaping feasible sets of alternatives) while it clearly cannot be improved through computing over an *a priori* given and fixed set of alternatives. Consequently, *modern decision analysis* should be more about reshaping the means to attain a tradeoffs-free design as closely as possible, rather than struggling with unnecessary tradeoffs brought forth by inadequate design of means.

Decision making is more about the scarce means (and the nature of their scarcity) than about the multiple ends.[3] It is more about the process (and its coordination) and less about its outcome (and its computation). An optimally coordinated and designed process will lead to an optimal outcome – but not vice versa. In fact, the conclusion is even stronger: suboptimal process and poorly designed means *must lead* to inferior outcomes. A badly designed feasible set cannot be saved through mere computation.

Decision making therefore means truly *making it* through reconfiguration and design, not just *taking it* from a pre-configured and fixed set of means. Perhaps *decision design* (or *decision production*) would be more appropriate labels than traditional decision making.

The very notion of *a priori* feasibility is dubious in decision design because the purpose of means reconfiguration is to expand and redefine feasibility, not to accept it axiomatically. Innovation is not about doing the same thing better, but about doing things differently and, more importantly, doing different things. In decision design, it is not the efficiency (computation) but the effectiveness (design) that is of real consequence.

Let us consider, as an example, the traditional *productivity frontier*, comparing the delivered non-price buyer value and the relative cost position, as in Figure 3. The frontier describes the maximum value that a company can deliver at a given cost under the best currently available circumstances. Observe that only companies operating below the productivity frontier are in a tradeoffs-free environment and can improve *both criteria* by moving towards the frontier. Once on the frontier, such companies can only trade off value against cost, by moving laterally along the frontier, back and forth.

As the productivity frontier shifts outwards (due to technological improvements), the companies scramble again for a temporarily tradeoffs-free environment, only to see their 'advantage' quickly dissipated as competitors copy each other and are forced to face the customer-unfriendly tradeoffs again.

The situation in Figure 3 is loaded with old and traditional assumptions. The tradeoffs between value and cost are assumed to exist *a priori*: only because of this assumption, the frontier is drawn. No differentiation of means and goals is present; companies cannot design their own frontiers by engaging in different activities and different ways of carrying them out, etc. This is not how it works in the real world.

In Figure 4, we represent how companies redesign and reengineer their own processes and operations (reallocate their resources), so that the frontier (tradeoffs) is eliminated and the tradeoffs-free environment can be continually expanded and improved upon. The shaded area (the universe of corporate activities) of Figure 4 represents a distinct advantage and improvement over the shaded area of Figure 3. The situation in Figure 4 is a true, long-term strategic advantage, while the situation in Figure 3 requires continuous operational improvements and tradeoffs choices, without ever fully satisfying the customer.

Figure 3 Tradeoffs-based improvements

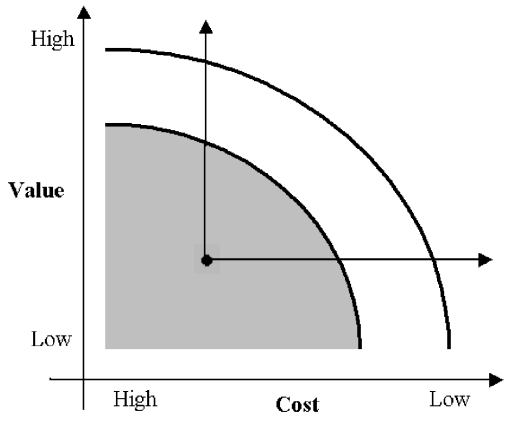
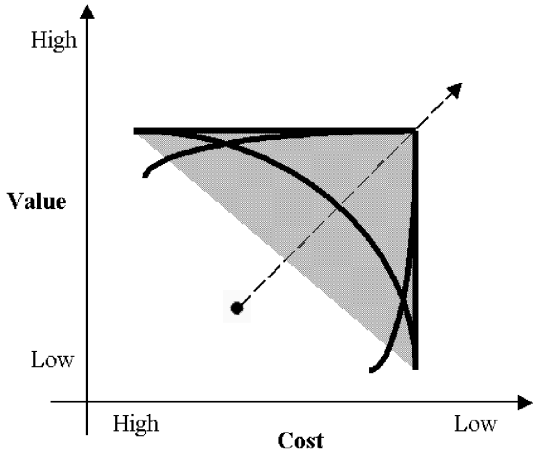


Figure 4 Tradeoffs-free improvements



Not only criteria, but also the very purposes of decision making are clearly multiple. One should identify the best (optimal) solution through balancing multiple criteria. There is no single-criterion decision making as there is nothing to balance and everything collapses into mere measurement and search computations. We have also established that decision making involves not only *a priori* fixed, given alternatives, but its most significant mode appears to be the design of the best (optimal) set of alternatives. If the decision-making process is designed to search and configure the best possible set of alternatives, then mere choice of the best decision is implied and can be explicated by computation.

