



Decision Support

Foundation of Nomology

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ABSTRACT

This article describes a foundation for modelling generic cognitive structures, under the heading nomology, sometimes known as the “science of the processes of the mind”. It proposes some principles and axioms that are consistent with the evidence in management systems used in business practice. It then reviews previous research about nomology in philosophy, science and the humanities. It shows that the main issue preventing the completion of the foundation of nomology has been the lack of an explanation of the relationship between the objective “nom” part as in economics and the subjective “ology” part as in psychology. It resolves this problem by showing that there are four main objective activities: proposition, perception, pull and push, and for subjective decisions the pull activity becomes redundant. It then describes tests in China and Chinese culture to validate that the results are truly generic. It proposes that nomology will be useful in providing a rigorous foundation for criteria structures in multi-criteria decision-making, and beyond into wider fields, especially those that combine subjective and objective aspects such as in conflict, inter-cultural and inter-disciplinary studies, ethics, and group decision-making.

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1. The challenge: to build a model of cognitive structures

The context of this article is operations research (OR), which is founded in science more than humanities, and relies on quantitative approaches more than qualitative. Recently OR has developed the important field of Multi-Criteria Decision-Making (MCDM) to enable it to deal with more general management problems where decision-makers have qualitatively different criteria. The OR approach is to build a model that reflects the essence of a problem, fit it to a context, and then apply it to a particular situation. The lack of an agreed set of rules governing the formation of cognitive structures has affected MCDM since 1980 when Von Winterfeldt (1980) wrote: “Structuring decision problems into a formal and manageable format is probably the most important step in decision analysis. Since presently no sound methodology for structuring exists, this step is still an art left to the intuition and craftsmanship of the individual analyst”. One approach is to try to convert multiple goals into a single value function. This article considers the alternative, to build a robust model of the cognitive structures that could be used for MCDM.

It asks do people share a unique set of cognitive structures across cultures and management fields. It examines a cross-section of management systems to discover if the cognitive structures that are used in practice can be explained by a set of simple decision rules. It next reviews similar previous research,

mainly under the title ‘nomology’, a ‘branch of science and philosophy concerned with the laws or principles governing the operation of the mind, especially as defined by custom or culture’ (Oxford, 2013). It considers the unresolved challenges to nomology: the relationships between dyadic and triadic systems, and between subjective and objective decisions. It develops additional rules to resolve these issues. It then considers the implications of the findings for inter-cultural research, and describes tests in collaboration with Chinese research scholars that validate the results.

2. Evidence of cognitive structures in management practice

This study begins by considering what are described as ‘regularities’ in practice, distinctions that people make between different aspects, criteria, goals, or constructs that might be involved in a decision. The following widely used examples have a common structure.

- (a) Hofstede analysed the HERMES cross-cultural surveys in 1968 and 1972 from over 116,000 questionnaires filled by IBM employees in 40 countries, and concluded that cultures can be categorised using four variables: Uncertainty Avoidance, Individualism, Power Distance and Masculinity (Hofstede, 1980).

- (b) Tuckman's forming, storming, norming and performing (Tuckman, 1965) is about group dynamics: forming the group, (brain-) storming, norming by giving and receiving feedback, and performing as a group to achieve a common goal.
- (c) DMR Consulting developed the Macroscope Methodology, which is used by Fujitsu for IT Strategy and project management: Are we doing the right things? Are we doing them the right way? Are we getting them done? Are we getting the benefits? Thorp (2007) (pp. 30/31).
- (d) Walter Shewhart developed the Shewhart Cycle in the 1930s for work in statistical process control in Bell Laboratories. W. Edwards Deming extended its use to more general quality control and management in the 1950s and it became known as the Deming Wheel. The Shewhart/Deming phases: plan, do, check and act (Shewhart, 1931): are used very extensively in quality management.
- (e) Holton's enabling elements, outcomes, motivational elements, and environmental elements (Holton, 1996) are used for evaluating training in organisations within human resource development.
- (f) Commitment, planning, action and evaluation are four phases that emerged from extensive research with members of Investors in People UK (IiP), a United Kingdom state-supported organisation that supports a national standard approach to improving training (Investors, 1996).
- (g) Innovation and learning, internal business, customer and financial are four phases of the Balanced Scorecard that was introduced so that accountants could evaluate all aspects of their business, not just the financial (Kaplan & Norton, 1992).
- (h) Fit, split, contend and transcend are four factors that drive stagnation and renewal in organisations (R. Pascale, 1990).
- (i) Kolb's learning cycle is described as a spiral of four processes that must be present for learning to occur: concrete experience, observation and reflection, concept formation, and testing implications in new situations (Kolb, 1984).
- (j) Functional automation, cross-functional integration, process automation and process transformation are four stages in the progressive adoption of technology (Woolfe, 1993).
- (k) Prediction Action Modelling (PAM), which was developed by Toomer working with Bowen (Brugha & Bowen, 2005), describes how to learn about people's world views to develop appropriate methods of control, and then suitable rules, leading to the management of people.

These systems show a similarity of structure despite their emergence out of practice and surveys of behaviour over a wide range of unconnected areas of business and culture. The extent of usage of these systems, and that there are many more like them, raises some questions. Could the similarity in their pattern be random, or is there intelligence behind it? How is it that groups of people from different management fields, and different languages, seem to be able to communicate with one another, to translate their constructs into the others' language? It suggests the existence of an underlying structure driving the formation of these constructs. What might this structure be? All of these have four aspects, with the first two more uncertain, such as doing some form of planning. To build a formal system will require names for all the important constructs, and will lead to introducing 'putting' as a word to describe 'what one does when one is not planning'.

The stability of this structure also suggests that there are more personal and universal examples such as body, mind, soul and spirit; fear, anxiety, guilt and resentment; and faith, hope,

Table 1
Cases that illustrate the four general adjusting activities.

What	Where	(a) Hofstede	(b) Tuckman	(c) Fujitsu	(d) Shewhart/Deming	(e) Holton	(f) Investors in People UK	(g) Kaplan and Norton	(h) Pascale	(i) Kolb's learning cycle	(j) Woolfe	(k) Prediction Action Modelling	Location	Feelings	Responses
Planning	Proposition	Uncertainty Avoidance	Forming	Are we doing the right things?	Plan	Enabling Elements	Commitment	Innovation and Learning	Fit	Concrete Experience	Functional Automation	Control	Body	Fear	Faith
	Perception	Individualism	Storming	Are we doing them the right way?	Do	Outcomes	Planning	Internal Business	Split	Observation and Reflection	Cross-Functional Integration	World Views	Mind	Anxiety	Hope
Putting	Pull	Power distance	Norming	Are we getting them done?	Check	Motivational Elements	Action	Customer	Contend	Concept Formation	Process Automation	Management of People	Soul	Guilt	Righteousness
	Push	Masculinity	Performing	Are we getting the benefits?	Act	Environmental Elements	Evaluation	Financial	Transcend	Testing Implications in New Situations	Process Transformation	Rules	Spirit	Resentment	Love

righteousness and love (Brugha, 1998a). Table 1 summarises these examples.

3. Foundational rules for nomology

The apparent evidence of underlying structure raises some broader questions that lead to some principles. Surely the processes that help to form constructs must be simple? This must follow because of the commonality in the ways that people think and structure the language that they use. Otherwise, how could people from different cultures, languages, disciplines and regions communicate at all? The idea that cognitive structures might be random and invented afresh every time people try to find coherence in their practice would seem absurd. It seems reasonable to accept a general principle about simplicity.

Principle 1 (Simplicity). Decision making processes, in general, are invariant and more likely to be simple than complex (Brugha, 1998a).

This is the first result, and will be followed by other principles and axioms, all of which start as assertions that are open to challenge. And any test should focus on trying to prove them false. The simplicity principle implies a natural flow from decision processes into language. One expects to see a natural language, or natural linguistic conventions for similar or related words. An example is the physical, political, social, cultural, emotional levels of activity in society, which will be described later. It is clear that, over a long time, people are induced to name similar things similarly.

Principle 2 (Natural language). In any culture, there should be a natural language that incorporates the concepts of a nomological system (i.e. based on the science of the laws of the mind) (Brugha, 1998a).

