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A strategic management framework of tangible and intangible assets

Marco Greco *, Livio Cricelli, Michele Grimaldi

Department of Civil and Mechanical Engineering, University of Cassino and Southern Lazio, Via G. Di Biasio 43, 03043 Cassino (FR), Italy

KEYWORDS
Tangible assets;
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Interdependencies;
Analytic network process;
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Summary This article is aimed at supporting the management in the strategic planning of investments on critical value drivers, taking into consideration their impact on competitive advantage and the cumulative investments made on them. We describe a framework through a step-by-step procedure. No previous strategic management framework has adopted a holistic approach to the strategic analysis of value drivers. In fact, unlike many other strategic management models, our framework adopts a competitive advantage perspective considering both the wholeness of organizational value drivers and the interdependencies among the value drivers. Managers are asked to make pairwise comparisons that are synthesized through the analytic network process. The outputs of the synthesis are analyzed both qualitatively (synoptic analysis) and quantitatively (Spearman's and Kendall's non-parametric rank correlation coefficients). The analysis of the resulting values turns in useful strategic suggestions for the top management in order to enhance the organizational strategic coherence.

Introduction

Organizations try to achieve competitive advantage (CA) in order to make more profits, gain market shares and increase their success in a long period perspective. Thus an organization should try to understand which of its tangible assets (TA) and intangible assets (IA) influence the sustainability of CA the most.

This article helps the management of an organization to make a ranking of its assets according to their capability to sustain CA, and to compare such capability with a holistic assessment of the cumulative investments made on the organizational assets.

In the first part of the article we conduct an in depth analysis of the literature about CA, decision support systems for the assessment and enhancement of an organization, and valuation of TA and IA. We identify critical groups of both TA and IA, classifying them according to a theoretical model. Critical asset groups are hereafter called ''value drivers'' (VDs) in order to emphasize their attitude to enhance the total value created by an organization and to sustain CA. We will also show that several authors recurred to VDs in order to perform organizational analysis and provide suggestions to the management.

* Corresponding author. Tel.: +39 0776 299 3641, mobile: +39 3201549032; fax: +39 0776 299 4353.
E-mail addresses: m.greco@unicas.it (M. Greco), cricelli@unicas.it (L. Cricelli), m.grimaldi@unicas.it (M. Grimaldi).

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In the second part of the article we present a step-by-step procedure for the implementation of the strategic management framework, which includes an assessment of the VDs' relative impact on CA through the analytic network process (ANP), an assessment of the relative weights of the organization's past investments on VDs through pairwise comparisons, and a strategic analysis of the results through synoptic and statistical approaches.

The third part of the article shows the results deriving from an implementation of the framework on a public agency.

Finally, in the fourth part, relevant conclusions and future developments of our research are discussed.

Theoretical background

Michael Porter is considered the father of CA theory, while several articles and books had dealt with the argument before his ''Competitive Advantage: Creating and Sustaining Superior Performance'' (1985). However, he succeeded in merging previous literature from different disciplines and organizing it in a holistic and innovative way. He defined the sustainable CA as ''*the fundamental basis of above-average performance in the long run*'' (Porter, 1985, p. 11) and suggested three generic strategies (cost leadership, differentiation and focus) as sources of CA (1985). Resource based view, on the other hand, argued that in order to achieve CA, firms need to search for valuable, rare, inimitable, and non-substitutable assets (Barney, 1991). Assets are ''valuable'' if they can exploit opportunities and/or neutralize threats, ''rare'' if the organization's current and potential competitors can hardly have them, ''inimitable'' if they are imperfectly imitable by other resources, and ''non substitutable'' if they cannot be substituted with other resources that are valuable but neither rare or imperfectly imitable. Others identified different critical groups of properties, such as durability, transparency, transferability and replicability (Grant, 1991); inimitability, durability, appropriability, substitutability and competitive superiority (Collis & Montgomery, 1995); complementarity, scarcity, low tradability, inimitability, limited substitutability, appropriability, durability, and overlap with strategic industry factors (Amit & Schoemaker, 1993). Amit and Schoemaker (1993) also distinguished resources from capabilities, the formers being non-specific of the firm and therefore tradable, the latters pertaining exclusively to the firm. Developments in the resource based view brought some scholars to appraise prevalently resources and capabilities pertaining knowledge (Barney, Ketchen, & Wright, 2011), giving birth to the knowledge based view. Teece (2007), Teece (2009) carried forward such theory adopting a dynamic approach focused on the organizational dynamic capabilities, as organizations create, integrate, and reset continuously the most critical resources to achieve CA.