There are several optimisation rules that have to be respected:

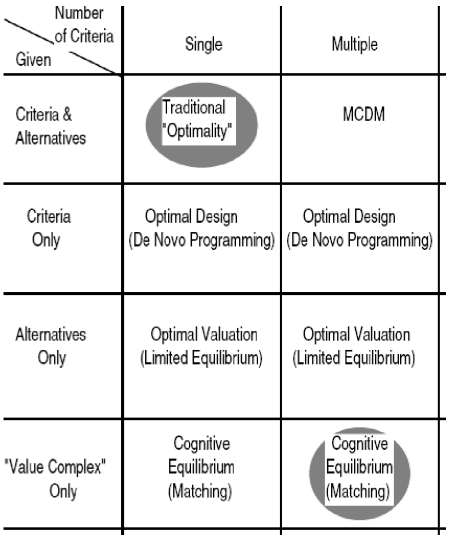
- What is determined or given *a priori* cannot be subject to subsequent optimisation and thus, clearly, does not need to be optimised: *it is given*.
- What is not yet given must be selected, chosen or identified and is therefore, by definition, subject to optimisation.
- Consequently, different optimality concepts can be derived from distinctions between what is given and what is yet to be determined in problem solving, systems design or decision making.

Traditionally, by optimal solution or optimal decision making, we implicitly understood maximising (or minimising) a single, pre-specified objective function (criterion) with respect to a given, fixed set of decision alternatives (situation constraints). Both the criterion and decision alternatives are given, only the (optimal) solution remains to be explicated (computed). A good example would be maximisation of any aggregate function (like multi-attribute utility function and the like) with respect to pre-defined alternatives. That is not decision making but computation.

3.1 The Eight problems of decision making

There are at least eight distinct decision-making problems, all mutually irreducible, all characterised by different applications, interpretations and mathematical/computational formalisms. They are displayed in Figure 5.

Figure 5 Eight problems of decision making



Observe that we use a simplest classification: single vs. multiple criteria against the extent of the 'given': ranging from 'all-but' to 'none except'. The traditional multi-attribute utility theory, characterised by given alternatives and a single criterion, is displayed as the first cell of the first row. It naturally appears to be the most remote from optimal conditions or circumstances for problem solving as is represented by cognitive equilibrium (optimum) with multiple criteria (last cell of the last row). Current Multiple Criteria Decision Making (MCDM) appears as the second cell of the first row, etc.

Elaborating the eight individual problems of decision making is beyond the subject of this paper. An interested reader can consult relevant works (Zeleny, 2005a, 2005b).

Thus, to answer the question "Are tradeoffs really necessary?" the answer is no: tradeoffs are not necessary. Pursuing and achieving lower cost, higher quality and thus improved flexibility, all at the same time, is not only possible but also clearly desirable and often necessary.

Conventional wisdom recommends dealing with multiple-criteria conflicts via 'tough choices' and a 'careful analysis' of the tradeoffs. Lean manufacturing has apparently eliminated the tradeoffs among productivity, investment and variety. 'Quality and low cost' and 'customisation and low cost' were long assumed to be tradeoffs, but companies are forced to overcome such 'wisdoms'.

Needless to say that standard economics paradigm, the economic literature or multi-attribute utility theories simply demonstrate that trade-off evaluations and decisions are frequently painful and almost always tedious. These sources do not question

their existence or contextual independence. Yet, tradeoffs are properties of badly designed systems and thus can be eliminated by designing better, optimal systems.

3.2 Interactive support for cognitive equilibrium

The decision-making process is a cycle rather than an open input–output chain.

As such, its support requires a number of pattern-searching iterations, interactively homing on the most desirable pattern: a stable pattern, an ideal solution, a tradeoffs-free alternative or a compromise solution.

Interactive MCDM represents a fundamental departure from the traditional approaches of decision analysis. It reinstates the human at the centre of the decision-making process and delegates external mathematical axioms of the prescriptive approach to the sphere of interesting scholastic speculations.

The best prescription of what is to be done comes from mastering that which is being done. The best outcome is bound to emerge from the best process. The opposite is not true: characterising the best outcome does not guarantee anything about the process of reaching it. It could be just luck or serendipity.