Practice with the systems that illustrate a four phase structure, such as in Table 1, shows that all of the phases appear to be equally important. They are inherently balanced. In fact, balance seems to be a key component in such systems. One can only conclude that such systems are more likely to have come from a combination of two systems each with an either-or alternative, which seeks its own balance. How do people form and use such two-by-two systems? Years of experience with such systems seems to suggest that people appear to ask questions in order to break problems down. Such a conclusion is much more specific than Principles 1 and 2. It follows that there should be at least two levels of rules. The following should be called an axiom because it is less general than the principles above, and yet it has a similar sense of universality. Likewise it is not as much provable as observed to be a known or accepted truth.

Axiom 1 (Simple questions). When people have a complex and not obviously structured decision-making problem that cannot be solved using standard quantitative techniques they try to analyse it by breaking it down into dimensions with which they are familiar by means of asking simple questions (Brugha, 1998a).

This seems reasonable even though more complex systems will emerge later. Some generative process must have led to the systems in Table 1. Not only does it appear that people tend to ask simple questions, but the evidence suggest that people use dichotomies to structure the answers to these questions. One induces that this is a natural activity that applies generically to systems.

Axiom 2 (Dichotomies). The natural way that problem-solvers structure their answers to such questions is in terms of dichotomies, i.e. questions with either/or answers (Brugha, 1998a).

Consider now the nature of these questions. One expects in general people to be induced to ask such questions in a similar

way, because the mind has its own internal mechanism to make judgements between certain kinds of alternatives. So one should be able to deduce what are the questions that applied in Table 1. One should also be able to induce what one might naturally expect should be the first of these questions. Combining both would suggest that people first want to know “what” is happening. Whenever one comes to such a conclusion, the idea is that it is at first tentative, and is open to being reflected on, and only becomes settled after a lot of consideration.

When considering this “what” question, one should also seek the names for the alternative answers. From the natural language principle it follows that there should be natural words for many of the constructs that will arise here, and later in the construction of nomological systems. One expects that the alternative answers should relate specifically to the different sides of the dichotomies in question. The first “what” question relates to the uncertainty in the problem.

Axiom 3 (What). The first dichotomy to be considered relates to the question what should be done. If one is relatively unclear about what should be done then one will focus on a *planning*¹ aspect. If, on balance, one feels relatively clear about the direction that should be taken one will focus on a *putting* aspect (Brugha, 1998a).

This naming process uncovers an anomaly in decision practice. People have a tendency to say they are *planning* or they are not. So they rarely use the complementary word, such as *putting*. The structural formality that nomology brings should induce us to use all such complementary words. Consequently one of the first results of nomology is to provide a device to scrutinise the language people use, and bring more discipline to it.

One is induced to see this idea of balance as very important, that it applies to language, and to the activities in Table 1, that no one activity is more important than any other. Taking this further, one knows from management that balance is important, that it is poor practice to have company executives constantly *planning*, and never getting anything done. One can deduce that this should apply to all the categories in Table 1. One should give attention to one of the areas only so as to resolve a problem that is causing the imbalance there, and to prevent staying there out of habit, laziness or because one enjoys that activity. Bringing out-of-balance systems back into balance must be a natural process in all decision-making.

Axiom 4 (Balance). Every system involving qualitative decision-making will have an inbuilt tendency to try to find a balance between all the relevant dichotomies. (Brugha, 1998a).

Looking at the evidence in Table 1 one can deduce the presence of a second dichotomy. The middle two columns relate more to the people who are involved. This leads to another axiom.

Axiom 5 (Where). The second dichotomy relates to the question where it should be done. Should one be doing something in a particular *place*, for instance in some part of the company or organisation, such as spending some money on a project or restructuring an institution? Or should one be focusing more on the *people* involved, agreeing what should be done or motivating the participants? (Brugha, 1998a).

As with *putting*, this gives the name *place* to any kinds of things that are not to do with *people*. How can one be so sure about mak-

¹ Throughout this article italics are used for words that have been defined explicitly to explain concepts in nomology. Quotation marks are used to indicate they refer specifically to their meaning in a nomological context. Words newly defined in this article are put in bold. A capital first letter is occasionally used for names of constructs where it needs to be emphasised that they come from other nomological systems.

ing the shape of this second dichotomy an axiom? One is induced to accept it because there should be generic cognitive structures shaping the formation of the cases in Table 1. Also one can deduce it from the empirical evidence of these and hundreds of other similar cases that are used every day in business without suggestion that there should be three or five constructs in the set. The fact that there are other systems with different structures does not negate the argument that some inherent generative processes must have driven the formation of the systems in Table 1. Other axioms follow in the same way, as do corresponding words.

Axiom 6 (Independence). Because the key questions asked are independent of each other so the answers should find their own balance independently of the others (Brugha, 1998a).

Some of the axioms should stand to reason, as is the case with this. It must be possible to combine the *what* and *where* questions together for particular relevant purposes. This does not mean that there is a direct connection between them. The same applies to the combinations they produce. One can assert that the *planning/putting* and *people/place* dichotomies are natural generic structures. Consequently one should expect them to form combinations that are so natural that they will be well known, because of their wide use in practice, that they will already have names, and that these names will be a good general fit for the four categories in Table 1.

Axiom 7 (Activities). The activities based on combinations of dichotomies of different dimensions have meaning and importance in the practice of decision-making. A *planning* activity within *place* is described as a *proposition*. *Planning* amongst *people* corresponds to developing a *perception*. *Putting* a solution into effect amongst *people* is a *pull* activity. And *push* describes the activity of *putting* the remaining aspects of the solution into *place* (Brugha, 1998a).

This raises an issue about our understanding of language and terminology. The determination that one is at some point more doing *planning* than *putting* is a matter of balance, like a see-saw, or *yin/yang* in eastern culture. The imbalance that needs correction could be very slight as in 51/49 or very prominent as in 90/10. This makes it inappropriate in nomology to rely strictly on dictionary definitions, because dictionaries describe words as discrete entities. This leads to the interpretation that *planning* and *putting* are an entity, that are defined in relation to each other, and being in one more than in the other is a matter of degree or balance. Also, names are now seen to be labels that are associated with constructs, which emerge from structures. Because of their frequency of usage, one expects there will generally be natural words for the most commonly used constructs (Principle 2). However, one need not expect that all such words will be natural or generic. Some of those that were invented for limited business purposes, as in Table 1, and need to make sense only to the communities that use them. However, one can conclude that the examples in Table 1 follow a ‘nomological system’, i.e. have definite patterns and appear to follow specific rules.

One comes now to decision processes: activities that are carried out using a particular order. Just as naming rules are not applied rigidly, neither are the rules about the order for doing them restrictive or narrow. One could be drawn toward a solution, or one could be driven to solve a problem. But some norms appear to be followed first. There is a natural sequence that involves *proposing* things, developing *perceptions* about them, getting *people* to *pull* together to *put* them into effect, and finally to *push* for their completion.

Axiom 8 (Sequence). *Planning* starts first in *place* and then moves to *people*; *putting* starts amongst the *people* and then moves back into *place* (Brugha, 1998a).

What was worked out above was a coherent response that was consistent with the evidence in Table 1. Presenting it in a tree form in Fig. 1 brings out the origin of the four phase structure. When shown as a wheel or map in Fig. 2 one sees that constructs are labels on a map, not discrete entities. Also processes connect the constructs within the cognitive structures; like the sequence in *proposition, perception, pull* and *push*. An analogy is bones, flesh and skin. The bones are the structures. The skin is like the constructs: the interface to the outside. And the flesh corresponds to the processes, mediating the intended purposes. For example, PAM starts with *perception* and goes in an anti-clockwise direction to form a set of rules. The next section considers the parallels between PAM and the process of developing rules in nomology.

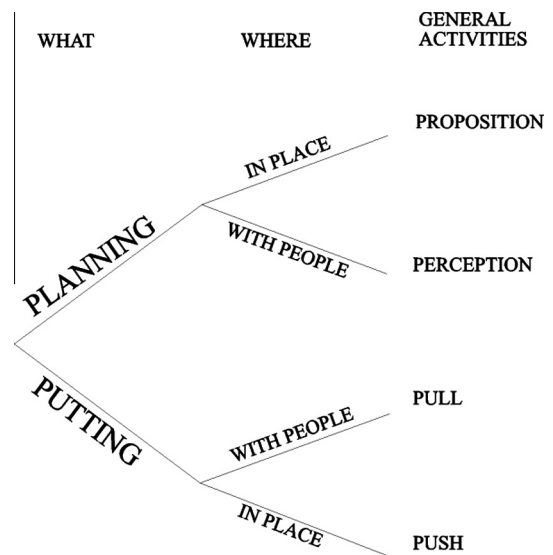


Fig. 1. “What” and “Where” dichotomies and general activities.

