

# FRAMEWORK TO STRUCTURE COMPLEX AHP/ANP SYSTEMS MODELS

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## ABSTRACT

Three Forms of Capital, defined as Individual, Collective and Institutional may be used as a framework for complex social systems at all levels of analysis and assist in the development of the Problem Definition by giving relative social context to primary data. Forms of Capital support the construct of suitable AHP/ANP models for prioritised trade off and sensitivity analysis.

Keywords: AHP, ANP, Forms of Capital, social context, sensitivity analysis

## 1. Introduction

Establishing the most appropriate response to a perceived problem may be achieved using a generic framework for analysis based on three, orthogonally related, Forms of Capital defined as Individual, Collective and Institutional Capital that are required for any capability or system to exist.

This approach permits the various elements of complex problems to be individually appreciated and assessed for comparative importance relative to the desired outcomes, without losing social context and using established OR techniques such as Analytical Hierarchy Process /Analytical Network Process (AHP/ANP) that already have well developed software to perform the computations.

Qualitative based methodologies like (Checkland, 2000) Soft Systems Methodology (SSM) or “Cognitive Edge” [http://www.cognitive-edge.com/sensemaker\\_suite.php](http://www.cognitive-edge.com/sensemaker_suite.php). may help initial, better understanding of the constituents of complex social problems, but the social framework, or context may then be lost in subsequent analytical processes if a proper reference framework is not used.

The concept of relating all of the constituents of a problem within a framework composed of three Form of Capital is an extension of the proposal by (Bourdieu, 1986) that capital distribution reflected the social world at that point in time and drove its persistent nature suggesting “*It is impossible to account for the structure and functioning of the social world unless one reintroduces capital in all its forms and not solely in the one form recognized by economic theory*”.

He considered capital as a form of energy that seeks to maintain itself and has three fundamental guises: as economic, cultural and social capital. This original concept and much of its underpinning arguments as to the importance of social relationships within systems analysis have been used as the genesis of this alternative generic, analysis framework for better interpretation of complex systems.

The framework uses as a base proposition that the state of any system may be represented as a balance between three orthogonally related capital forms defined as Individual, Collective and Institutional and proposes that sufficient autonomy exists between the characteristics of these three Forms of Capital to justify treating them as independent variables which may, through the use of a common comparative judgement scale of the constituent components, be represented within an x, y, z coordinate system.

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Any specific element or characteristic of the problem can be defined within the context of these three generic classifications and then ranked in comparative importance with other elements within a hierarchical structure, making it possible to include the social impact of decisions on outcomes. The possibility exists, using this approach for a mathematically based resolution of optimisation trends but this is currently only a concept highly dependent on proving the equivalence of “mathematical independence between the three variables of capital” when captured in a qualitative form.

## **2. Forms of Capital**

The three Forms of Capital are:

### **2.1 Individual:**

Individual capital represents the inherent properties and capability of the smallest functional entity of the analysis. This can represent individual persons or any grouping that may be treated as a single entity comparative to the level of their collective form.

It captures personal qualities of knowledge (both fundamental and tacit), relevant domain experience, social position and connections, emotional and social intelligence, courage, honesty, integrity, tolerance, beliefs, in fact any personal characteristic that may be relevant to the issue being examined. A person would consider these as “*My*” attributes, or worldview.

If the analysis was at a much higher level (say a worldwide epidemiological study) the smallest relevant study group may be a family, a community or even a country, it will simply depend upon selecting the smallest sub set having definable and bounded characteristics relevant to outcomes.

This interpretation also means that the analysis need not be limited to human systems but may well be used with other single type groupings (perhaps an elephant herd or migrating whales).

### **2.2 Collective:**

Collective Capital represents the aggregated or emergent properties of a group comprised of a number of individuals who hold a set of common beliefs, share a variety of skill sets that are used for the betterment of the group rather than the individual and maintains a cultural doctrine that encourages and reinforces cooperation between them and can evolve over time in response to external change. This results in a synergy multiplier to their collective knowledge, domain experience and abilities to manage within their environment that makes the group better able to succeed than they would as separate individuals. Collective capital tends to have an enduring nature as it is being constantly renewed and nurtured by a steady turnover of individuals who transfer their tacit knowledge and learning experiences to the group (this may well be in the form of conversations, stories, myths and legends that support group behaviour and beliefs). It captures the forms of delegation within the group which define leadership hierarchy and authorities to act on behalf of the group. Simply stated it is thinking “*We*” in preference to “*My*”.