Although CA is traditionally referred to for-profit or business sector, also non-profit organizations have to compete with each other in order to obtain community support and achieve government grants (Fletcher, Guthrie, Steane, Roos, & Pike, 2003).

The scholars supporting the resource based view, as well as those supporting the knowledge based view or the dynamic capabilities view, made special efforts to categorize the components of their theoretical models, arranging them into coherent groups. Frequently, ''assets'' or ''unique skills'' have been grouped in VDs (e.g., Carlucci & Schiuma, 2009; Green & Ryan, 2005; Low, 2000), whose balanced and inspired management can enhance value creation and CA (Matthyssens & Vandenbempt, 1998). Managers may find difficult to comprehend the specific impact of each VD on CA, because most VDs (especially intangible ones) create value through interactions with the others (Carmeli & Tishler, 2004). Thus, an assessment based on the contribution of a VD by itself would be probably inaccurate.

Both TA and IA (knowledge and relational based) have been considered as potential sources of CA (Argote & Ingram, 2000; Boisot, 1998; Dyer & Singh, 1998; Flamholtz & Hua, 2003). As discussed by Andriessen (2004), TA and IA may be evaluated (defining their value in monetary terms), measured (defining their value using non-monetary criterions translated into observable phenomena such as the number of an organization's patents), or assessed (their value is not calculated on the basis of observable phenomena, but instead on the personal judgment of an evaluator). While investments on TA can be easily monetized, and many financial and economical ratios have been defined, the valuation of investments on IA has represented a challenge (Capece, Cricelli, Di Pillo, & Levialdi, 2010; Edvinsson and Malone, 1997; Grimaldi & Rippa, 2011; Lev, 2001; Sveiby, 1997; Teece, 2000). Lately, authors defined methods to monetize IA by integrating the strategic viewpoint of an organization in the form of mutual influence among assets, interrelation between IA and TA performance and strategic developments (Jhunjhunwala, 2009; Moeller, 2009). However, TA and IA monetization may not reflect the internal dynamics of value creation, and the economic value of the formers may not be compared with that of the latters (Bontis, 1998; Cricelli & Grimaldi, 2008; Marr, 2008).

Decision support systems emerged in order to facilitate managers in making the best decisions to achieve CA (Eom & Kim, 2005). The early systems were close to Porter's vision of a CA enhanced by the organizational strategies. For example, Tavana and Banerjee (1995) defined an analytic hierarchy process (AHP)-based methodology for the evaluation of strategic alternatives (such as centralization of a department versus the implementation of certain organizational changes). More recently, several decision support systems embraced the resource based view, focusing on the determination of critical strategic assets for the CA. Low (2000) developed a ''value creation index'' focused on nine VDs in order to support the management in their evaluation. He identified indicators for each VD, standardized them to a common scale, and traduced them into one overall score. Carmeli (2004) introduced the ''strategic analysis technique'': a framework for the assessment of IA in which participants were asked to choose up to seven VDs possessed by their firm and to distribute a total of 525 points among them according to Barney's four properties. However, the approach proposed by Carmeli does not allow the evaluation of interdependencies among VDs. Green and Ryan (2005) assessed intangible VDs weights through the AHP in order to find those more critical to the value creation process. In their work, Carlucci and Schiuma (2009) considered also the interdependencies among assets

through the ANP. The resulting model provided a ranking of the knowledge assets critical to the new product quality improvement process. Finally, Grimaldi, Cricelli, and Rogo (2012) assessed the most relevant VDs through AHP or Delphi analysis, in order to estimate an overall indicator of intellectual capital.

As shown, even though many authors proposed frameworks to enhance the comprhension of VDs, their models have been focused on specific subsets of VDs (such as TA or IA), or did not consider the interdependencies among the VDs, or were focused on specific organizational goals (such as new product quality improvement). To overcame some of the limitations of the existing decision support systems, and to help managers in prioritizing investment in specific areas and tracking the effectiveness of their choices, we adopted a holistic approach to the strategic analysis of VDs, addressing the following research question:

Q1: Can a framework be defined to support the management in the strategic planning of investments on critical VDs, taking into consideration their impact on CA and the cumulative investments made on them?

Q1 embeds two sub questions:

Q1.1: As TA and IA may mutually influence one another, how can managers understand their capability to enhance CA?

Q1.2: How can the amount of investments made on TA (which are easy to valuate through monetary techniques) be compared with the investments made on IA (which are often measured through non-monetary proxies)?

