

**Measuring the Impact of Research Networks in the EU:
Value Networks and Intellectual Capital Formation**

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Abstract: Intangible asset management has largely focused on valuation of intangible assets rather than conversion strategies. Value conversion is the act of converting one type of value (financial or non-financial) into another form of negotiable value. Without a thorough understanding of how intangible assets are effectively accumulated and deployed, static valuation measures have limited practical value.

Value Network Analysis (VNA) has been successfully deployed in many different types of organisations to address strategic and operational issues, including intangible asset growth and utilisation. It is not a valuation method, but it is an integrative modelling language that readily links to other business performance models, including intangible asset monitors. The method coherently links indicators from strategic macro models down through the levels process, technology and data integration.

An empirical study in 2007 demonstrated that VNA is a useful method for describing intangible value conversion at a macro level. This research was an evaluation study for the European Commission to better understand the impact of research networks on Intellectual Capital formation and competitiveness in regions. At the levels of organisation, network, and region, value network patterns were linked to specific patterns or 'thumbprints' of anticipated Intellectual Capital formation.

The practical implication of this work is that it provides a possible solution to one of the most challenging business issues in the intangibles economy: describing and monitoring the role of intangibles in value creation. Many acknowledge that approximately 80% of a company's value lies in intangibles, yet practical methods for managing intangibles are not widely used. This problem is especially intense in government, civil society and non profit organisations, and networks. In these cases value impacts are exceedingly difficult to describe in only tangible or financial terms. VNA offers a scalable method for understanding the dynamics of intangibles and value creation at virtually every level of complexity from shop floor to regions and global networks.

Keywords: value networks, intangible value, value conversion, Intellectual Capital, regions, intangibles

1. Understanding value conversion

One of the most challenging issues at the organisational, network and regional levels today is describing and monitoring the role of intangibles in value creation. At the organisational level pioneers in Intellectual Capital have demonstrated that interventions and actions must be understood in both tangible and intangible terms (Sveiby 1997, Edvinsson and Malone 1997, Wallman and Blair 2000, Lev 2001, Eccles et al 2001). Much of the early work was focused on measuring or valuing intangibles as assets. Intangible assets include brand, employee know-how and competency, the effectiveness of the organisation's work groups and structure, the efficiency of the organisation's production and service processes, and quality of relationships with customers and suppliers.

More recently, researchers and analysts are attempting to demonstrate exactly how value is created from intangible assets. However, as Andriessen (Andriessen 2004) points out, intangible asset scorecards or valuation methods such as the Skandia Navigator (Edvinsson and Malone 1997) and the Intangible Assets Monitor (Sveiby 1997) do not adequately demonstrate cause and effect. Without a thorough understanding of how intangible assets can be effectively accumulated and deployed, static valuation or asset measurements hold little practical value (Allee 2003, Taug 2004).

The method described in this paper focuses on how intangibles accumulate and are deployed in business and organisations, in networks and in regions. Specifically it addresses how networks serve as

mechanisms for value conversion, linking value network patterns to specific types of Intellectual Capital creation and utilisation.

Value conversion is the act of converting one type of value (financial or non-financial) into another form of negotiable value. In the securities profession value conversion is narrowly defined as the positive difference between the market price of a convertible security and the price at which it is convertible. We use the term value conversion in a larger sense as it relates to the managing and utilisation of intangible assets or Intellectual Capital. This usage is closer to how value conversion is handled in social exchange theory (Homans 1958.)

1.1 Intangibles as negotiable deliverables

To understand how intangibles create value, we must first understand how they go to market and are deployed in a business model. Intangibles can be converted into other forms of value as negotiable offerings or outputs. One can convert an intangible asset such as knowledge into the form of a product or service, thereby converting the intangible asset to a tangible output. Intangible deliverables in this sense include all unpaid or *non-contractual* activities that make things work smoothly and help build relationships. In contrast, tangible deliverables include anything that is *contracted, mandated or expected* by the recipient as part of the delivery of a product or service. Tangibles typically are directly connected with generating and delivering on revenue or funding. One also negotiates exchanges of intangibles for other intangibles such as information, benefits or intangible forms of support.