### **2.3 Institutional:**

Institutional Capital represents the institutions, infrastructure, physical environments, ecosystems, economic systems or indeed any asset or system that empowers and / or supports an individual or group in a specific undertaking. It may be likened to being the tools that a social system would use to achieve its objective and is normally prefaced by the term “*Ours*”.

Although these three Forms of Capital have their own unique characteristics they are symbiotic and synergistic when viewed as a system framework. This presents the opportunity to analyse the options for a problem more holistically by first identifying and prioritising the most important influencing factors within each of the forms of capital and then extending the prioritised comparisons against each other.

### 3. Justification for using the framework

The main purpose of this framework is to ensure through a structured approach that the societal implications of decision making are recognised and understood and assist in developing a problem definition that is the most appropriate for the intended outcome.

The Forms of Capital framework does this by guiding an interpretive appreciation of the problem from three orthogonal perspectives and allows the identification by the analyst of the most important criteria for further in depth examination. Because this approach only adds relative importance within a social context it is equally suited to scope and appreciate analytical methodologies across the entire spectrum from reductionist to non reductionist.

By adopting the Three Forms of Capital as the Criteria (second level of an AHP/ANP hierarchy) the subordinate criteria and subsequent subordinate criteria may be identified against the alternatives of the problem being analysed.

### 4. Possible Subordinate Criteria within the Three Forms of Capital

Each of the capital forms have a number of possible sub criteria that could be considered within a particular study or problem. As each problem is unique the relative importance of constituent subordinate criteria will differ and may even change or evolve over the period of a study.

Although there may be a significant number of possible sub criteria within each Form of Capital many of them may be of such relatively minor importance to the outcome of a particular study that they may, after due consideration, be rejected from further consideration. It is recommended that the maximum number of criteria within an equal level of a AHP/ANP hierarchy should be held between five and nine in line with established good practice.

The most important subordinate criteria within both Individual and Collective Capital relate to the most appropriate balance between knowledge held and the level of application experience relevant to a specific domain. It is this balance that is used by societies to identify differing levels of understanding and expertise and was identified by (Lawson, 2005) as being *“derived from congruence with the values and beliefs of the dominant culture of the total environment, both private and public, and based on achievement and reputation.”*

Deciding the optimum relationship between knowledge and experience for any specific goal is a qualitative process but is so critical to understanding what must be managed within complex social systems that it should be the start point in any analysis.

### 5. Subordinate Criteria for Knowledge

(Blackler, 1995) suggests five forms of knowledge that are suitable as subordinate criteria within a hierarchical structure:

#### 5.1 Embrained knowledge

This relates to *individuals* and their ability to interpret data and conceptualise outcomes based on prior learning. This form of knowledge particularly applies to those who possess a high degree of fundamental or applied science awareness along with heightened sensory perceptions that can rapidly draw logical or abstract conclusions to a given data set.

#### Potential sub-descriptors:

Analytical	Constructive	Deductive	Reasoning
Innovative	Visionary	Scientific	Rational
Logical	Abstract	Technical	Precise

## 5.2 Embodied knowledge

This relates to the knowledge of mentor transference normally linked to profession or family. It is associated with the guidance of “master craftsmen” or experts to journeymen and apprentices as they perform tasks so that they may understand the standards that are expected and the responsibilities that are bestowed on members of the group through their active participation. It also captures through direct exhibition by an experienced practitioner those aspects of understanding that must be mastered by individuals within the group including the subtlety of recognising the appropriate context that makes the understanding valid. It is both *Individual and Collective* in nature as it requires individual awareness of the meanings of body language and physical cues from members of the collective group that are related to the learning process.

### Potential sub-descriptors:

Practical	Applied	Artistic	Elegant
Proficient	Functional	Feasible	Useful

**5.3 Encultured knowledge** – This is the shared understanding or beliefs of a *Collective* societal group with commonly held worldviews or perceptions normally founded in a single language and cultural system. It captures the stories, myths and legends of the society and defines the benchmark standards that are used for the judgement of transgressions. Being entrenched within a societal group it is evolutionary in nature and constantly being reconstructed.

### Potential sub-descriptors:

Ethics	Piety	Devout	Fidelity
Committed	Fanatical	Zealot	Advocate

**5.4 Embedded knowledge** – Captures processes and procedures of accepted professional practice or methodologies at both an *Individual and Collective* level. It gives reason to the way that Institutional resources are incorporated or can be used, and being holistic in nature crosses cultural or national boundaries. It also represents established common processes of a transactional nature and can be quite explicit.