Strategic management framework

In order to answer to the research question and sub questions we identified 10 basic VDs that are suitable to represent sources of CA in most industries: tangible assets, customers, institutions, investors, partners & suppliers, internal relationships, corporate culture, know how, intellectual property, process. More VDs could be identified in order to fit the characteristics of specific organizations, but this would make impossible any inter-organization or inter-industry comparison. The VDs may be classified according to a hierarchic structure (Figure 1). More detailed hierarchies may be realized in order to fit the characteristics of specific organizations, but this would make impossible any inter-organization or inter-industry comparison.

We consider two macro-categories of VDs:

- The **TA** macro-category (Durnev, Morck, & Yeung, 2004) deals with the organization's equipment and infrastructure, both physical (such as logistic centrality of the plant, access to plenty of water or to mines of raw materials) and technological (such as sophisticated mainframes or advanced machineries) (Calabrese, Gastaldi, & Levialdi, 2005; Capaldo, Rippa, & Teta, 2008).
- The **IA** macro-category (Hall, 1992; Kristandl & Bontis, 2007) includes all the other assets that may not be considered ''tangible'' in general. It can be classified according two categories:
  - o The **Relationships** category (Sveiby, 1997) deals with the organization's network with stakeholders and with its internal relational dynamics, and is also known as ''Social Capital'' (Nahapiet & Ghoshal, 1998). The category can be divided into two subcategories:
    - ■ Internal relationships: refer to vertical relationships (e.g., the interaction dynamics among managers and team leaders and among team leaders and staff) and to horizontal relationships (e.g., the interaction dynamics among workers at the same hierarchic level).
    - ■ External relationships: refer to the relationships with external stakeholders. This sub-category has been further detailed into ''customers, suppliers, institutions, investors and partners'' in order to provide useful and circumstantiated strategic suggestions through the application of the proposed framework (Calabrese, 2012; Cricelli & Grimaldi, 2010; Cricelli, Grimaldi, & Levialdi, 2011).
  - o The **Knowledge** category deals with human resources tacit knowledge and with the organization explicit knowledge (Nonaka, 1994).
    - ■ Tacit knowledge refers to the human resources tacit know how and to the corporate culture within the organization.
    - ■ Explicit knowledge refers to the intellectual property of the organization (such as trademarks, patents and licenses) and to its processes (such as methods of production, organizational dynamics and knowledge management support systems) (Costa, 2012; Costa & Evangelista, 2008).

VDs' impact on CA is assessed on the basis of the four critical asset properties defined earlier by Barney (1991), through the ANP (Saaty, 1996). The ANP has been used in the literature for several purposes (Sipahi & Timor, 2010). It is a multicriteria theory of measurement that generalized the widely known AHP. It is characterized by an influence network of clusters and nodes contained within the clusters. While AHP only allows comparisons based on hierarchic structures with no feedback, the ANP is much more flexible and detailed in the analysis of interdependencies. The ANP ''*synthesizes the outcome of dependence and feedback within and between clusters of elements*'' (Saaty, 2004, p. 1). Such synthesis is based on pairwise comparisons about which of two elements dominates the other with respect to a criterion, and which of two elements influences a third one more with respect to a criterion. Hereafter we present the step-by-step application of the framework, including:

1. Assessment of the VDs' impact on CA through the application of ANP to the VD tree.
2. Assessment of the relative investments made on each VD with respect to the others through pairwise comparisons.
3. Strategic analysis of the results through statistical and synoptic tools.

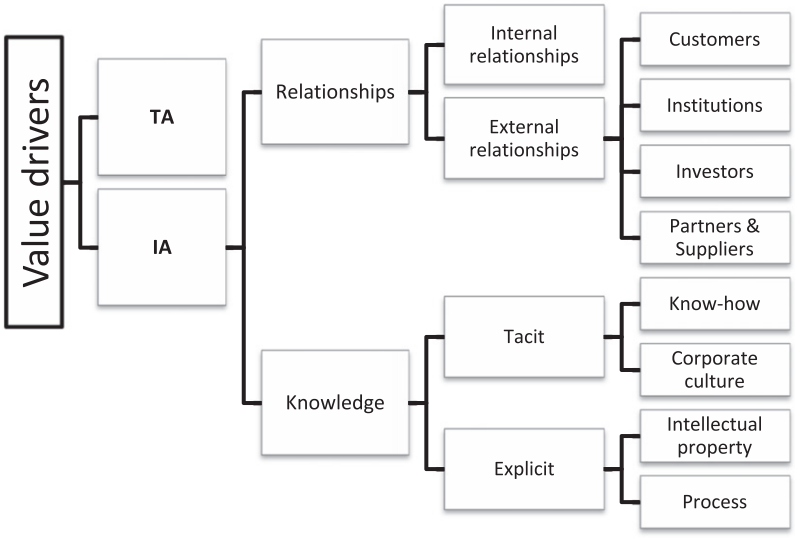

Figure 1 Categories and components of the VD theoretical tree.