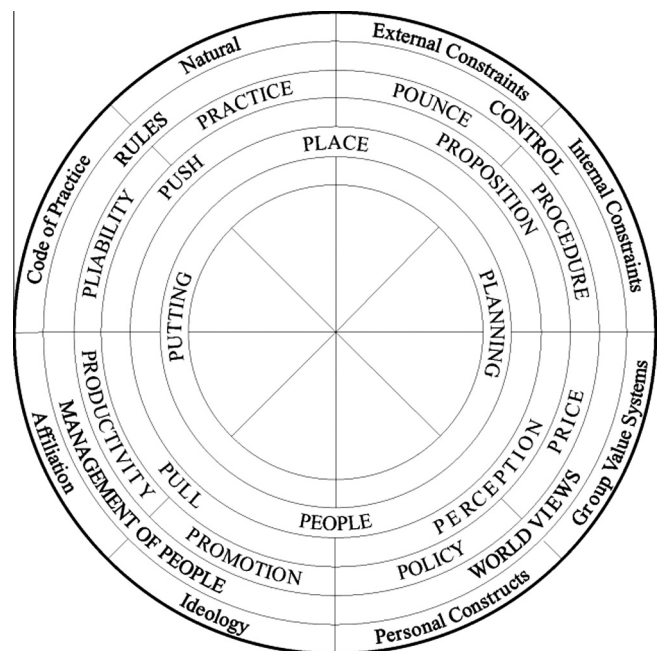


Fig. 2. Adjusting system.

The simplicity principle suggests that because both have a similar structure they may be comparable.

4. Using nomology as a meta-system

Eddy Davelaar (2010) suggests that “the future of mathematical modelling within Cognitive Science lies not only in the endeavour of interfacing between levels of description, but also in the use of comparative meta-modelling. Just like a meta-analysis of empirical work summarises and quantifies the effects obtained in experiments, so will a meta-model quantify the core principles or laws, that are needed to understand the phenomenon”. Edward Toomer developed PAM following years of practice with managing people. Its depth and extensiveness is indicated by how its four stages in Table 1 divide into eight in Fig. 2, and then into sixteen sub-stages (Brugha & Bowen, 2005), and into thirty-two ‘cues’. The basis for the division into eight and sixteen stages will be considered below. PAM’s aim was to address the challenge of how to manage people. It starts with trying to understand how people think, their world views. These begin with the individual, with their personal constructs. The same applies to the criteria that people use to differentiate what they want in a personal or a business decision. Cognitive mapping and some streams of multi-criteria decision-making (MCDM) employ personal construct theory (PCT) to access criteria constructs (Kelly, 1955), using qualitative or quantitative methods or both (Bannister & Fransella, 1971). Personal constructs emerge out of one’s own coherent experience. They become usable only when they are accepted as part of group value systems (Fig. 2), as indeed is the case with those in Table 1. These then can be used to develop appropriate methods of control. Here there is also a two stage process. Control will not work unless it brings some internal constraints on behaviour. People must have an internal sense of why and when it is appropriate at different times to be in different phases, such as forming, storming, norming or performing. If people lack that sense then there is little point in trying to get them to work as part of a team. But if they have it then management can try to impose some control by setting external constraints on behaviour. The idea of control implies assumptions about behaviour that are consistent with the views of and about systems that have been agreed. The same applies to nomological systems that emerge from practice. Systems such as in Table 1 are used by management to control behaviour. PAM takes this beyond a control system to the next phase, to formalise the control into a set of rules. These rules should be compelling in the sense that they should be unchangeable, even if people do not always abide by them. In PAM they appear to come in two stages. First there are natural rules that should apply to the behaviour of managers and employees in a company. Then there are codes of practice that apply to particular circumstances, contexts or situations.

The suggestion here is that the development of nomology is part of a meta-system in management decision-making culture, and the principles and axioms in nomology correspond to PAM’s natural rules. It follows that the further rules in nomology would correspond to PAM’s ‘codes of practice’. Some of these provide the basis for the Structured MCDM methodology (Brugha, 2004), which will be considered in a subsequent article. Another example is where a small number of ‘experts’ determine a set of rules for a profession and practicing professionals to “use, interpret and perhaps adapt the guidance according to local circumstances” (Ormerod, 2014).

In PAM the rules provided a foundation that helped with the management of people, first by building affiliation to the company, and then to an ideology that bonded the people even more. In the management of professionals such as accountants the affiliation would be to the accountancy profession, for some of whom a theory like the Balance Scorecard (Kaplan & Norton, 1992) could

fit as an ideology. For nomology it is about the management of decision systems. Here affiliation would be to systems that have been proven to be compatible with nomological rules. Ideology would correspond to taking it further towards a view that all management systems including MCDM methodologies should follow nomological rules. This is a rather grand claim.

This section has considered the idea that nomological rules can have two levels: natural and applied, as codes of practice, and asserted that this idea on the basis of its explanatory power. We continue in this vein, focusing only on the natural rules. If nomology is ‘natural’ then surely there must be evidence. We start by looking at the past.

5. Nomology over the centuries

This subjective/objective dichotomy seems to be a significant over-arching framework. It is embodied in the name nomology, which may come from Aristotle (1995). The ‘nom-’ part of nomology comes from ‘nomos’ the Greek word for ‘law’, and implies being subject to objective rules and systems. Aristotle wrote books on economics and physiognomics. The ‘-ology’ suffix comes from the Greek word ‘logos’ meaning ‘order’, ‘word’ and ‘reason’, and is about the ‘logic’ associated with sociology, ecology, psychology, anthropology, etc. Aristotle’s only ‘-ology’ book was on meteorology (Aristotle, 1995). He started as a scientist by observing fish, and believed that “credit must be given rather to observation than to theories, and to theories only if what they affirm agrees with the observed facts” (Crespo, 2009) (p. 136). He used both principles and axioms and suggested that people should be convinced because of something being self-evident. In books that he wrote on ‘Prior Analytics’ and ‘Posterior Analytics’, he developed deduction and induction so as to generalise theory. It appears that, for him, “analysis was the process of assuming that a problem had been solved, or a proof found, and then working backwards deductively to previously established results, then a proof or solution could be found by reversing the steps” (p. 65) (Smith, 2013). While Aristotle’s methods were rooted in science his reach was very general, including into psychology (Anagnostopoulos, 2013).

The description of nomology as both in science and philosophy illustrates one of its problems. Philosophy, the love of wisdom, is generally located in the humanities. But is nomology located in science, humanities, both, or neither? The literature on nomology is thin and sporadic and spread over a long period of time. Abbé Girard (1677–1748) called it one of six classes of knowledge (Horne, 1825). Tappan described nomology as one of two grand divisions of philosophy, the other being metaphysics (Tappan, 1855) (pp. 70–85). He is very wide-ranging on all aspects of philosophy, and then focused mainly on Logic in four books, on induction, deduction, evidence and primordial logic. The latter contains a section on nomological ideas (pp. 177–218), and another on axioms, both metaphysical and nomological. The nomological axioms are on: universal law, uniformity of nature, universal design, of the correspondence of ideas and reality, as well as moral, esthetical, somatological axioms, axioms of pure science and logical axioms (pp. 228–234).

William Hamilton (Hamilton, 1877) also had a wide-ranging approach to metaphysics and logic, and described (Vol. 1, p. 122) “the Laws by which our faculties are governed, to the end that we may obtain a criterion by which to judge or to explain their procedures and manifestations, we have a science which we may call the Nomology of Mind, – Nomological Psychology”, which he also called ‘rational psychology’. This has three sub-aspects: cognitions, feelings and conative powers. He credited (Vol. 1, p. 186) Cudworth (Cudworth, 1838) as the first to use the term conative, and (Vol. 2, Lecture 41, pp. 414–430) Kant with being the first to identify feelings as being between cognitions and conations. This later was to

become thinking, feeling and knowing. Little is known of Girard's writings. Tappan's and Hamilton's wide-ranging writings synthesise much of what was widely discussed at the time about philosophy, logic and meta-physics; but are rarely cited anymore.