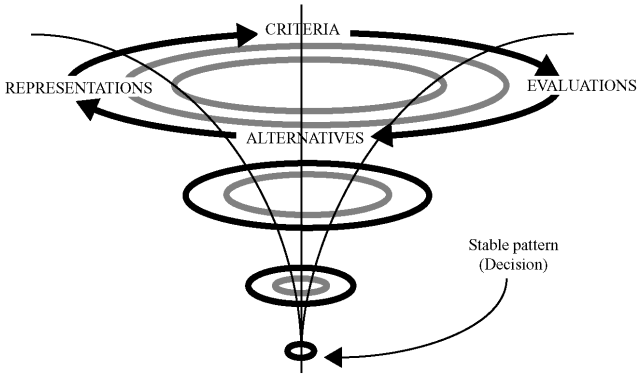
It is clear that humans do not follow the precepts of axiomatic rationality. Humans are fundamentally unconvincing *vis-à-vis* the axioms of rationality, yet their decisions continue to be superior to the recommendations of expected utility maximisation. Human decision making cannot be and is not based on formulas. Formulas simplify, reduce and annihilate information variety. Humans do the opposite: they produce new information and add value through their decision iterations.

All important aspects of the decision-making process – criteria, alternatives, representations and evaluations – remain in a flux of mutual adjustments and co-determination. Nothing is fixed a priori, be it criteria, alternatives or evaluations. The human decision-making process is a complex and circular search for internal consistency and stable patterns through layers of definitions and redefinitions of a problem.

All aspects of decision making are changing and mutually adjusting until a stable configuration or equilibrium among them is reached. The problem is thus *dissolved*, harmony achieved and there remains no other choice but the emerged stable pattern.

In Figure 6, we sketch such a self-producing process of decision making. Observe that all aspects (criteria, alternatives, representations and evaluations) are continually re-examined and readjusted throughout the process.

Figure 6 Recursive search for a cognitive equilibrium (=> decision)



To interact with the decision-maker for the purpose of forcing the use of a priori fixed formulas or patterns is fundamentally different from guiding the decision maker through the creative search process of Figure 5. Decision making is a process of successively redefining the problem.

What are the characteristics of the emergent conflict-free or tradeoffs-free, stable configuration?

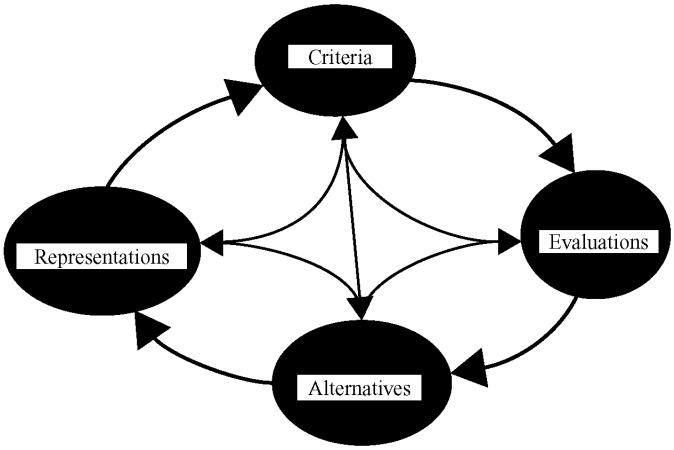
Decision production should be recognised as an emergent 'harmonious' pattern or equilibrium, properly balancing all decisional components. Conventional wisdom of so-called 'rationality' is not correct. Human decision-making and the problem-solving process is determined by the way neural networks are structured as a whole: as a spontaneously wired and re-wired self-organising 'free market' of repeatedly propagated patterns of formulation, re-formulation of re-formulation and so on and so forth.

Humans do not maximise functions, but search for recognisable patterns.

Decision-making is not about maximising some components subject to given levels of some other components, but about relatively stable patterns of harmony and equilibriums among all components. Most if not all thinking and judgement can be related to pattern recognition. Human thinking is not to be modelled by logical rules and calculations, but through application (or even matching) of 'habits of the mind' (patterns) prompted by specific contexts.

Humans create or construct both information and decisions. All important aspects of decision making: criteria, alternatives, representations and evaluations are maintained in a constructive flux of mutual adjustment and interdependent co-determination. Nothing is to be fixed a priori. Figure 7 shows a scheme of a minimal decision production network of components and their interconnections.