Step 1-assessment of the VDs' impact on CA

An assessment may be based on two types of judgment: comparative and absolute (Blumenthal, 1977). Both of them are based on comparisons: in the former two *stimuli* are compared while they are both present to the observer; in the latter one *stimulus* is compared with the observer's memory of past assessments or information held in short-term memory. Experimental economics showed that people are not comfortable with absolute judgments and that cognitive biases are likely to happen (Ariely, 2009). The top-managers of an organization have a holistic comprehension of the sources of its CA; on the other hand their understanding of the absolute value of each source may be biased by their own bounded rationality and by self-reinforcing influences that can distort their perception of a VD's impact on the overall performance (Grimaldi et al. (2012)). Moreover, managers overestimate their own organizations' competencies, especially when their nature is ambiguous (e.g., IA) (Powell, Lovallo, & Caringal, 2006). Pairwise comparisons might reduce such biases, because the observer has to make simple judgments, answering to the following question: ''*Given a control criterion, a component of the network and a pair of components, how much more does a given member of the pair influence that component with respect to the control criterion than the other member?*'' (Saaty, 2005, p. 124).

In the first step of the framework, managers are asked to make comparative judgments based on the general goal: ''VD's impact on CA''.

Step 1.1 — Model construction

The model is kept as simple as possible in order to avoid redundancies and to facilitate its application to organizations competing in virtually any industry. The ANP network structure consists of two clusters of elements that are listed in Table 1 and refers to the VD Theoretical tree defined earlier and to the properties of an asset that can make it a source of sustainable CA, as defined by Barney (1991). We choose to focus on Barney's properties because they are by far the most cited in the literature and suitable for contemporaneous TA and IA. Indeed, Barney's four properties have been used for similar purposes also in the past (e.g., in Carmeli, 2004).

Table 1 Clusters in the ANP network structure.

Cluster 1 — properties	Cluster 2 — VDs
P.[1] Value	VD.[1] Customers
P.[2] Rarity	VD.[2] Institutions
P.[3] Inimitability	VD.[3] Investors
P.[4] Non-substitutability	VD.[4] Partners and suppliers
	VD.[5] Internal relationships
	VD.[6] Corporate culture
	VD.[7] Know how
	VD.[8] Intellectual property
	VD.[9] Process
	VD.[10] Tangible assets

Cluster 1 can be easily integrated with one or more properties defined by other authors, in order to fit the specific characteristics of an organization. Likewise, managers can add in Cluster 2 other VDs, or modify existing VDs in order to describe their organization more accurately. They can also customize the framework deleting one or more VDs, if they consider them not relevant, although this may result in different weights. However in a large scale analysis involving many organizations, such modifications will impede any comparison among them.

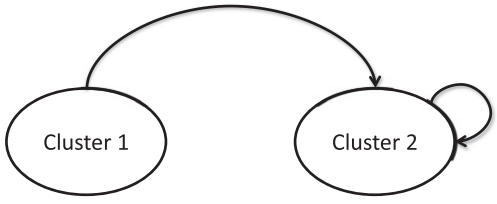

Figure 2 The proposed ANP network structure.

Table 2 The matrix of influences among VDs in Cluster 2 (*a black box indicates that the row VD influences the correspondent column VD*).

	VD.1	VD.2	VD.3	VD.4	VD.5	VD.6	VD.7	VD.8	VD.9	VD.10
VD.1. Customers			■	■			■		■	■
VD.2. Institutions			■			■			■	■
VD.3. Investors		■		■				■	■	■
VD.4. Partners & Suppliers	■	■	■			■	■	■	■	■
VD.5. Internal Relationships						■	■		■	
VD.6. Corporate culture				■	■				■	
VD.7. Know How	■	■	■	■	■			■	■	
VD.8. Intellectual property	■		■	■			■		■	■
VD.9. Process	■				■	■	■	■		■
VD.10. Tangible assets	■	■	■	■	■		■	■	■	

Figure 2 depicts the relationships within and between the clusters. The loop in Cluster 2 indicates that the elements within it mutually influence one another, and the arch from Cluster 1 to Cluster 2 indicates that elements of the former influence those of the latter.