Charles Sanders Peirce (Atkins, 2006; Vehkavaara, 2012) developed a comprehensive classification of sciences, which includes nomology in two forms: objective as nomological physics – the sciences of physical laws, and subjective as nomological psychics – the sciences of psychical laws or psychology. Peirce's extensive writings continue to be studied, especially about dyadic and triadic structures, which he developed in the context of linguistics into semiotics. He suggested “that there are no phenomena that can only be described in a language which contains expressions for four-place relations”, that the most complicated type of statement is triadic, i.e. of the form: “(someone) gives (something) to (someone else)” (Ormerod, 2005). The study of patterns in the relationships between different versions of words: nouns, verbs, adjectives, etc. continues to be studied in the humanities as morphology (Booij, 2012; Pullum & Zwicky, 1983). The study of linguistics has not contributed to an understanding of the structures in decision-making that might be relevant to MCDM.

Peirce inherited his interest in dyads and triads from the remarkable Ramon Llull (Raymundus Lullus) (1232–1316) (Atkins, 2006; Fidora, 2007; Maróstica, 1992; Pietarinen, 2006) whose extensive writings still evoke discussion. He is not popularly known in the west because he wrote in Latin and his native Catalan. Llull described his body of work as his *Ars Magna Generalis Summa* or his ‘art’. His intention was to describe the set of rules that are foundational to decision-making. His project was close to management in that he had an active intent to change practice, and he constantly updated his ideas to help with their application in practice. His research mission was to discover the general foundation of the theories under-pinning both Christianity and Islam in order to convert Muslims. Unlike his contemporary Thomas Aquinas who was endorsed by popes along with his teachings, Llull was much more the logician philosopher, who believed that everything that is true can be proven. “If the catholic faith is impossible to be understood, then it is impossible that it be true”, quoted by Schmidt (p. 126) (Schmidt, 1960). Johnston (p. 50) suggests that his entire logic is summarised in his urging study of the universal more than of the particular, “since it is naturally right that truth comes from the greater to the lesser”, quoted by Johnston (p. 50) Johnston (1987). Llull's aim was religious; however his example was prescient for studies of MCDM and nomology. Few other than John Scotus Erigena are considered to have significantly influenced Llull (Hillgarth, 1971) (p. 15). Llull used cognitive structures similar to those in this article, both tables and wheels as in Table 1 and Fig. 2. People mainly acknowledged his influence on quantitative theory. His *Ars Combinatoria* inspired Leibniz's foundations of mathematical logic (Hoffmann, 2001). “Llull and Leibniz both subscribed to conceptual atomism, the belief that the majority of concepts are compounds constructed from a relatively small number of primitive concepts” (Welch, 1990). Uckelman has suggested that George Boole, who is described as the ‘Father of Symbolic Logic’ synthesised ideas on computation as arithmetic calculation from Leibniz's together with Llull's concepts on rule-based manipulation (Uckelman, 2010). Llull's writings are accessible due to Bonner's short introduction (Bonner, 1997) and his translation (Llull, 1985) which includes sections on the *Ars Demonstrativa* (pp. 305–568) and the *Ars Brevis* (pp. 569–643). In the latter Llull suggests (p. 318) that the “principles of this art are clearly provable by themselves. ... Those principles of the Art that need most to be proved will be proved in the questions”. His way to try to convert Muslims was by “starting in an objective world and asking questions” because he “believed that the solution of these questions would convince the hearers of the

truth of Christianity” (Crossley, 2011). The use of questions is central to the description of nomology in this article.

Llull's two kinds of cognitive structures also have parallels here. His *Ars Demonstrativa* uses 16 symbols; a similar structure will be developed below. This was deemed to be too complicated when he tried to lecture on it. He switched his focus more to his *Ars Brevis* that uses 9 symbols, which will also be developed below. Extending this to a system with a $9 \times 9 \times 9$ structure (see Figs. 1 and 2 in Uckelman) (Uckelman, 2010) has parallels with the structure of nomological criteria trees (Brugha, 2004). Llull's detailed structures are accessible including ‘The Structure of Being’ (Appendix V, p. 422), ‘The Structure of Man’ (Appendix V, p. 425), and ‘The Plan of the Breviculum’ (Appendix VIII, p. 446) (Hillgarth, 1971). His contributions to computer science have been noted, but also apply to OR and MCDM (Crossley, 2011). He developed a system for selecting a preferred candidate from a group that predates and is more effective than Condorcet's when there are multiple criteria (Colomer, 2012). Other contributions include developing a formal language for decision-making; being able to interpret his nine ‘primitives’ in many ways: as nouns, verbs, adjectives and questions; having systems based on combinations; and his use of principles, which could be described as axioms, rules or meta-rules. Crossley also suggests that Llull might be the first person to have introduced binary and tertiary relations. Llull also joined different systems such as into $9 \times 8 = 72$ combinations (Crossley, 2011). This has parallels with an application by Brugha (2001a).

Russell Ackoff was the first to introduce a formal approach to cognitive structures into OR. In the pioneering OR text-book he co-authored (Churchman, Ackoff, & Arnoff, 1966) he showed an early awareness of multiple objectives (pp. 108–109), the need to know the *relative importance* of objectives (p. 115), the difficulty with additive assumptions when weighting objectives (p. 151), and about the “problem of amalgamation... of a social group's values from the values of individual members” (p. 153) (italics his). He was later to criticise OR for its failure to incorporate ‘psychological and social variables’ (Kirby & Rosenhead, 2005). He promoted interactive engagement with decision-makers (DMs) (Ackoff, 1979a, 1979b), and to the end of his life condemned the narrow view of rationality in the OR community (Ackoff, 1983). In *The Art of Problem Solving* (pp. 178–182) (Ackoff, 1978) he suggested an approach to understanding objectives that involved two dichotomies: subjective vs objective, and “two equal areas, one representing *internalization* – an inclination to act on oneself, to adapt oneself and modify one's own behaviour to solve problems – and *externalization* – an inclination to act on and modify the environment in problem-solving efforts”. Ackoff's criticism of the excessive quantitative emphasis in OR led to a journey into the subjective and self quadrant, and a study of personality types. He also used this grid to explore if these four approaches show how personality leads to different ways to address problems. Later he became sceptical about its possibilities for offering a generic approach to problem-solving (Ackoff, 1989).

Ackoff's over-arching framework helps to elucidate the challenge to OR and its connections with MCDM. In decision-making the influencing factors can be ‘subjectively felt’ criteria, or alternatives that have an ‘objective’ reality. Also, the decision agents can be the DMs, bringing their ‘self’ view to the problem, or they can be the constraints, coming from outside, caused by ‘others’, whether people, regulations, resources or systems. Combining both, there can be subjective and objective kinds of constraint. Quantitative constraints are where a project may be constrained by objectively felt resource limits that are mediated as quantitative limits on the alternatives. Qualitative constraints are where DMs feel subjectively constrained such as by a concern to empower employees or maintain ethical standards. This clearly affirms that the subjective/objective dichotomy embodied in the name nomology is important.

6. Nomology in the philosophy of science

Nancy Cartwright is a modern philosopher who has written about Aristotle's book on 'Categories' (Aristotle, 1995). She describes these categories as having 'capacities' or 'natures' (Crespo, 2009) (p. 113), and that she wants to "recall the Aristotelian idea that science aims to understand what they can do, regularly and as a matter of course" (p. 123). While she is more sceptical "about the possibilities of causal explanation in the social realm than in natural science" she maintains that "both the natural and social sciences belong to a world that is governed by capacities and that cannot be made sense of without them" (p. 127). Cartwright defines a 'nomological machine' as a "stable (enough) arrangement of components whose features acting in consort give rise to (relatively) stable input/output relations", and she puts the thesis that 'nomological machines' are the 'real engines of change' (Cartwright, 2009). Her ideas have been reviewed favourably by Crespo (2009) and more critically by Kitcher (1999). In response to criticism she tends to return to scientific justification, to put the case that "nomological machines are sufficiently stable arrangements of components and capacities or powers... that can, under suitable circumstances, give rise to causal regularities" (Cartwright & Pemberton, 2011). Cartwright's argument is that because nomological machines work in science they should be valid in humanities. Generally philosophers have not been convinced, but possibly based on a narrow interpretation of what she means by 'regularities'.