### Potential sub-descriptors:

Professional	Fiduciary	Dutiful	Authoritative
Integrity	Honourable	Veracity	Truthful
Legislative			

**5.5 Encoded knowledge** – This is very *Institutional* as it represents the form of knowledge transfer between individuals or groups using text or visual representations that are found in codes of practice, technical standards, reference manuals or books or data base collections. It also represents the extracted knowledge or discovery from the processes of data mining or data analysis.

### Potential sub-descriptors:

Mathematics	Science	Engineering	Encyclopaedia
Hieroglyphic	Journal	Cited	Library
Terms of Reference	Contracts	Technical Drawings	Specifications

Fleck(1997) offers alternative knowledge classifications of formal, instrumentalities, informal, contingent, tacit and meta knowledge whilst Lundvall (1994) suggests know-what, know-why, know-who and know-how which could be a highly suitable alternative for economic analysis,.

## **6. Subordinate Criteria for Experience**

Subordinate criteria for forms of experience are more difficult to define generically than those relating to knowledge as they tend to be constrained by context, or to specific occupational activities, preventing citation from established publications. In this instance experience will be based on either its sensory or emotional aspects.

**6.1 Sensory experience** – Covers all the attributes that are associated with the five sensory perceptions of sight, smell, taste, touch, and hearing, including the qualitative assessments occurring within the brain that interprets the data and results in reasoning, intuition, perception, context, actioning, past pattern recognition or instinctive reaction.

**6.2 Emotional experience** – These are the outcomes from a sensory experience which can produce feelings of happiness, sadness, curiosity, anger, fear, desire or despair (among others) within an animal species, based primarily upon previous or instinctive patterning. As such the same sensory stimuli may well generate a completely different emotional response within different beings or animals, meaning that outcomes may only be predicted within likely probability limits. This form of experience also covers spiritual or extra sensory perceptions.

The combinations of the above experiences within a particular context may result in the emergent characteristics of wisdom, tolerance, compassion, sympathy and empathy or equally as their negative counter forms.

## **7. Subordinate Criteria for Traits**

Traits are the composite description of what best describes the intuitive and emergent characteristics of individuals. Some are specific, like height, weight, intelligence, or colour of eyes which tend to capture natural attributes, whilst others are judgement opinions of the societal group like courageous, ingenious, truthful, trustworthy, loyal which represent how the natural attributes are applied within the group.

## **8. Subordinate Criteria for Culture**

Culture is the acquired emergent property of societal groups generated by their collective perception of the world and their environment that influences their individual and group attitudes, standards and levels of trust. It is commonly manifest or perceived in terms of self interest, isolationism, intolerance, tribalism, arrogance, prejudice and fanaticism. Of significant importance in light of current societal dependence on technology to find solutions to its own sustainment are the cultural differences identified by (Raelin, 1985) between technology providers like scientists, chemists and engineers and the managerial or government structures that employ them and provide the resources for their work.

## **9. Subordinate Criteria for Resources**

Resources represent mercantile exchange, property, material goods, institutionalised ownership or exclusive rights, raw resources or any item that may be readily converted to mercantile exchange. It may take the direct form of physical entities that are used at the discretion of the owner to support activities or may be an indirect, esoteric, emergent quality like community health.

These are often categorised into either natural resources or societal resources dependent upon their primary nature of being “unprocessed” or resulting from human intervention or application.

## **10. Subordinate Criteria for Infrastructure**

Infrastructures are those physical entities that are used to support daily activities of a society and are generally available to all within that society, albeit often with an additional personal contribution at the time of use. They tend to be fixed and permit individuals to have high levels of independence as to how and when they might use them and minimises the need to create new social trust networks. They normally require ongoing expenditure to maintain a serviceable state.

## **11. Limitations of the Framework**

Knowledge and understanding is evolutionary and an emergent property of applied experience, as such it is the first comparator that we use as humans to appreciate a problem. We observe the class, pattern and context of the problem, we reference against previous experiences and if we obtain a close match, utilise the methodology that was the most successful last time. A framework limitation is that it does not readily support the identification or reaction to a new class of problem which will require an appreciation from basic fundamentals and so every problem definition study should start with the question "Is this a new problem or a previously addressed one in a different context or guise?" Justification of the methodology or approach selected may then be supported by an analysis of the similarities or differences that exist to known problems.