Figure 7 The decision-producing network



The human decision-making process is a complex, organisationally closed search for internal consistency, passing through interrelated layers of definitions and redefinitions of the problem. A problem has been fully formulated only *after* it has been solved. All aspects of decision-making are ever-changing and mutually adjusting until a relatively stable pattern or cognitive equilibrium among them has been reached. The problem is then temporarily dissolved, the harmony achieved and recognised;

there remains no other 'choice' possibility than that of the accepted pattern (ideal solution, dominant option, prominent alternative).

The concept of conflict dissolution provides the necessary operationalisation of the decision-making process.

3.3 Conflict dissolution

Conflict occurs when two or more distinct alternatives, selected as the means for achieving stated objectives, are mutually exclusive.

With respect to this definition, we can identify the following necessary conditions of a potential conflict:

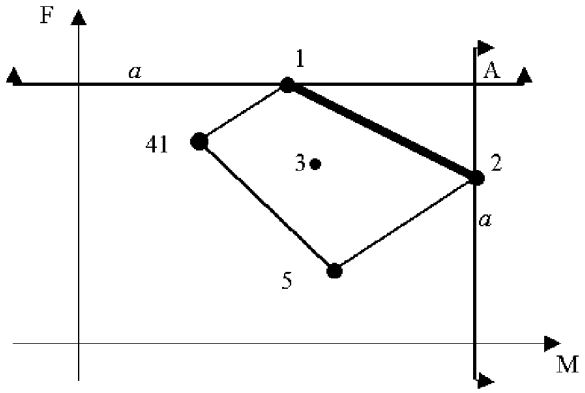
- One or more decision agents, i.e., organisms or machines capable of making a choice: human decision-makers or judges.
- Two or more available alternatives of choice, including a 'no choice' alternative, or 'no preference' vote.
- One or more objectives or criteria of choice, used to evaluate the decision agents' choices.

Next, we show that conflict can be characterised as being induced by the mutual exclusivity of distinct alternatives selected by decision agents. We shall argue for a concise and general definition of conflict: *Conflict is the absence of a prominent alternative*.

This prominent alternative is a *tradeoffs-free solution* (or as close as to tradeoffs-free as possible).

Let us graphically represent a generic conflict of two decision agents with a joint single objective *a*, as in Figure 8.

Figure 8 Conflict dissolution at point A



We can similarly formulate the problem for one decision-maker and two criteria (*a* and *b*), and so on.

Observe that M and F (like Male and Female) maximise criterion *a* at 2 and 1, respectively. Even though they have a common objective and there are no cognitive differences, no mistakes or insufficient communication, *there is a conflict*. The prominent

alternative A is either non-existent or it has not been considered by either M or F. It is the absence of A which causes the conflict to emerge. Note: should A become feasible, the conflict would be *fully dissolved*.

The heavily traced boundary of X represents a region of compromise, a *bargaining set*. Observe that no *compromise solution*, including both extremes 1 and 2, removes or resolves the underlying conflict. Conflict resolution via compromise is only a temporary disguise of the absence of A. At any compromise located on the heavy boundary of X, there is at least one decision agent (or at least one objective), which remains unsatisfied in relation to what is actually achievable.

Even if M 'persuades' F to go along and accept alternative 2, and even if F is genuinely convinced that such a negotiated outcome is the best for both, M and F, the conflict has not been dissolved. Sooner or later, the suppressed perceptions and value judgements will claim their toll, a conflict will re-emerge, hasty agreements will not be honoured, and deceit and treason will appear.

The methodology of the so-called '*conflict resolution*' clearly does not remove conflict; it might not even reduce conflict. It is a temporary disguise of a lack of innovation and creativity needed for inventing, discovering or considering a prominent alternative A.

The only way to dissolve conflict is to consider, find or create A. The only way to reduce the intensity of conflict is to generate alternatives that are 'closer' to A.

Negotiators, persuaders, diplomats, and bargaining experts are devoting most of their efforts to inducing a 'cognitive change' in the adversary party, to make them see it from 'our point of view'. But the true sources of conflict are left untouched.

Human objectives, values, perceptions, cognitive differences, etc., are the result of very complex evolutionary processes. Interactions of hereditary, cultural, environmental, and educational experiences, as well as a unique and non-reproducible history of evolution of an individual, group, nation or society – all such deeply ingrained characteristics are surely not reversible in a matter of days or weeks, changeable and adjustable from conflict to conflict. Is the art of compromise simply a skill of persuasion? The art of *true compromise* is the art of finding or creating a prominent, conflict-free (i.e., tradeoffs-free) alternative.