From this perspective intangibles can be considered to be *deliverables* and can be modelled as outputs and inputs. Economists rarely consider these intangible or 'bartered' exchanges in economic models as they usually are not calculated in financial terms. But whenever we negotiate any kind of exchange we are in an economic interaction, whether money is involved or not.

With an understanding that intangibles can also be deliverables then we can begin to address the question of exactly how intangible assets are converted into other forms of value or outputs in the business model. The conversion picture is complete when we also can accurately describe how specific value inputs in turn are used to increase both our tangible and intangible assets.

2. Using VNA to model how intangibles create value

Modelling value conversion requires moving away from static views of intangibles as assets into a more dynamic model of how intangibles create value. Some have attempted to understand intangible value creation as a type of value chain (Lev 2001, 2003). However, the value chain concept is fundamentally limited in understanding value as a dynamic system or model. As business or economic models *value chain, value stream* and *business processes* have their roots in the industrial age production line. Thus they are linear and mechanistic both in orientation and practice, based on a presumption of predictability and control.

In contrast Value Network Analysis is oriented toward a complex adaptive system view of value creation, specifically a living systems view of organisation. VNA understands value as an emergent property of human networks (Allee 2000a, 2000b, 2002). Value conversion occurs through complex interactions where people utilize their tangible and intangible assets to contribute goods, services and support to each other and gain value for themselves.

Sveiby reminds us that organisations are not real entities – they are constructed in a constant process by people (Sveiby 1994, 2001). "If one looks for an organization one will not find it. What one will find are events linked together. These sequences, their pathways and their timing are the forms we tend to make into objects or processes when we talk about organizations". Sveiby observes that these event sequences begin with Weick's response patterns or *double interacts*: "patterns in which an action by actor A evokes a specific response in actor B (interact), which is then responded to by actor A," (Weick 1979). The complete sequence is a double interact.

VNA more commonly uses the term *exchange* as one way of describing this double interact. An A to B action with *no* response would simply be an event or more specifically a single *transaction*. VNA models

value conversion as it is executed by the active agents of that conversion – real people, who engage in exchanges of both tangible and intangible forms of value.

2.1 Growing interest in value networks

It has been well established that network analysis can be used to describe work groups, organisations, business webs and other purposeful networks where both tangible and intangible value exchanges support the achievement of specific outcomes and generate economic and social good (MacCauley 1963, Granovetter and Swedberg 1991). Interest in understanding business models as value networks intensified in the late 1990s as companies achieved rapid success through creatively weaving their business webs.

In a 1997 study VNA revealed the innovative ways companies such as Cisco, Amazon and eBay were operating from very different business models than most of their competitors – before they hit the covers of business journals in any significant ways (Tapcott, Ticoll and Lowy 2000). The difference was how they using intangibles to build real network relationships. These companies as well as Facebook and Google are all based on a value network model or archetype. They have become engines of wealth and growth with multi-billion dollar valuations.

Early discussions about value networks were usually focused on supply chain, using frameworks, scorecards, and variations of supply chain models to describe supply chain networks (Parolini 1999, Bovet and Martha 2000). Benkler (2006) moved more solidly into a value analysis with his landmark book, *The Wealth of Networks*, but focused primarily on Internet-based social production models. Zuboff (2002) drew a bit closer to the network value question in *The Support Economy* with her brief discussion of intangibles in federated support networks.

Social Network Analysis (SNA) has been a valuable tool in the social sciences since the 1930s, and has been widely used in business to address a variety of questions about relationships and communication (Nohria & Eccles 1992). Several analysts are using SNA, both metaphorically and analytically, to try to understand networks as economic entities with some limited focus on intangible outcomes and exchanges (Cross and Parker 2003, Dawson 2003, Iansiti and Levien 2004). Although these efforts provide powerful insights into knowledge flows and relationships, they fall short in being able to demonstrate a direct linkage between network patterns and value creation or value conversion.