## **12. Conclusions**

An appropriate hierarchical structure and sub criteria to suit AHP/ANP evaluation of any specific problem may be developed from this framework permitting the use of propriety software developed for AHP or the more recent generalised network form. Recommended reading on this issue may be found in (Saaty&Vargas, 2006).

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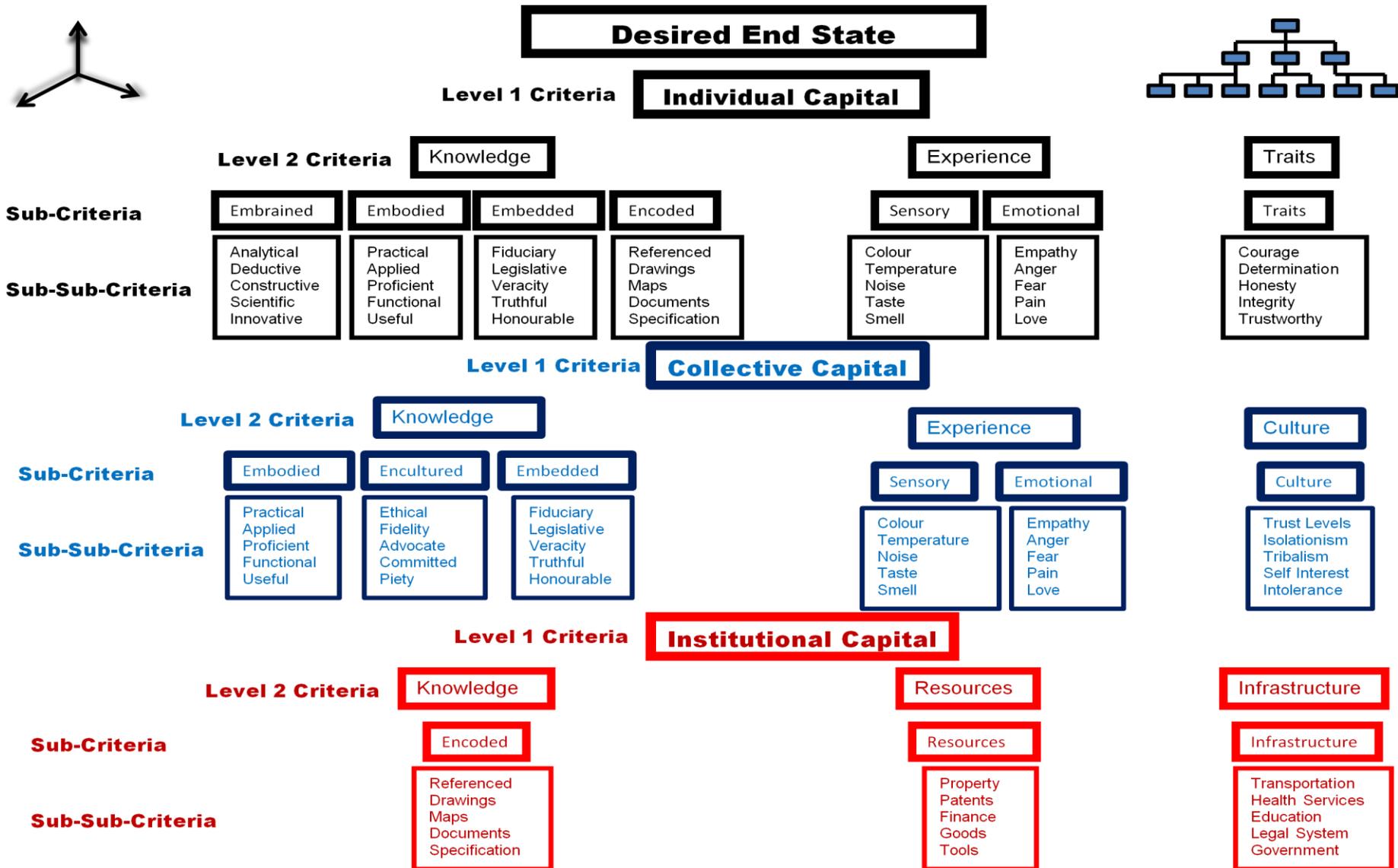


Fig 1 Representation of typical AHP/ANP Decision Hierarchy