Since genuine conflict resolution is impossible and conflict dissolution is a lengthy process of invention, innovation, and discovery, one can attempt *conflict reduction*, i.e., reducing the distance between A and a compromise solution. Such partial reduction of conflict intensity can be termed *conflict management*. We emphasise that no traditional compromise resolution actually removes the conflict. The only way to dissolve a conflict is through the establishment of A.

The concept of a prominent alternative is not entirely new. What is new is the recognition that its absence constitutes the source of conflicts. Observe that alternative A represents a point at which multiple objectives are maximised: an overall optimum, an unattainable ideal. That does not mean that it does not serve as a norm or a rationale of human decision making. If we cannot achieve A, we should at least attempt to move as close as possible to it. The unattainability of an ideal should not serve as an excuse for trying to achieve the attainable only. Ignoring the ideal and settling down to what is 'good enough' does not remove the conflict and it is incompatible with good management.

Identification of new and prominent alternatives along with their subsequent embodiment in a decision-making situation – that is a skill, knowledge or expertise.

That is why *decision making is neither art nor science*, but a knowledge. Knowledge and KM are crucial for decision making and conflict dissolution.

4 Information and knowledge

By three methods we may learn wisdom:
First, by reflection, which is noblest; second, by imitation, which is easiest;
and third by experience, which is the bitterest.
Confucius

Let us draw a short distinction between information and knowledge.

The fundamental difference between the two must be drawn sharply so that we do not confuse decision making and KM with information-processing technology. Information is always an input (like any other low-value resource) while knowledge refers to the coordination of value-adding and information-transforming process, like decision making. More detailed expositions of this distinction can be found in Zeleny (2005b, 2006a).

First, there is a growing *information overload*, but there can never be a *knowledge overload*. The two concepts are very different, as the inputs and outputs are very different from a production process.

Knowledge is a purposeful coordination of action. Achieving its purpose is also the sole proof or demonstration. Its quality can be judged from the value of the attainment (its product) or from the quality of the coordination (its process). Coordinated action is the test of possessing knowledge. *All doing is knowing, and all knowing is doing*.

Repeated action leads to accumulated experience and thus to enhanced understanding of the process and better knowledge. So, the already *demonstrated ability* to act effectively towards purpose has value as it represents an active knowledge potential in new contexts.

Whenever we act – make decisions, pass judgements, reorder priorities – we create a world of action, for us and for the others.

Every act of knowing brings forth a world. *Bringing forth a world of coordinated action is human knowledge*. Bringing forth a world manifests itself in all our action and all our being. Knowing is *effective* (i.e., coordinated and 'successful') *action*.

When we concentrate on the inputs and outputs of the decision process, then we input and output information and information is all that is needed. But decision making is a process leading to real action and therefore is dependent on knowledge and not just information.

Information is a symbolic description of action. Or, in Dawson's (2005) version: *Information is anything that can be digitised*. True. Information acquires value only if it leads to action (is transformed into knowledge), which in itself is valuable only in terms of its purposes and outcomes.

Such a clear distinction is needed to avoid ambiguity and fuzziness in traditional KM pursuits. Let us heed A. Einstein's warning: *Information is not knowledge*. In fact, a new taxonomy of knowledge (Table 1) is needed:

While information allows us to do things right (efficiency), knowledge aspires to do the right things (effectiveness). Doing the right thing, especially in business, requires

not only knowing how, but also knowing why. *Explicability* of purpose is an essential ingredient of its effectiveness in attainment. *Wisdom is about explicability and ethics* of our doing.

Table 1 DIKWE chain or taxonomy of knowledge

	Technology	*Analogy* (*Baking Bread*)	*Effect*	*Purpose* (*Metaphor*)
Data	EDP	Elements: H_2O, yeast, bacteria, starch molecules	Muddling through	Know-Nothing
Information	MIS	Ingredients: flour, water, sugar, spices + recipe	Efficiency	Know-That
Knowledge	DSS, ES, AI	Coordination of the baking process → result, product	Effectiveness	Know-How
Wisdom	WS, MSS	Why bread? Why this way?	Explicability	Know-Why
Enlightenment	Personal BSC	This bread, for sure	Truth, insight	Know-Yourself

Another way of activating the distinction is: *It does not matter what they* (customers, consumers) *say, the only thing that matters is what they do*. It was Ryle (1949) who taught us that the capacity to act is more fundamental than propositional knowledge: *Knowing how* (knowledge) *is more fundamental than knowing that* (information). These are entirely different kinds of 'knowledge' (knowledge and information), and those who confuse them make a categorical mistake.