The Cartwright case is that just because there are 'regularities' in physics does not imply rigidly what will happen in any empirical experiment or when one uses some man-made machine (Pemberton, 2011). Similarly there is no suggestion that this rigidity applies in the human sphere (Cartwright, 1983). Nomological machines have two levels. The 'ideal level' corresponds to fundamental laws of physics. The 'material level' gives rise to phenomenological laws, about which conclusions should be less rigid because they involve measurement and experimentation, and the material world is intricate and changing (Mets, 2012). This has parallels with PAM's differentiation above between natural rules and 'codes of practice'.

Carl Hempel made a similar distinction between deductive-nomological and statistical explanations (Hempel, 1962). He introduced the term 'covering laws' to describe deductive-nomological explanations, which apply to general laws such as gravity that are of a 'strictly universal form'. The other kind are of "probabilistic-statistical form, i.e., they are, generally speaking, assertions to the effect that if certain specified conditions are realized, then an occurrence of such and such a kind will come about with such and such a statistical probability" (Hempel, 2002). His deductive-nomological model gave too strong a feeling of causality (Cartwright, 2002, 2006), and led to an over-prescriptive view amongst some researchers, and scepticism about nomology amongst others.

7. Nomology in the humanities

Cronbach & Meehl (1955) introduced nomology to develop construct validity in psychological testing. This led researchers to work with nomological 'nets' or 'networks' to measure the relationships between related constructs (Spreitzer, 1995), for testing construct validity (Salekin, Trobst, & Krioukova, 2001), and for predictive validity (Van Rooy & Viswesvaran, 2004). Straub applied these ideas to 'positivist' research in management information systems, exploring three kinds of validity, in descending order of preference: the instrument (the constructs), internal (ruling out rival hypotheses) and statistical conclusion validity (Straub, 1989), to develop measures of the performance of entire networks of firms, as

opposed to individual firm performance (Straub, Rai, & Klein, 2004a, 2004b), and involving structural equation modelling (Bielby & Hauser, 1977; Gefen, Straub, & Boudreau, 2000; Straub et al., 2004a, 2004b), which Mullins characterised as the 'new causal theory' (Mullins, 1973). Sometimes this combined tests for internal nomological validity, and external nomological validity (McKnight, Choudhury, & Kacmar, 2002).

The lack of a formal basis for naming the constructs, or for the relationships between them (the nomological model), and the reliance on statistical validation, such as using Cronbach's alpha score (Cronbach, 1951) to decide if the results were good is an ongoing cause of discomfort. Evidence that *there is* a relationship is generally insufficient, when researchers wish to identify *what is* the relationship. While the 'deductive-nomological' approach has its supporters (Ladyman, 2003; Psillos, 2002), its detractors judge it to be inappropriate to analyse subjects with a high social content as if it were a 'natural science phenomenon' (Chirkov, 2009). Sociologists generally reject 'nomological nets' as excessively 'positivist' because they do not address the complex and difficult-to-explain relationships between constructs in sociology. Straub alluded to this at the start of this line of research. "A weak argument can possibly be made that some degree of nomological validity can be gained from employing previously utilized instruments. This is a very weak argument, however, because nomological validity usually occurs only in a long and well-established stream of research, a situation that does not apply in this case." (Straub, 1989).

This assumes that the way to develop research is by 'codes of practice', by communities of researchers. The alternative proposed here is first to use nomology to identify and formalise the 'natural rules' about structuring decisions, which can then provide a secure platform on which to then build such 'codes of practice'. But nomology itself needs a *foundation*. Getting to this point has proven difficult historically, in science and in humanities. It is now possible to do this by going directly to settled practice *in general*.

With the extensive development and codification of management practice over the past century, and with access to the internet and library systems, millions of decisions have been synthesised into thousands of applications of management systems. These provide a vast source of 'regularities' that give fresh evidence of the structures that shape management and business practice, and consequently of the structures that people use to shape decisions. This could make the difference in the context of the history of failed attempts to develop a set of principles and axioms that together support and explain practice. The next section considers two major issues that emerged from the review of nomology over the centuries that should be confronted for the project to succeed: how to deal with the over-arching subjective/objective dichotomy, and the relationship between dyadic and triadic structures, otherwise known as binary and tertiary relations. Can nomology deal with the issue of compatibility between triadic and two-by-two systems? The question is can this be done through interpreting the evidence that can be found in practice, and using some simple rules?

8. The relationship between subjective and objective cognitive structures

Table 2 contains some common triadic systems (Brugha, 1998a). From Principle 1 and Axiom 1 we expect a simple relationship between Tables 1 and 2. The most obvious is that the structure in Table 2 is derived from Table 1, as if one of its aspects had become redundant. Observe that the content of Table 2 is subjective, whereas in Table 1 it is objective. The difference is that the decision-maker in Table 2 systems is "in charge", in the sense of not having to refer to anyone else, some "outside owner" of the decision. This becomes encapsulated in a third question.

Table 2

Cases that illustrate the three general subjective activities.

What	Where	Levels	Development	Relating Functions	Location	Simon	Activities	Feelings	Responses
Planning	Proposition Perception	Needs Preferences	Analyse Design	Thinking Feeling	Soma Psyche	Intelligence Design	Getting Doing	Fear Anxiety	Faith Hope
Putting	Push	Values	Implement	Knowing	Pneuma	Choice	Being	Resentment	Love

Axiom 9 (*Who*). The third dichotomy relates to the question who possesses the problem. If it is the decision-participant then his or her involvement will be more *subjective*, in which case he or she cannot self-impose a feeling of guilt about not dealing with the problem. If it is not the decision-participant then his or her involvement will be primarily *objective* in character, in which case he or she can feel at some distance from the problem (Brugha, 1998a).

The mediating issue is guilt, the feeling arising from not having done what someone else has expected. This is not the guilt that is determined in a court of law about whether one has committed a crime. One might feel guilt if one has messed up a company project, but not if it is your own private personal affair, such as a private letter or a poem. Behind this is the sense that with the mainly business cases in Table 1 there is an “outside owner” to whom the decision-maker must answer, which is not the case for Table 2.

Axiom 10 (*Subjective*). With *subjective* decision-making the *pull* activity becomes irrelevant (Brugha, 1998a).

See Brugha (1998a) for a discussion of *subjective* levels (needs, preferences and values), activities (getting, doing, being), and relating functions (thinking, feeling, knowing), and how *subjective* ownership resolves a long-standing discussion about the relationships between these entities involving Kant, Jung, Hegel, Feuerbach and Karl Marx amongst others. Other well-known *subjective* systems are analysis, design and implementation in information systems development (Whitten, Bentley, & Barlow, 1989), which is widely used as understand the problem or opportunity, develop a solution, and implement a solution (O’Brien, 1993), and as intelligence, design and choice (Simon, 1977) (pp. 2–3) (Gorry & Scott Morton, 1971).

Comparing the differences both between and within the *objective* systems in Table 1 and the *subjective* systems in Table 2 suggests a principle about the naming of constructs.

Principle 3 (*Similar Words, Specific Differences*). Different aspects of a particular dynamic will be described by words that are similar to each other, with the differences in the words specific to the differences in the concept (Brugha, 1998a).

The *objective* and *subjective* cases differ in their language. Also they use different processes.

Axiom 11 (*Levels*). With *subjective* decision-making the phases correspond to levels of a *developing* process (Brugha, 1998a).

In contrast, the original two-by-two *objective* system focuses more on making multiple refinements to ensure balance between the four aspects. The closest description is “adjusting”.

Axiom 12 (*Objective*). With *objective* decision-making the activities and phases are parts of an *adjusting* process (Brugha, 1998a).

9. Adjusting structures

In the second article introducing the ideas (Brugha, 1998b) Brugha considered *adjusting* decision-making in further detail by extending the four *general activities* to eight *particular activities*, which are represented in Fig. 2. This led to a further question, about which way to *propose*, *perceive*, *pull* or *push* an activity.

Axiom 13 (*Which Way*). The fourth dichotomy relates to *which way* should be used. For *adjusting* decision-making the question becomes as follows: Should we be relying more on using the particular *position* that the company or an employee is in, i.e. some impersonal way of doing things? Or should we be focusing more on the *person*, such as discussing with our key people how to resolve a particular problem? (Brugha, 1998b).