VNA has been applied to a wide range of business issues in global companies, start ups, government agencies and non-profit or civil society organisations. Part of its growing popularity is due to the fact that the basic modelling language and method can be learned in just a few hours. Thus it lends itself readily to being a management tool. At the Boeing Company (Boeing), for example, it is included as a method in their Lean+ Toolkit (Angers 2007). Also at Boeing, system dynamic techniques applied to value network modelling of performance dynamics in work was carried forward into a graduate-level course for Boeing employees. The ITIL handbook, a basic guide for the IT community, has included VNA as a strategy tool. More recently, companies like Boeing, Wal-Mart, SAP, and Telenor are focusing on both their strategic value networks and their internal value networks or 'process ecosystems' as well.

2.2 Basics of value network analysis

VNA determines the potential for value creation in internal and external networks by comparing tangible (contractual) relationships to intangible (informational or knowledge sharing) relationships, based on the assumption that creating value and achieving desired outcomes requires both contractual business relationships and informal innovation pathways represented by knowledge sharing and other types of mutual support.

An organisation consists of real people playing a variety of roles in different activities. Any role controls tangible and intangible assets or resources that support execution of the role. Those assets are used to create value outputs or deliverables that can be traded for other forms of value, whether financial or non-financial. Basically, each role initiates or offers a potential deliverable for trade that becomes a completed value *transaction* upon acceptance by another role in the network (Allee 2008).

A Value Network Analysis begins with describing contributing *roles* and *value transactions* visualized as a graph or map. Nodes represent roles, and directional arrows between nodes describe each critical tangible or intangible deliverable in the network. Typically solid lines indicate contractual, *tangible* revenue generating or funding related *deliverables* and their flow paths. Along with those, dashed lines show the critical *intangible* or informal deliverables such as knowledge exchanges and benefits that build relationships and keep things running smoothly. See Figure 1.