Our generic framework allows interdependencies between each couple of VDs and between each property and each VD. However this turns into a very large amount of pairwise comparisons ($O(VD^3)$), thus managers may discard one or more VDs, or delete interdependencies within Cluster 2 before starting the assessment. This simplification process may reduce dramatically the managers' assessment effort, avoiding unnecessary comparisons. Table 2 shows a simplified network of interdependencies (represented through a matrix where a black box means that the row VD influences the column VD) among VDs which reduces the management's efforts of almost 40%. Even when a VD is not influencing another directly is still influencing it indirectly. In the simplification process we removed unlikely direct influences. For example, it is unlikely that the organizational internal relationships will influence the external relationships with the institutions. Influences can be brought back to fit with the specific context of the framework implementation (e.g., peculiar ''active'' investors such as venture capitalists may want to enhance directly the workers' know-how, while usually they only improve processes, influencing know-how indirectly), as well as more arches can be removed (e.g., the investors' direct impact on process and intellectual property may be discarded in an organization that cannot obtain investments from ''active investors'').

Step 1.2 — Pairwise comparisons

The elements of both clusters are compared pairwise in terms of their relative importance with respect to one upper-level element or cluster at a time. Managers are asked to express their judgments on the basis of Saaty's Scale (Saaty, 1980), saying whether the two elements are equally important, or one is moderately more important, strongly more important, very strongly more important, or extremely more important than the other. Verbal judgments are then translated in numerical values (1, 3, 5, 7, 9 respectively, while even numbers from 2 to 8 are considered intermediate values). Pairwise comparisons allow estimating the relative priority weights through the computation of eigenvalues and eigenvectors (Saaty, 1980).

The following comparisons must be completed:

- Comparisons between P.i and P.j (for all i, j = 1..4) with respect to VDs' impact on CA (e.g., value is three times more important than rarity with respect to the capability of a VD to enhance CA).
- Comparisons between VD.h and VD.k (for all h, k = 1..10) with respect to VD.z (for all z = 1..10, if both VD.h and VD.k are connected directly with VD.z by an arch) (e.g., know how is five times more important than TA with respect to the development of intellectual property that may impact on CA).
- Comparisons between VD.h and VD.k (for all h, k = 1..10) with respect to P.i (for all i = 1..4) (e.g., corporate culture is nine times more important than TA with respect to inimitability).

The comparative assessment may be conducted by a single top manager as well as a group of top managers. In case of multiple interviews, the comparisons may be synthetized using the weighted geometric mean method (Saaty, 1980). Some authors tried to overcome the limitation of the AHP method, merging experts' indications with objective judgments: for example Falsini, Fondi, and Schiraldi (2012) tried to correct eventual errors resulting from the acceptance of interviews where the consistency ratio is high using historical data analysis.

Step 1.3 — Check consistency of judgments

One of the assumptions of perfect rationality theory refers to the transitivity of judgments (if you prefer A to B, and

$$W = \begin{array}{c} \\ VD_1 \\ VD_2 \\ \vdots \\ VD_9 \\ VD_{10} \\ - \\ P_1 \\ P_2 \\ P_3 \\ P_4 \end{array} \begin{bmatrix} w_{1,1} & \cdots & w_{1,10} & | & w_{1,11} & \cdots & w_{1,14} \\ & & & | & & & \\ \vdots & & & | & & & \vdots \\ & & & | & & & \\ & & & | & & & \\ - & - & - & - & - & - & - \\ w_{11,1} & \cdots & w_{11,10} & | & 0 & \cdots & 0 \\ & & & | & 0 & 0 & 0 \\ & & & | & 0 & \vdots & 0 \\ w_{14,1} & \cdots & w_{14,10} & | & 0 & \cdots & 0 \end{bmatrix}$$

Figure 3 The W matrix.

$$A = \begin{array}{c} \\ VD_1 \\ VD_2 \\ \vdots \\ VD_9 \\ VD_{10} \end{array} \begin{bmatrix} 1 & a_{1,2} & \cdots & a_{1,9} & a_{1,10} \\ \frac{1}{a_{1,2}} & 1 & & & \\ \vdots & & & & \vdots \\ & & & & \\ \frac{1}{a_{1,10}} & & \cdots & & 1 \end{bmatrix}$$

Figure 4 Triangular matrix A.

B to C, than you also prefer A to C). As the number of alternatives increases, transitivity is challenged and a real person's judgments are usually inconsistent (Saaty, 2004). Inconsistency is considered acceptable if the consistency ratio (CR) — as defined by Saaty (1980) — is not higher than 0.1. If CR is higher than 0.1, managers should revise their judgment in order to obtain a feasible value of CR. Some suggestions may be provided to them in order to find quickly the judgments that increase inconsistency the most (Saaty, 2006).