In an *adjusting* process *which way* acts as a third loop within *where*, within *what* (Fig. 2) in each of the *proposition*, *perception*, *pull* and *push* activities. Just as the process moves from *place* to *people*, and back (Axiom 8 “Sequence”), the same happens with the third loop.

Axiom 14 (*Precedence*). In the move through *planning* from *place* to *people* the use of *position* takes precedence over using the *person* as the emphasis on centralised control is lost; in the move through *putting* from *people* back towards *place* the use of the *person* takes precedence over using *position*. (Brugha, 1998b).

In the *where* loop the *place* aspect is at the centre of control, and the *people* aspect acts as an indirect mediator to help determine if it is safe to move from *planning* to *putting*. Similarly the decision-maker’s *position* is central, and a *personal* approach or engagement provides comfort or assurance that it is right to move to the next phase. With both loops, these devices are released when the decision-maker has the assurance to move the *adjusting* process towards completion.

Axiom 15 (*Principal Activities*). The eight principal activities *pounce*, *procedure*, *price*, *policy*, *promotion*, *productivity*, *pliability*, and *practice* operate in a cycle when solving a problem in management (Brugha, 1998b).

These words are intended to be the best descriptors possible of the eight principal activities in Fig. 2. When these labels were being considered it turned out that most of the words for the *objective* activities began with the letter “p”. This was not intended, and it does not apply on the *subjective* side, see Tables 2, 5 and 6. But when it was emerging it became a device to discourage relying on dictionary definitions of the language, to emphasise that these are labels for constructs that emerged from the structure. For example, *policy* is understood to mean *planning* with *people* using a *personal* approach. And *practice* is understood to mean *putting* in *place* by using one’s *position*.

Cases of the eight principal *adjusting* activities generally have emerged from extensive studies or surveys.

- The European Foundation for Quality Management (EFQM) (EFQM, 1999) is a large not-for-profit organisation with a membership network containing thousands of organisations and millions of members. Its mission is to promote sustainable excellence in European organisations.
- Pettigrew Ferlie McKee (Pettigrew, Ferlie, & McKee, 1992) elucidated its eight factors during a large study of health care organisations in the UK.
- The Change Kaleidoscope (Balogun & Hope Hailey, 2004) reflects years of observing change management.
- Jeffrey Pfeffer extracted his list of Seven Practices of Successful Organisations (Pfeffer, 1998) from various studies, related literature, personal observation and experience.

(e) Some systems have emerged from others. For example, McKinsey's Seven Ss system (Pascale & Athos, 1981) emerged from Peters and Waterman's Excellent Companies study (Waterman, Peters, & Phillips, 1980).

These systems are illustrated in Table 3. Occasionally a system will not fully reflect the inherent structure. This can simply be a matter of over-sight, or it can reflect the particular point of view of the organisation. For example Seven Ss over-emphasises "super-ordinate goals" which later re-named as "shared values", and misses an "S" corresponding to "pounce" decisions, as might be expected from a consulting company whose role is to assist companies in the policy area. An understanding of the generative structures can help to critique how systems are developed, interpreted and used. This led to another principle.

Principle 4 (Evaluating and Interpreting). Nomological systems can be evaluated and interpreted by seeing them in the context of a generic system. (Brugha, 1998b).

The business cases described in this article, especially those in Tables 1, 3 and 4, reflect 'settled practice', i.e. years of reflection, or large surveys of practice, or the accumulation of the experience of experts in management. But they are invariably confined to within their own context, and expressed in the language of their own system. For example, in EFQM, "Corporate Social Responsibility" is defined in terms of how it fills a space compared to others in that column in Table 3, i.e. "Customer Focus", "Continuous Learning", etc. Nomology offers an orthogonal perspective, comparing it with others in its row: "Skills", "Preservation", "Employment security", "Environmental pressure, etc.", and similarly to the corresponding rows in Tables 1 and 4. The heading for this row is *price*, which corresponds to *planning with people* using one's *position*. This can be understood in a variety of ways, such as the price people are willing to pay for something, or a variety of ways that people might put a value on something. With this understanding one can flesh out the meaning of *price* by relating it to its context. For a consultant from McKinsey the value of a company partly relates to the "Skills" of its staff.

An earlier empirical study by Brugha (1974, 2000) revealed that decision-makers makes choices about the benefit from using each of the eight principal activities.

Axiom 16 (Whether (Adjusting)). The fifth *adjusting* dichotomy considers the question *whether*, within any activity, it is appropriate to focus on increases in *power* or on its control so as to ensure the necessary balance between and progression through all the activities when solving a problem (Brugha, 1998b).

The *whether* question generates two further processes that control movement through the *adjusting* cycle, making 16 "Extended *Adjusting* Activities".

Axiom 17 (Punch/Prevention). Within each of the eight principal activities the cycle is controlled by two processes: the first *punch*, which increases the *power* needed to deal with the activity, and then *prevention*, which ensures the completion of that activity and the move onto the next one in the sequence (Brugha, 1998b).

These two processes show how decision-makers can ensure there is balance within each of the eight activities in the context of the *adjusting* cycle.

Axiom 18 (Pure/Pragmatic). The most dynamic organisation has a high tolerance for and a large spread of differentiation of usage and balance between the various activities it uses, and this is controlled by the *punch* and *prevention* processes, which correspond to providing a balance between a *pure* and a *pragmatic* approach to each activity (Brugha, 1998b).

Table 3
Cases that illustrate the eight principal adjusting activities.

What	Where	Which Way	(a) EFQM	(b) Pettigrew	(c) Balogun and Hope-Hailey	(d) Pfeffer	(e) Pascale and Athos
Planning	Proposition	Adjusting System Pounce	Excellence Model Customer Focus	Health Care Simplicity and clarity of goals and priorities Supportive organisational culture, including the managerial subculture	Change Kaleidoscope Time Scope	7 Practices of Successful HRM Organisations Selective hiring of new personnel Extensive training	Seven Ss None Style
		Procedure	Continuous Learning, Innovation and Improvement Corporate Social Responsibility People Development and Involvement	Environmental pressure, moderate, predictable and long-term Quality and coherence of local policy	Preservation Diversity	Employment security Extensive sharing of financial and performance information throughout the organisation	Skills Superordinate goals/Shared values
	Perception	Price Policy	Leadership and Constancy of Purpose Results Orientation	Key people leading change Co-operative inter-organisational networks	Capability Capacity	Reduced status distinctions and barriers, including dress, language, office arrangements, and wage differences across levels Comparatively high compensation contingent on organisational performance	Strategy Staff
Putting	Pull	Promotion Productivity	Partnership Development Management by Processes & Facts	Fit between the change agenda and the locale Positive pattern of managerial and clinical relations	Readiness for change Power	Self-managed teams and decentralization of decision making as the basic principles of organisational design None	Structure Systems

Table 4
Cases that illustrate the sixteen extended adjusting activities.

What and Where	Author	(a) Gantz–Wiley	(b) Butler	(c) Burke–Litwin	(d) Investors in People	Eight Principal Activities	Four General Activities
Proposition	Pounce	High Performance Model	Organisational Errors	Individual and Organisational Performance	Sixteen Extended Activities	Organisation to its People	Commitment
Perception	Procedure	Customer Orientation vs Quality Emphasis Employee Training vs Involvement/Empowerment	Too Slow vs Constantly Forced Too Informal vs Constrains Decisions	None Organisational Culture vs Work Climate	Development vs Equality of Opportunity Performance vs Contribution Recognised	Of the Organisation's People	
Pull	Price	Information/Knowledge vs Teamwork/Cooperation Overall Satisfaction vs Employee Retention	Too Closed to Views vs Too Much Politics Ideas Stifled vs Not Enough Action	External Environment vs Task and Individual Skills Mission and Strategy vs Individual Needs and Values	Clear Aims & Objectives vs Understood In Line with Aims vs Explain Contribution	Of the Organisation's People	Planning
Push	Promotion	Responsive Service vs Product Quality	Insufficient Participation vs Interference	Leadership vs Motivation	Learn & Develop vs Understand Expectations	By the Organisation's People	Action
	Productivity	Overall Satisfaction vs Customer Retention	Not Enough Authority vs Top-Heavy	Management Practices vs Individual and Organisational Performance	Effective Support vs Support Understood	By its Managers	
	Pliability	Sales Growth vs Market Share	Boundaries too Rigid vs Lack of Structure	Structure	Shows Improvement vs Understand Impact	Of the People	Evaluation
	Practice	Productivity vs Long-Term Profitability	Power Too Diffused vs Too Concentrated	Systems	Gets Better vs Can Show Improvements	Of the Organisation	

The *punch/prevention* processes, corresponding to balancing *pure/pragmatic* approaches, reflect how the general *adjusting* activities are used in dynamic situations, such as studies of priorities for strategy and of how to improve company performance. Identifying all sixteen different aspects in any application or business situation requires a lot of reflection by both researchers and decision-makers, who should have high-level access to a wide cross-section of settled practice in the business.