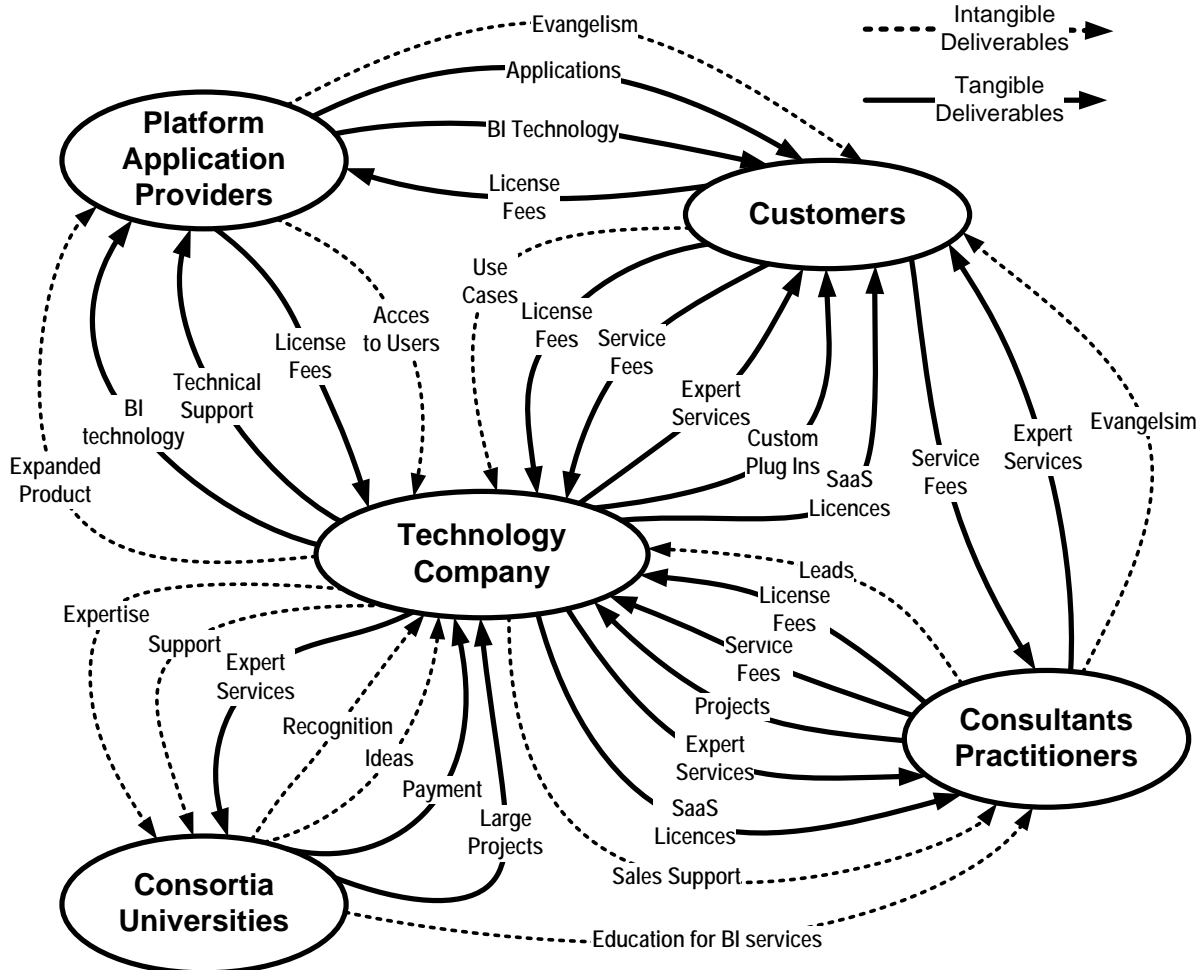


Figure 1: A typical value network graph – for the business model of a technology company

Analyzing a value network requires addressing three basic questions or analyses (Allee 2008):

- (1) *Exchange Analysis:* What is the overall pattern of *exchanges* and value creation in the system as a whole? How healthy is the network and how well is it converting value? Indicators used include classic network structural indicators as well as indicators regarding value flows, such as reciprocity.
- (2) *Impact Analysis:* What *impact* does each value input have on the roles involved in terms of value realisation? In other words, how well are inputs being converted to growth of financial and non-financial assets? Typical categories of asset impact are financial, human competence, business relationships and internal structure (Sveiby 1997.)
- (3) *Value Creation Analysis:* What is the best way to *create, extend, and leverage value*, either through adding value, extending value to other roles, or converting one type of value to another? Value Creation Analysis basically addresses the question of asset utilisation. How well are assets being utilized to generate value outputs for other roles in the network?

Impact Analysis and Value Creation Analysis use a spreadsheet type of assessment that essentially is an expanded Cost/Benefit Analysis. Both address value conversion by expanding assets and deliverables to include intangibles.

3. Modeling value conversion at the level of network and regions

Expanding the VNA method to assess large-scale networks and Intellectual Capital formation at the level of networks and regions requires finding good sources of data and determining intangible asset indicators that can reasonably be linked to value network patterns. Several developmental projects helped to lay the foundation for large scale VNA.

A study of mobile workers in 2006 used VNA to bring a unique role perspective to the needs of mobile workers and their usage of technology and the physical office environment (Venezia, Allee and Schwabe 2008). Data was collected by a survey that allowed insight into the roles and interactions of mobile workers in their internal and external value networks. A total of 557 respondents, representing 84 participating organisations, participated in the study. Findings identified the *type of value* being created, the *level of value* as perceived by the worker, and the *type of output* generated.

The survey provided subjective data for VNA, but non-subjective sources are also important. In 2006 Cisco Systems provided our researchers with proprietary monthly data from their customer interaction network database. Call content could be readily identified as being tangible or intangible in nature. This data was used to generate both value network visualisations and value network indicators as a test case for utilizing large data sets and addressing issues that are global in scope. Additional experience with web-based surveys and handling large-scale data sets was gained in work with Telenor and their Way of Work program (Allee and Taug 2007.)