Step 1.4 — Supermatrix construction
Once consistency of judgments has been verified, the weights can be included in the supermatrix W, which is a partitioned square matrix that describes the influence of an element on the left of the matrix on an element at the top of the matrix. The W matrix used in our framework is described below (Figure 3).

By construction, there is no reciprocal influence within the Cluster 1 of properties (no loop), thus all the elements in the corresponding partition of the W matrix are 0.

Once all the weights are introduced in the supermatrix, a weighted supermatrix W_s is calculated as $W_s = W \times C$, where C is the matrix of clusters' weights. Then W_s is raised to powers of $2k + 1$ (with k large enough to find an approximation of W^{∞}) in order to indicate the long-term mutual influences of the elements. All the columns of the limit supermatrix W^{∞} are the same, and stand for the overall priorities.

Step 1.5 — Estimation of VD's impact on CA
The values corresponding to VD1 ... VD10 in any of the columns of the limit supermatrix can be normalized and the resulting normalized values will represent an assessed impact of the VD on the CA of the organization.

Step 2-Assessment of the relative investments on VDs

The second step of the framework aims to assess the long-term organization's investments on VDs. An objective measurement of the VDs, although desirable, would lead to different units of measurement that may not be compared one with another, unless they are all converted in monetary values, which may not be a correct approach to the problem as discussed before. Thus, managers are interviewed again in order to calculate a ''vector of the relative investments on VDs''. In the third step, the vector will be compared with the one estimated in Step 1.5.

Step 2.1 — Pairwise comparisons
The same managers interviewed during the first step are asked to complete a short series of pairwise comparisons between VDs, determining ''how many times'' the cumulative organization's investments on one VD are higher or lower than those made on another. While a precise measurement of such cumulative investments may be impossible (especially regarding IA), a global understanding of such investments' order of magnitude is sufficient to complete the pairwise comparisons effectively, which are resumed in the triangular matrix A (Figure 4).

Where the element a_{ij} can be interpreted as ''the i-th VD benefited of a times more investments than the j-th one''.

Weights are finally estimated through the computation of eigenvalues and eigenvectors (Saaty, 1980).

Step 2.2 — Check consistency of judgments
Consistency of judgments is verified as done in Step 1.3.

Step 2.3 — Estimation of the relative investments on VDs
The weights $Y_1, \ldots, Y_i, \ldots, Y_{10}$ resulting from Step 2.1 and Step 2.2 show managers' perception of the organization's repartition of the investments on VDs.

Step 3-Strategic analysis

The normalized vector of VDs' impact on the CA is now compared with the normalized vector of investments repartition. Table 3 shows an example of the appearance of the comparison between the two vectors. If in Step 1.1 the manager discarded one or more VDs, the corresponding values in the ''impact on CA'' vector are set equal to 0.

The strategic analysis of the results can be conducted through two different approaches: synoptically, and/or statistically. A benefit/cost analysis cannot be conducted in this case, because even though ''impact on CA'' may be interpreted as ''benefit'' and ''cumulative investments'' as ''costs'', the former ones have a long term interpretation that goes from the past to the future, while the latter ones have a long term interpretation that refers only to the past.

Table 3 Example of comparison between the vectors of Impact on CA and cumulative investments.

	Impact on CA	Cumulative investments
VD.1.	X_1	Y_1
VD.2.	X_2	Y_2
—	—	—
VD.10.	X_{10}	Y_{10}
TOT	1.00	1.00

Step 3.1 — Synoptic strategic analysis
Synoptic strategic analysis may be conducted drawing a matrix similar to Figure 5 on the scatterplot of the two series. The four circles represent exemplificative VDs. A partition into four areas of action (resulting from the combinations of high/low cumulative investment and high/low impact on CA) is useful to provide strategic recommendations. The partition can be based on a central tendency indicator, such as mean, mode or median of the calculated values.

''*Lost bets*''. VDs positioned like ''A'' benefited from large cumulative investments that cannot be justified with an impact on CA. They may depend on past miscalculations of technological or social expected trends that changed suddenly, leaving the organizations without significant returns from such investments (e.g., a European light bulb enterprise builds a new plant for the production of traditional light bulbs, which are banned from the European market a few years later). Even though it is often difficult to admit mistakes of this entity, continuing investing on such VDs may be a real waste of resources. In the absence of any other tactic or operational reason, new investments on such VDs should be avoided.