To know-that is to know *facts*. But, the term know-how is related to the knowledge of *how to do* things, i.e., *skills*, *knowledge* and *expertise*. For example, developing new software requires know-how. We have to *know* (i.e., act upon) *the rules* of programming, as well as necessary inputs and desired outputs, which are all instances of know-that, i.e., information.

This distinction between information and knowledge is at the very foundation of human enquiry. Already Aristotle, in his *Nicomachean Ethics*, distinguished between *epistêmê (*knowing-what or that) and *technê* (knowing-how). Only *technê* can get married with *praxis* (doing).

It is therefore more than remarkable that certain strains of KM have conflated information with knowledge (tacit and explicit). All knowledge is tacit, all information is explicit.

Many informed people know what to do, quite a few knowledgeable experts know how to do it, but only a few *wise persons* know why it should (or should not) be done. There can be no *knowledge overload*. To paraphrase Thoreau: *To know that we know what we know, and that we do not know what we do not know, that is true knowledge*. And 'true knowledge' leads to wisdom.

4.1 What is the Knowledge-Information cycle?

To pursue action effectively, we have to integrate knowledge and information flows into a *unified system of transformations*. It is insufficient, although necessary, to manage, manipulate, mine and make do only with data and information. *The purpose of knowledge is more (and better) knowledge, not more information.* Information is only a symbolic intermediary between the two phases.

Useful knowledge can be *externalised* and codified into its recordings or descriptions. Thus, the obtained information is *combined* and adjusted to yield more useful, actionable information. Actionable information is *internalised* as input into effective coordination of action (knowledge). Effective knowledge is then socialised and shared, i.e., transformed into usefully distributed knowledge. In short, the cycle (knowledge → information → knowledge) can be broken into its constituent transformations:

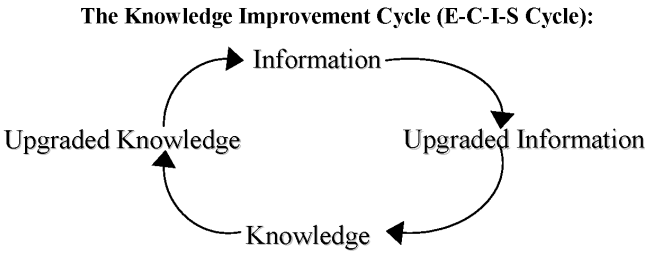
- *Externalisation*: knowledge → information
- *Combination*: information → information
- *Internalisation*: information → knowledge
- *Socialisation*: knowledge → knowledge.

These useful labels are due to Nonaka (1991) who explores the transitions of 'knowledge' as tacit to explicit => Externalisation; explicit to explicit => Combination; explicit to tacit => Internalisation; and tacit to tacit => Socialisation. But they are not separate dimensions and should not be separately treated. In fact, *there is no explicit knowledge, only information*. Let us not forget Polanyi's dictum: *All knowledge is tacit*.

The above sequence E-C-I-S of knowledge and information flows is repeated in a circular organisation of *knowledge production*, see Figure 9:

Figure 9 The Knowledge-Information cycle

Knowledge*(K*)	→ Information (I)	(Externalisation)
Information (I)	→ Information* (I*)	(Combination)
Information*(I*)	→ Knowledge (K)	(Internalisation)
Knowledge (K)	→ Knowledge* (K*)	(Socialisation)



It is clear that the *internalisation* of information into the process of knowledge production is the key. That is, the process I → K → K* → I* adds value to information through knowledge socialisation (sharing, observing, imitating, repeating), while K → I → I* → K* adds value to knowledge through information combination (analysis, research, data mining, integration, synthesis, interpretation).

We can summarise some additional conclusions about knowledge:

Knowledge is real and tangible. Knowledge, wisdom, and ethics are measurable. The relationship between knowledge and value creation is tangible: knowledge, wisdom and ethics must add value (Data and information are mere inputs into the value-adding processes). This added value can also be interpreted as the value of knowledge.

5 Added value

Decision making is a process and its coordination of action stages or phases, as well as their sequencing and structural configuration, is a matter of knowledge and skills. It is this *knowledge* (purposeful coordination of action) that adds value to the decisional inputs. Among all these inputs, *information* is dominant. While knowledge is the demonstrated capacity to coordinate action, information is just a description, a digitisable record of past, present and future actions. As such, information per se is of very little value (often accessible for free) or usefulness: it attains value only through being internalised in the decision-making process and transformed into knowledge, i.e., only through action and the value of its outcome (Dawson, 2005).