Another key study in 2006 applied VNA to a national network of institutions and organisations involved in commercializing scientific discoveries in New Zealand under sponsorship of AgResearch, a government agency. There commercialisation activity was described as a series of phase changes in a value network. A similar approach was applied to assessing the impact of innovation systems at the regional level in Europe.

4. Linking value network patterns to Intellectual Capital formation in regions

In 2007 an evaluative study "*Effectiveness of ICT RTD Impacts on the EU Innovation System*" was conducted for the European Commission, DG INFSO Evaluation and Monitoring Unit, by ALTEC SA and Edna Pasher PhD & Associates (Allee et al 2007a and 2007b) under the direction of Peter Johnston, Head of Unit, and Frank Cunningham, Evaluation Specialist. The aim was to assess how effectively EU ICT RTD and deployment initiatives are being exploited in European systems of innovation at member state and regional levels.

Four methodologies were applied to this question: Intellectual Capital Assessment, Value Network Analysis, the PACE toolkit (Project Assets, Core competences and Exploitable items) and macro-econometric Multivariate Statistical Methods. This empirical approach combined a quantitative elaboration of data available for all EU regions with a more in-depth analysis of 10 regions.

There were *three primary goals* for the evaluation: 1) to understand the effectiveness of networks of collaboration in facilitating knowledge transfer across regions and sectors; 2) to identify where and how the links between ICT RTD, technology diffusion and systems of innovation could be strengthened at the EU, Member State and Regional levels; and 3) to target where and how to strengthen the impact of EU ICT RTD and deployment initiatives by leveraging on Structural Funds programmes, co-ordinated public procurement and Information Society deployment initiatives.

4.1 Intellectual Capital assessment

For this evaluation a base set of Intellectual Capital indicators were identified and applied at both the regional and national levels, drawing from established practices in Intellectual Capital and the Skandia Navigator model (Edvinsson and Malone 1997). The Intellectual Capital (IC) framework provided a set of

indicators based on five focal areas: 1) financial capital, 2) market capital, 3) process capital, 4) human capital and 5) renewal and development capital.

Starting from the EUROSTAT data, Intellectual Capital indicators were developed to profile 10 selected regions in terms of the local knowledge base, the structure of local industry and the presence of research and innovation networks within the region. The assessment was based on statistical data representing the five areas of the IC Framework collected from public sources. See Table 1.

Table 1: Regional indicators of Intellectual Capital used in the study

Indicator	Category Intellectual Capital
Human resources in Science and Technology (% of population)	Human Capital
Participation in Life-Long Learning (per 100 population aged 25-64)	Process Capital
EPO Patents per million population	Process Capital
Employment in Medium-High and High-Tech Manufacturing (% of total workforce)	Market Capital
Employment in High-Tech Services (% of total workforce)	Market Capital
Public R&D expenditures (% of GDP)	Renewal and Development
Business R&D expenditures (% of GDP)	Renewal and Development
Unemployment (% of total population)	Financial Capital
GDP per Capital	Financial Capital

4.2 Linking value network patterns to Intellectual Capital formation

An analysis of FP6 data revealed network patterns of typical roles and interactions occurring across FP6 projects. From these basic patterns four specific types of purposeful value networks were identified and categorized as noted below. These categories were not predetermined or driven by instrument, but were a result of a direct analysis of project deliverables as described in project documentation. Analysis of the actual described deliverables made it possible to assign an intended purpose for each project that corresponds to one of the four archetypes.

The value network archetypes are important for two reasons: 1) each archetype generates a Value Network Intellectual Capital Profile based on its typical deliverables and beneficiaries; and 2) The four value network archetypes each support a particular stage of innovation from conception to implementation in the form of commercialization or production.

It can be assumed that in regions where participation in any particular value network archetype is high then there would be a corresponding high performance in generation of Intellectual Capital at both the organizational and the regional levels corresponding with the project deliverables supported by that type of network. Thus regional Intellectual Capital creation can be linked directly with value network archetypes that are the intended outcomes of FP6 programs. Table 2 shows the distribution of value network archetypes across the 10 sample regions.