''*Flagships*''. VDs positioned like ''B'' are an outstanding example of strategic coherence and awareness of the sources of CA: critical VDs are getting the attention that they deserve. For example the huge investments made on data search algorithms allowed the incumbents in the Internet search engine market to achieve a strong CA over potential competitors. Managers should plan future investments in order to maintain such VDs on high levels and avoid them from becoming ''Runner-ups''.

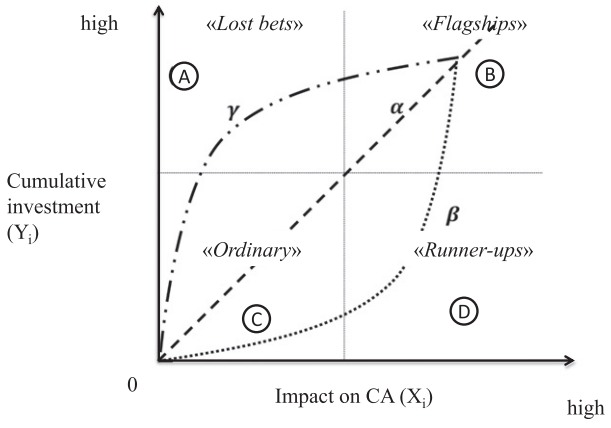

Figure 5 Example of synoptic strategic analysis.

''*Ordinary*''. VDs positioned like ''C'' are also an example of strategic coherence: nuisance VDs are not getting overinvestments. Managers should avoid planning investments on such VDs, unless they have any other tactic or operational reason. It is quite important to specify that these VDs are only ''comparatively useless'' with respect to others, but they may be useful in some ways in absolute terms. For example, investments on the corporate culture in a cement factory may somewhat improve its performance; nonetheless the same investments may produce much more benefits if used to buy the exclusive license of an innovative mixture.

''*Runner-ups*''. Finally, VDs positioned like ''D'' are high-potentials that have not been exploited by the organization. This may depend on recent changes in the industry (e.g., a new technology may be purchased in order to achieve a strong CA), or on a limited investment capacity of the organization, which forced to invest on ''Flagships'', or on wrong strategic choices, which resulted in investments on ''Lost bets''. ''Runner-ups'' should benefit of more investments, because they can be powerful sources of CA and they are actually undervalued.

Even though it is difficult to provide generic considerations about where to invest or disinvest, some exemplificative guidelines may be provided. In general, managers should prefer investing on VDs below the bisector α in Figure 6, disinvesting from those above it. If the investment capacity is very limited, the management could use a curve similar to β, focusing their investments on ''Flagships'' and on best ''Runner-ups''. On the other hand, if the investment capacity is very high, they may take as a reference a curve similar to γ, which includes the best VDs of ''Lost bets'' and ''Ordinary''.

Step 3.2 — Statistical strategic analysis
In this step of the strategic analysis the two vectors are compared trough non-parametric correlation statistics such as Spearman's (ρ) and Kendall's (τ) rank correlation coefficients, because both series are unlikely to be normally distributed.

ρ and τ can be interpreted as ''Indexes of Strategic Coherence'' (ISC): the more their value is statistically significant and close to 1, the more the investments of the corporate have been coherent with the research of CA.

If ISC are statistically significant and close to -1, the strategic choices of the management have been deliberately incoherent and should be accurately analyzed to avoid further waste of resources.

Finally, ISC with low statistical significance may be interpreted as the lack of a strategic plan of investments on VDs enhancing CA, because only some of the investments have been coherent with the VDs' impact on CA.

ISC can be used also in order to compare an organization with other ones that recurred to a different number or typology of VDs, or track temporal evolution of the strategic coherence within the same organization.