- (a) Gantz–Wiley Research's High-Performance Model (Wiley, 1996) is a good example because it grew out of research into over 7500 business units over the course of more than a decade. It articulates the sixteen activities of the Extended Adjusting Model, and also relates them to the four general activities, which they present in a sequence as “Leadership Practices” (*proposition*) to “Employee Results” (*perception*) to “Customer Results” (*pull*) to “Business Performance” (*push*).
- (b) Butler *et al*'s Organisational Errors (Butler, Price, Coates, & Pike, 1998) clearly illustrates the *pure/pragmatic* dilemma.
- (c) Burke–Litwin's causal model of organisational performance and change (Burke & Litwin, 1992) balances the *pure* intention of the organisation's interests by *pragmatically* accepting that this needs the individuals' activities' support for the organisation's intentions. This is an excellent example of a work-in-progress that has not been used extensively. It looks based on the Seven Ss, but has not discovered one is missing. Also it has extended only five of them. Seeing the generic structure could help them improve it.
- (d) Investors in People (Investors, 1996) provides the most powerful verification of the *adjusting* structure, in that it is articulated on multiple levels, $\times 16$, $\times 8$, $\times 4$. Table 4 illustrates the Extended Adjusting Activities and shows how the constructs in the different cases are like ‘facets of a diamond’ that illustrate aspects of the structure.

10. Structures for developing

Brugha (1998c) has considered the *subjective* side, and examples that are triadic but where the decision-maker himself or herself is not highly involved in the output of the decision. Table 5 shows some of these that are different in character to those in Table 2 (General Subjective Activities). Their nature is more familiar when seen as 3×3 combinations in Table 6. The following four examples reveal different aspects of the many cases and systems that have this structure (Brugha, 1998c).

Confusion (1a), Denial (2a), Upset (3a), etc., are stages of relating to a development, that were originally used for counselling people who were dying (Kubler-Ross, 1969). Physical (1b), Political (2b), Economic (3b), Social (4b), Cultural (5b), Emotional (6b), Artistic (7b), Religious (8b) and Mystical (9b), are a consistent and coherent set of nine levels of activities that Brugha developed based on Maslow's Hierarchy of Needs (Maslow, 1987). Survey (1c), Study (2c), Define (3c), etc., are stages of an OR, systems, or any kind of project, such as the Systems Development Life Cycle (SDLC) (Whitten *et al.*, 1989) in Information Systems.

Table 5
Cases that illustrate the three convincing activities.

What	Where	Levels	Convincing	Study	Attitude
Planning	Proposition	Self	Technical	Science	Involving
	Perception	Others	Contextual	Humanities	Protecting
Putting	Push	World	Situational	Practice	Observing

Table 6
Cases that illustrate the nine developing activities.

Key		CONVINCING OTHERS					
(a)	(b)	Self	Technical	Others	Contextual	World	Situational
(d)	(c)	Involving	Science	Protecting	Humanities	Observing	Practice
COMMITTING SELF		1		2		3	
Soma	Need	confusion	physical	denial	political	upset	economic
Thinking	Analyse	Intuiting	survey	recognising	study	believing	define
		6		5		4	
Psyche	Like	inertia	emotional	depression	cultural	bargaining	social
Feeling	Design	trusting	acquire	learning	design	sensing	select
		7		8		9	
Pneuma	Value	jealousy	artistic	compliance	religious	enthusiasm	mystical
Knowing	Implement	experiencing	construct	understanding	deliver	realising	maintain

And Intuiting (1d), Recognising (2d), Believing (3d), Sensing (4d), Learning (5d), Trusting (6d), etc., are psychological or thinking types, which Jung formulated from observing people during counselling (Jung, 1971). He described these as differentiated by being either introverted or extroverted. This provided a link to the question “Which Way” for *subjective developing* systems that corresponds to the same question for *objective adjusting* systems.

Axiom 19 (*Introverted/Extroverted*). The fourth dichotomy relates to the question *which way* should be used. For *developing* decision-making this becomes: should we focus on introverted or extroverted *developing*? (Brugha, 1998c).

Having this “Introverted/Extroverted” distinction makes it easy to see that Table 5 is about phases of *convincing*, which become the columns in Table 6. Then it becomes clear that the rows in Table 6 are about phases of *committing*, and the combination of both as *committing* by *convincing* becomes stages of *developing*.

Axiom 20 (*Convincing*). Extroverted decision-making increases *convincing* about something by *developing* through *technical*, *contextual* and *situational* levels (Brugha, 1998c).

Axiom 21 (*Committing*). Introverted decision-making increases *committing* about something by *developing* through *somatic*, *psychic* and *pneumatic* levels (Brugha, 1998c).

Axiom 22 (*Developing*). Where decision-making combines both aspects, extroverted decision-making is shown to be nested within introverted decision-making, making nine kinds of behaviour or stages of relating to or dealing with a problem (Brugha, 1998c).

Note on the naming of Phases and Stages. Although we have used these terms before, we here define “**phases**” to refer to single processes, and “**stages**” to refer to combinations of processes, such as in *developing*.

The *pure/pragmatic adjusting* question “Whether” (Axiom 16) then had its *developing* version revealed as relating to the mechanism that controls moving between the nine **stages**/types/levels.

Axiom 23 (*Whether (Developing)*). The fifth *developing* dichotomy considers the question *whether*, within any activity, it is appropriate to focus on increases in *power* or on its control so as to ensure the necessary balance between and progression through all the activities when solving a problem (Brugha, 1998c).

The structure also helps to clarify ideas by Maslow, about the SDLC, from Jung and from Kubler-Ross, and shows one of the strengths of nomology: the idea of mapping research discoveries using their underlying structures. Furthermore it leads to another principle.

Principle 5 (*Deconstructing, Reconstructing and Completing*). Nomological systems can be deconstructed, reconstructed and completed by seeing them in the context of a generic system (Brugha, 1998c).

This can be applied to any kind of application, including studies of personality types such as the *Enneagram* (Brugha, 1998c; Riso, 1987) to give a rounded view of people’s *development*.

Axiom 24 (*Personality Types*). Introverted and extroverted experiences have their own effect on personality typing independently of each other; consequently the nine basic personality types have variations based on the dimension of extroversion to introversion (Brugha, 1998c).

This completes a summary of the basic rules in the foundation of nomology. Subsequent articles will consider implications for decision-making practice (PAM, Table 1 and Fig. 2). This article verified that the *subjective/objective* dichotomy is important, as was implied in the name nomology. How universal is this result? It relied on synthesising practices within businesses and in philosophy research, both of which are based in the west. The next section explores how nomology crosses inter-cultural boundaries and business disciplines.

11. Subjective and objective decisions in inter-cultural applications

The *subjective/objective* dichotomy helps to explain a controversy about Hofstede’s model (Table 1). His inter-cultural research

fits into the *objective* structure, whereas most other authors emerged from the *subjective*, an early example being by Triandis (1972)). This is evident from the *subjective* language in their constructs and how the systems fit the nine **stages** or levels in Table 6. For example Schwartz describes cultures as differing on universal values: Power, Achievement, Hedonism, Stimulation, Self-Direction, Universalism, Tradition, Conformity, Security and Benevolence (Schwartz, 1992). And Trompenaars and Hampden-Turner's system uses seven dimensions to distinguish national cultures: Universalism/Particularism, Individualism/Collectivism, Achievement/Ascription, Neutral/Affective, Specific/Diffuse, Internal/External, and Time Orientation (Trompenaars & Hampden-Turner, 1998), originally from Parsons (1953). Some researchers start with the belief that inter-cultural constructs come from the same system, and so should be comparable in their effect on a dependent variable. This confusion has led to criticism of Hofstede's model as "problematic from both a methodological/theoretical and practical view" (Jackson, 2011), because of its incompatibility with other cultural models (McSweeney, 2009), and even a claim that Hofstede never studied culture (Baskerville, 2003). Attempts continue to resolve the differences between Hofstede and proponents of the *subjective* approach (Kirkman, Lowe, & Gibson, 2006; Tung & Verbeke, 2010). Some correctly treat the *objective* and *subjective* models separately (Pagell, Katz, & Sheu, 2005). Others reach modest – although correct – conclusions, such as that the *subjective* model might have provided a better explanation than the *objective* (Cleveland, Erdogan, Ankan, & Poyraz, 2011).