All this is rather straightforward, as 'uninternalised' information becomes a commodity at best, and just background clutter, noise and overload at worst. Information is being transformed, at an alarming rate, into some sort of *exformation*, or informational waste. The only value any uninternalised information can attain is through imposed monopoly, limited access or attention enhancement. While information (and exformation) becomes overwhelming, human attention span becomes a scarce resource.

If the information (or knowledge) does not add value to decision-making (its use benefits are lower than the cost of obtaining or internalising it, its value is not zero, but negative) or if it even subtracts existing value from the user, then it should not even be collected.

However, because there can never be any 'knowledge overload', the only effective and safe way to improve decision making is through knowledge, i.e., through a purposeful coordination of the decision-making process.

5.1 What is added value?

Knowledge is measured by the value coordination of effort. Action and process adds to materials, technology, energy, services, information, time and other inputs used or consumed in the process. Knowledge is measured by added value.

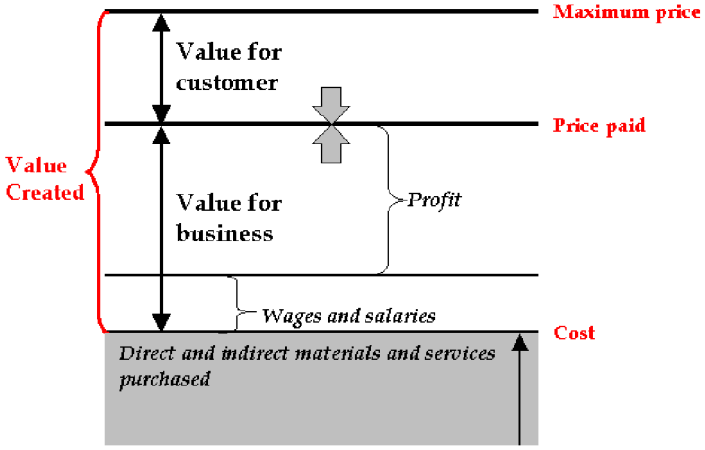
In any business (and human) transaction, value has to be added to both participants (or sides): the provider and the customer. Adding value is what makes the transaction satisfactory and sustainable.

There are two kinds of values to be created: value for the business and value for the customer. Both parties must benefit: the business – to make it; the customer – to buy it. In the global age, it is precisely this business–customer value competition that is emerging as the hardest and the busiest battleground.

In Figure 10, we attempt to explain the process of creating new value. This is crucial for the identification and assessment of innovation.

First, the customer pays for the service or product: the price paid. The producer subtracts the cost incurred, including all direct and indirect materials and services purchased. The difference is the added value for the business. This added value can also be interpreted as the value of knowledge engaged in producing the service or product. To pay wages and salaries, the production process and its coordination must generate this added value. Added value is the only source of corporate wages, salaries and profits.

Figure 10 Adding value for the customer and business



If the added value does not cover the wages and salaries, then these must be correspondingly lowered. If no value has been added, then the value of knowledge is zero and no payment can be attributed to it. The business must add enough value to cover at least its workers and managers, their salaries and wages. If even more value has been created, then profits can be realised, up to the price received.

The customer, of course, must be willing and ready to pay more for the service/product than he actually paid. The maximum price the customer would be willing to pay must exceed the price the producer has asked for. The difference is the added value for the customer.

If there is no value for the customer – the maximum price is lower than the price to be paid – then the customer would not buy the service or product. In a competitive market, the customer pays money only for the value received, i.e., the value for the customer.

6 Towards an integrated model of DIKWE cycle

Thoughts lead on to purposes; purposes go forth in action;
actions form habits; habits decide character; and character fixes our destiny.
Tyron Edwards

The DIKWE value chain of [data → information → knowledge → wisdom → enlightenment] is not really a chain (from inputs to outputs), and certainly not a hierarchy, but a cycle. We can use X[DIKWE] as a short notation for expressing the cyclical nature of most 'chains' and processes, including the decision-making process.

So far, in both MCDM and KM, rather than integration, the specialised, isolated pursuit of component functions has dominated. Yet, X [DIKWE] represents an ever ascending, integrated whole, balancing symbolic descriptions, actions and value explications towards emerging synergies. The synergic effect of X [DIKWE] integration is worthy of pursuit and more in harmony with natural world, biological systems and ancient philosophical wisdoms than prevailing tendencies towards specialisation, atomisation and decomposition.