Table 2: Distribution of value network archetypes across the 10 sample regions

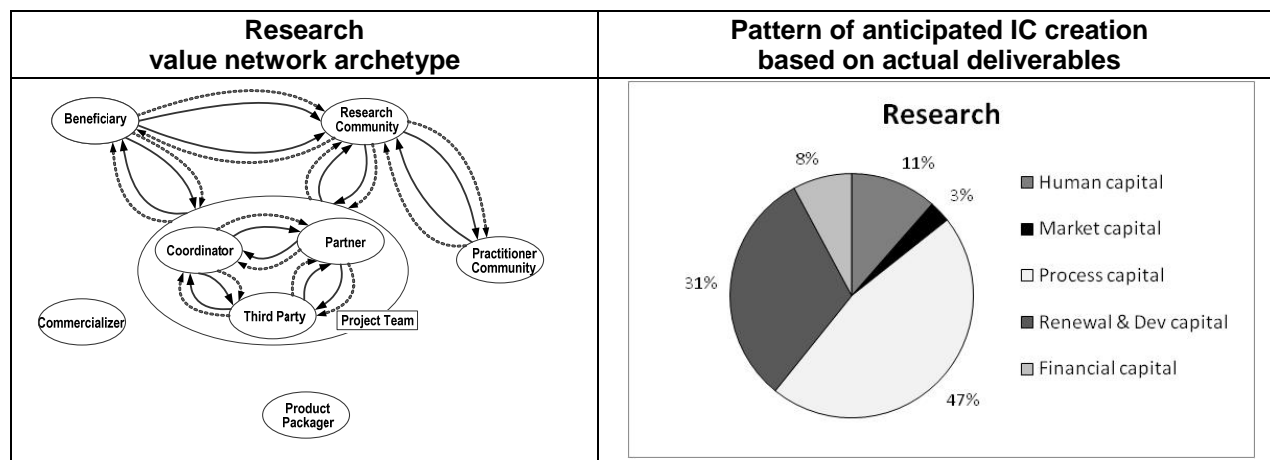
Value Network Analysis	All 10 sample regions
Total number of value network archetypes served (Max: 4)	3
Number of projects supporting archetype: Research	180
Percentage of projects supporting archetype: Research	69.77%
Number of projects supporting archetype: Community Building	60
Percentage of projects supporting archetype: Community Building	23.26%
Number of projects supporting archetype: Market Validation	18
Percentage of projects supporting archetype: Market Validation	6.98%
Number of projects supporting archetype: Commercialization	0
Percentage of projects supporting archetype: Commercialization	0.00%

The following descriptions and visuals have been greatly simplified in order to demonstrate the basic patterns of roles and interactions. Each value network archetype or pattern is shown with a ‘thumbprint’ graph of its anticipated IC formation for the 10 regions. Anticipated IC generation provides a foundation for comparative analysis with the actual IC indicators generated at the organizational and regional level. Analysis of these patterns over time potentially can surface the critical causal relationships between value network patterns and IC formation.

4.2.1 Research value network archetype

Most FP6 projects include descriptions of research activity or innovation exploration. The category of Research was chosen where the *primary* aim is to produce research results or an innovative product. The Research value network shown in Figure 3 consists of tangible and intangible exchanges between the project team (central node with sub-nodes), intended beneficiaries and the research community.