The resolution lies in the relationship between the *objective* and *subjective* structures. In nomology "decision making processes, in general, are invariant and more likely to be simple than complex" (Principle 1 'Simplicity'). This means that the same processes will be used in similar situations in other fields. A standard three-level process is about determining "what" to do (Axiom 3), "where" to do it (Axiom 5), and "which way" to do it (Axiom 13). See for example *adjusting* processes (Table 3). In the SDLC in information systems (Table 6) each of the nine *subjective stages* should be carried out in an *objectively* good way (Brugha, 2001a). Applying this to cultural choices, people generally first *commit* to "what" they "like" (Table 2). Then they wish to be *convinced* that they are relating to the "context" "where" they are (Table 5). At a third level they *adjust* "which way" they should behave, to do what is *objectively* proper in the local culture. For example, most people "like" to be polite to their hosts. In the Chinese "context" you should follow the "norm" (Table 1) and leave a little food on your plate to indicate you have had enough, but not in Japan where it is seen as wasteful. Dining etiquettes are examples of culture's consequences, as in the title of Hofstede's book (Hofstede, 1980).

The quest to prove that nomology is valid beyond its origins in western culture, led to over a decade of research collaborations and discussions with Chinese scholars, focusing particularly on understanding how eastern cultures approach the most challenging aspect of nomology, the *subjective/objective* dichotomy. The language independent nomological cognitive structures facilitated the comparisons. They showed that oriental culture is more comfortable with *objective* structures, especially the dichotomies *Yin* and *Yang*, which form the *Ba Gua* and its eight *trigrams*, and the *Yi Jing/I Ching* and its $8 \times 8 = 64$ *hexagrams*. *Yin* is more open, soft and uncertain, as in *planning*, *people* or *personal*, and *Yang* is more closed, hard and certain, as in *putting*, *place* or *positional*. In Eastern culture *Yin* and *Yang* are meaningless without the other.

Brian Bruya suggests that in Chinese culture the *Yi* is "directly rooted in the patterns of the cosmos" ... (and has) ... "two significant features: (1) patterns, which are related in a fundamental way to natural (including human) processes of change, and (2) this

dynamism itself, which is a fundamental aspect of the universe" (Bruya, 2007) (p. 346). With *Yin* and *Yang* there can be no certainty, unlike with Aristotle's *logos*. "For expositors of the *Yi* ... there was no dream of a synchronic comprehensive nomology. In other words, there was not the view that the workings of the world could be brought, even theoretically, under one umbrella all at once" (p. 347). This means that western type processes, or "*lis*", are treated with suspicion, if they do not have a *Yin* and *Yang* aspect. "There is no power of *li* if there is no learned and accepted convention ..." (p. 349). The idea that people can make some decisions *subjectively* without a feeling of guilt (Axiom 9) or referring to the '*pull*' from some higher authority (Axiom 10) seems to offend an oriental "learned and accepted convention" about the *objective Yin/Yang* nature of the "cosmos".

On the other hand, 'cosmological thinking' in both modern Chinese discussion and ancient Confucian texts is not confined to *Yin/Yang*. Although they see *adjusting* as the norm, when some scholars look beyond their *objective* activities they see themselves as humans that "can form a trinity with Heaven and Earth" (Weiming, 2001) (p. 249). Within our *developing* system frame (Table 6) humans corresponds to 'others', Earth to 'world', and Heaven to 'self'.

In recent years China has been westernising. Correspondingly, theory has been moving towards more *subjective* thinking. In the mid-nineties Chinese scholars combined their own with international methods for evaluation to propose a system based on three processes or '*lis*', called *wuli-shili-renli* (WSR) (Gu & Zhao, 1996). With WSR "*Wu* (objective existence), *Shi* (subjective modelling), and *Ren* (human relations) constitute a differentiated whole that conditions systems projects" (Gu & Zhu, 2000). Brugha used nomology to show parallels between *adjusting* and *wuli*, *convincing* and *shili*, and *committing* and *renli*, and made a connection to the SDLC. He suggested "if one were to represent *renli* by R, *shili* by S, and *wuli* by W, then a suggested formalisation of an embedded version of the WSR process would be R[S(W)], i.e. much *adjusting* within moderate amounts of *convincing* within an essentially *committing* process" (Brugha, 2001b).

Brugha next applied the ideas to political conflict (Table 6), and showed how conflict decision processes use an *objective* structure (Brugha, 2006a). Considering them in a Chinese context (Brugha, 2006a, 2006b) showed the location of the Chinese constructs *guanxi* and *mianzi*, that do not translate well into English. These are about relationships with *people* (the bottom half of Fig. 2). *Guanxi* is about *personal* relationships (corresponding to *policy* and *promotion*). *Mianzi* is about relationships that relate to one's *position* (corresponding to *price* and *productivity*). *Mianzi* is usually translated as 'face', as in one's image or value in the community.

A collaboration with scholars in China tested different applications of nomology. One described three case studies about trust building in conflict management (Du, Ai, & Brugha, 2011). Another drew on work mainly from Japan to propose an Integrated Knowledge Management Development System (IKMDS) where each of the nine SDLC **stages** uses an *adjusting* process (Brugha, Du, & Ai, 2008). Some articles were directed at a Chinese language readership (Du, Ai, & Brugha, 2008, 2009a). The language independence of the cognitive structures was tested further in a nomology-based MCDM application (Brugha, 2000) where the empirical research was done in the Chinese language (Du, Ai, & Brugha, 2009b; Du et al., 2009a). Separate collaborations with Chinese scholars in Ireland showed how Irish people who do business in China link their success to an understanding of *objective adjusting* Chinese concepts such as *guanxi* (interpersonal relationships) and *mianzi* (face) in business relationships (Li, Brugha, & Wang, 2010).

12. Conclusions

This article has provided a foundation for nomology, the ‘science of the laws of the mind’. To do this it built a generic model of cognitive decision structures based on business systems used in management practice, so as to provide a foundation for multi-criteria decision-making. It uses terminology based on common parlance. It contains a set of axioms and principles where each stands on its own, and is consistent with the others.

It shows that all cognitive structures stem from dyads (dichotomies) the first two of which form four balanced fundamental general activities: *proposition*, *perception*, *pull* and *push*. It shows how a *subjective* structure arises when not having an outside owner of a decision makes the *pull* activity redundant. This explains the basis of ‘triadic structures’ that intrigued Peirce and Hegel, and also the relationship between the ‘nomo’ and ‘ology’ components of nomology that goes back to Aristotle, who described there being ‘regularities’ in how people make decisions. Kant later called them ‘cognitive structures’ to reflect that they provide the basis for how people think. It proposes that they be called ‘nomological structures’ to reflect that they govern all decision processes.

The article describes an *objective* structure for *adjusting*, and two *subjective* structures, one for *committing self* and the other for *convincing others*. It uses further evidence from practice to build combinations of nomological structures that have been known from Lull onwards. It shows that *committing self* and *convincing others* combine into a *developing* structure, elements of which are seen in Kubler-Ross’s stages of relating, Maslow’s hierarchy of levels, the systems development life-cycle, and Jung’s thinking types.

It describes illustrations of *developing* combined with an *adjusting* structure, in an inter-cultural context, that includes systems developed in China and using Chinese culture. This demonstrates that the nomological structures are truly generic and independent of the western context out of which they grew. The article claims that the axioms and principles in the model are all true, severally and together, and reflect the natural way that people structure decisions. This is technically supported by the evidence of the cases, fits the context of previous research into nomology, and can accommodate any decision situation.

It proposes that a decision be called ‘nomological’ when it is consistent with the rules of nomology. Making decisions ‘nomological’ will be relevant for fields that combine *subjective* and *objective* aspects such as in conflict, inter-cultural and inter-disciplinary studies, ethics, and group decision-making, and will be particularly important for building criteria structures and for scoring in MCDM.

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