A new strategy of systems integration is needed. A *strategy of re-integration* of what should not have been separated and pursued in a specialised way in the first place: namely Data (D), Information (I), Knowledge (K), Wisdom (W) and Enlightenment (E). These are all inputs or resources into successful business action and decision-making process. All such inputs into a value-adding process must *work together*, in an integrated fashion, to effectively bring to fruition their dependencies and synergy potentials.

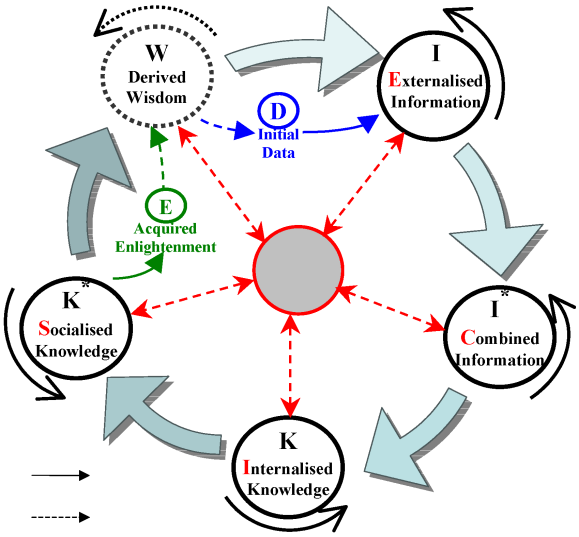
Separate, non-interacting or only loosely connected pursuits of vital business functions and components lead to wasteful competition for resources and unbalanced development of component functions.

In Figure 11, we sketch the basic outlines of the *Integrated Management Support System* (IMSS), based on X[DIKWE] and provide a new base for *decision support systems*. Modern business management needs support from an integrated system, not from separate and increasingly isolated parts.

For example, database management and data mining make hidden information explicit and store it in data warehouses: this is only a small part of the whole. It should not be pursued *per se*, disconnected from the rest of the enterprise. Information has to be combined and internalised into knowledge. Knowledge has to be socialised and shared. From the experience of actions taken, new information can be externalised and processed as input into the next cycle.

Can any of the activities of Figure 11 stand alone, isolated and separate, and still be useful to the enterprise? Although it is difficult to imagine, it often happens.

Figure 11 Integrated X[DIKWE] coordination system



The cycle continues. The newly produced knowledge is circulated and its purposes explicated into wisdom: knowing why to do or not to do something. Wisdom is derived from experiencing repeated action. New initiatives can be justified and initial data collected at a start of a new or parallel cycle. D is a semi-autonomous point of entry, an input from environmental scanning. Finally, after requisite iterations of cycling experiences, enlightenment can be acquired to strengthen self-confidence in the wisdom acquired and in the pursuit of new ventures. That should not be carried out as separate

activities of disconnected teams of experts. E is a semi-autonomous point of exit, an output into individual (and corporate) self-understanding.

Circular knowledge and information flows are stimulated, coordinated, maintained and removed by the *catalytic function* of the *Coordination Hub* (C-Hub). The C-Hub functions are performed under the supervision of IMSS Coordinator who is responsible for maintaining all necessary transformations of the E-C-I-S cycle.

What is the purpose of IMSS? Why does it have to function as an integrated whole? Because it *supports* the most important functions and challenges of business enterprise: *Innovation* cycle, *Process* management, *Decision-making* process, *Customer* satisfaction and *Capital* appreciation. These functions cannot be pursued separately because they are fundamentally interdependent and influencing one another.

Clearly, *data mining* does not stand alone but must be directed towards better *information processing*. Information and knowledge are interconnected through mutual externalisation and internalisation in a self-reinforcing cycle of *KM*: production, maintenance and degradation of knowledge. *Wisdom systems*, as explication of corporate values and experience, provide justification and ethical anchoring for human action. Finally, *enlightenment* directs our efforts towards human life and its purpose in social action in civilised society; not just towards technology, science and economics. In the end, it is how we live, not just how we work, produce and consume, that is the ultimate value of *enlightened business – and enlightened life*.

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Notes

[1]This is reinforced in Bennis and Tichy (2007). Others might call such calls as shooting from the hips or shooting off one's mouth.

[2]Aggregating multiple criteria (or attributes) into a single super-function (like utility function) forms a single aggregate criterion and therefore does not pertain to decision-making as no tradeoffs along the same function (regardless of its complexity) are possible.

[3]Even single ends can be improved through the reconfiguration of means, although no decision making is ever needed in single-end 'decision making' because there are no tradeoffs. Mere computation (measurement and search) is necessary and sufficient.

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