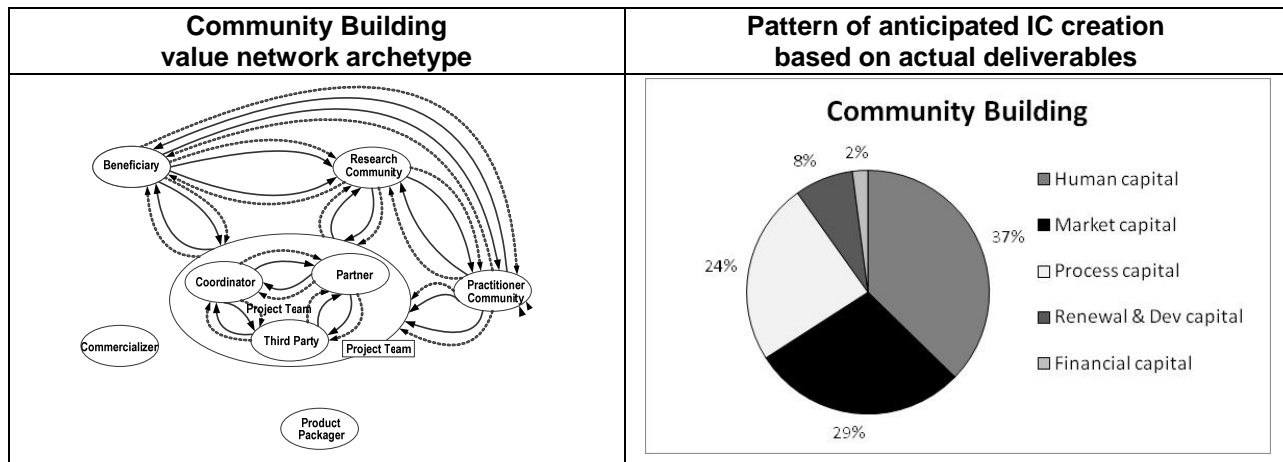
Table 3: Research value network archetype and anticipated IC creation for 10 regions



4.2.2 Community Building value network archetype

The category Community Building was chosen when the aim of the project is primarily coordinated action or building a network or a community of people sharing a common interest or common task. The Community Building value network shown in Table 4 logically builds on the efforts of a Research archetype, although it also could be a precursor to launching a research project. This network type consists of tangible and intangible exchanges between the project team (central node with sub-nodes), intended beneficiaries, research community and the practitioner community.

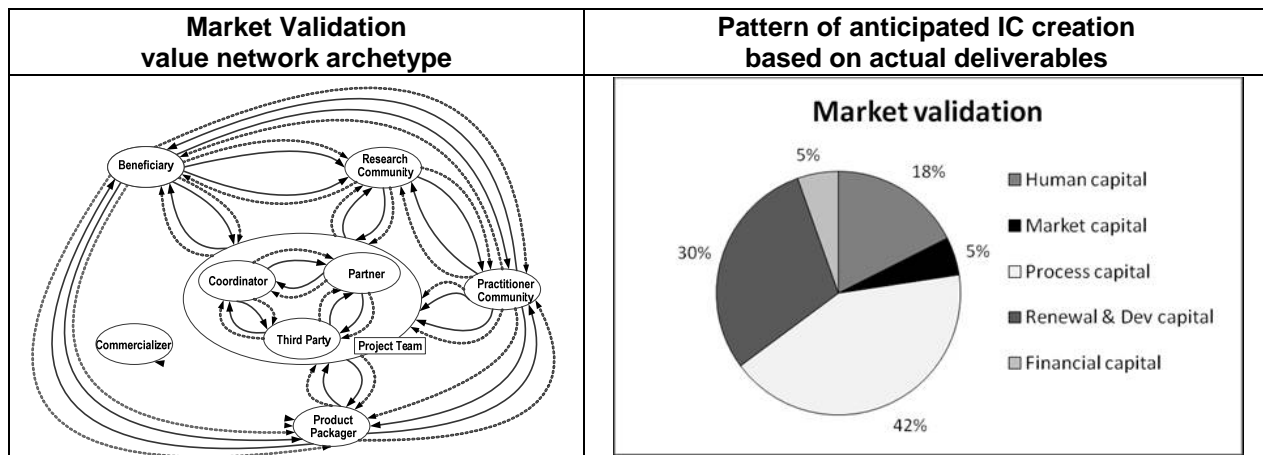
Table 4: Community Building value network archetype and anticipated IC creation for 10 regions



4.2.3 Market Validation value network archetype

The Market Validation category was chosen when the product or the result is well defined, and the project goal is to test and validate market or beneficiary readiness. The Market Validation value network shown in Table 5 logically builds on the efforts of a previous Community Building value network. This network consists of tangible and intangible exchanges between the project team (central node with sub-nodes), intended beneficiaries, research community, practitioner community and the product packager.

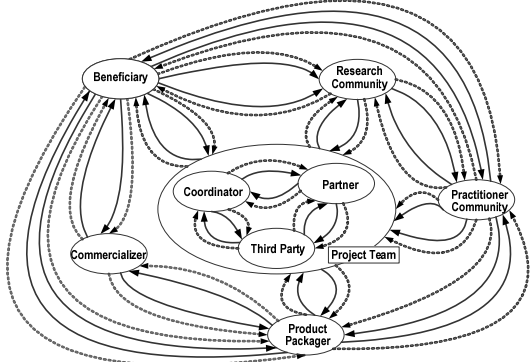
Table 5: Market Validation value network archetype and anticipated IC creation for 10 regions



4.2.4 Commercialization value network archetype (visualization)

Commercialization involves actually bringing the product or result to the market or implementation through production and distribution. The Commercialization value network in Figure 6 logically builds on efforts of a previous Market Validation value network. This network consists of tangible and intangible exchanges between the project team (central node with sub-nodes), intended beneficiaries, research community, practitioner community, product packager, and the commercializer. It then 'closes the circle' through exchanges between the commercializer and the beneficiary. None of the 10 regions in the sampling had this archetype represented in their roles and deliverables.

Table 6: Commercialization value network archetype and anticipated IC creation for 10 regions

Commercialization value network archetype	Pattern of anticipated IC creation based on actual deliverables
	<p>The 10 sample regions did not have a Commercialization value network.</p>

4.2.5 Implications for value network archetypes and Intellectual Capital generation

Since the ICT-RTD programs are not designed to generate direct Financial Capital either for the participating organizations or the beneficiaries of specific projects, assessing financial impact requires indirect evaluation, consideration of value deliverables generated, and comparison of macro-economic data with archetype distribution.

Data mining and project interviews confirmed that not only are there very few cases of organisations being active in both RTD and deployment networks, but there is also little evidence of ICT results having followed the entire value network pathway from invention to development, and from research to deployment/innovation. In-depth analysis of the 10 regions shows the great potential for these value networks to increase innovation capacity, diffuse innovation and contribute to Intellectual Capital formation at the Regional level. Even though the entire innovation process is not supported by current ICT RTD and deployment instruments, the potential for Intellectual Capital Impact and increased network cohesiveness at the organisational and regional level is significant.

While the EU project focused on regions, additional work is underway applying a similar assessment in support of global action networks. Global Action Network Network (GAN-Net) is sponsoring application of VNA to global networks of organizations working in sustainable finance, peace keeping and mass atrocities. This work will deepen the work of connecting value network patterns to Intellectual Capital creation and value conversion.

5. Conclusions

The 2007 EU evaluation demonstrates that research program interactions can be fruitfully represented as value networks, operating both at European and national/regional levels. Regional performance in terms of value created from FP6 project participations depends on the projects being used to improve value network patterns of knowledge sharing, cooperation and connectivity within a region, in addition to benefitting organisations taking part in the project. Value network patterns link to specific value conversion activities and Intellectual Capital formation for project partners as well as to the innovation capacity of the region as a whole.

The practical implication of this work is that Value Network Analysis provides a possible solution to one of the most challenging business issues in the intangibles economy: describing and monitoring the role of intangibles in value creation. Many acknowledge that approximately 80% of a company's value lies in intangibles, yet practical methods for managing intangibles are not widely used. This problem is especially intense in government, civil society and nonprofit organizations and networks. In these cases value impacts are exceedingly difficult to describe in only tangible or financial terms. VNA offers a scalable method for understanding the dynamics of intangibles and value creation at virtually every level of complexity from shop floor and business networks to regions and global networks.

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