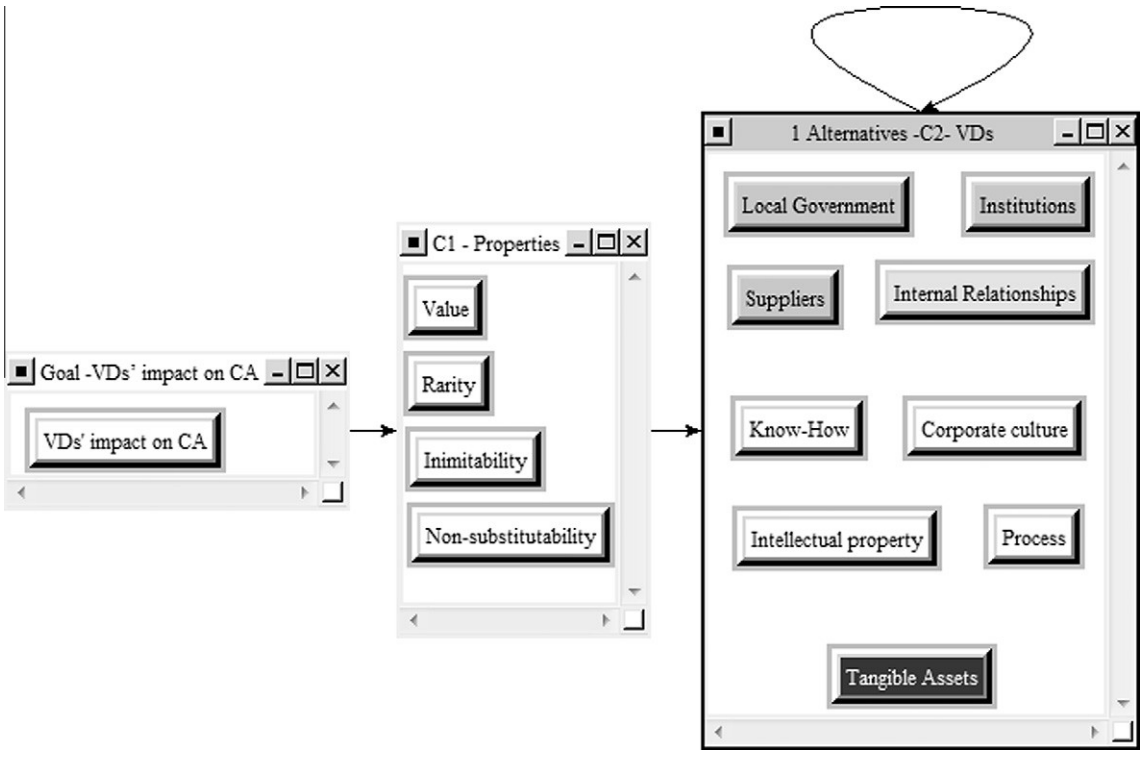

Figure 6 Super decisions screen shot of the ANP network structure.

An implementation of the framework

In order to show the extreme adaptability of the framework to various industries, hereafter we discuss an implementation in a non-profit agency for the development of Information and Communication Technologies in an Italian region. Most Italian regions own a similar agency. The agency is owned by the local government, which is also the only possible investor, and works to implement the regional Information and Communication Technologies policies. In this case, a definition of CA cannot be focused on the comparison with real competitors. Thus, at the beginning of the interview conducted with the General Manager, we agreed on a definition of CA fitted to the organization's peculiarities: ''The basis to provide services more effectively and efficiently than other agencies in Italy''. Then, as ''customers'' and ''investors'' coincide in the same body, we merged the two VDs in the ''Local Government'' VD. Moreover, when considering the VD ''institutions'', we excluded the local government from it. Figure 6 shows how the resulting ANP network structure appears in the computer program Super Decisions (Adams & Creative Decision foundation., 2009), which is specifically designed to implement the ANP. Saaty and Saaty (2002) wrote a useful manual that both provides theoretical concepts regarding AHP and ANP, and explains how to use Super Decisions.

Once discussed the characteristics of the elements within Cluster 1 and Cluster 2 we started the pairwise comparisons. Figure 7 shows how the interviewer took note of each comparison through the computer program Super Decisions.

Overall, the interview lasted almost three hours. The resulting strategic analysis has been based on the two vectors of Impact on CA and cumulative investments, which are shown in Table 4 and mapped synoptically in Figure 8.

The two lines that divide the area into four parts have been drawn in correspondence of 0.11 (mean value). The increasing austerity in Italian public administration pushed us to choose β as a reference curve to analyze the VDs. Noticeably, X_i and Y_i are not supposed to be interdependent. Thus, if the management chooses to invest more on a specific VD, its X_i will not necessarily increase in the future. If its X_i is quite high, it is likely to expect an increase in the organizational performances, which depends on both the amount of investments made on a VD and its impact on CA. For example, if the Synoptic Strategic Analysis shows that ''the VD 19 has the highest value of X_i'' it would be reasonable to invest on it, because its impact on CA is comparatively higher than other VDs and the return on investments could be higher. Often investments are affected by diminishing returns, thus it may be also reasonable to reduce further investments on VD 19 if it benefited of high amount of money.

In the synoptic strategic analysis represented in Figure 8 the only ''Flagship'' is the VD.9-process: an accurate process is critical to avoid risks of disputes and inefficiencies, this point has been understood by the past management and there is space for further investments, for example through an extensive business process reengineering. The position of the VD.6-Corporate culture and VD.5-internal relationships (and possibly VD.7-know how and VD.8-intellectual property) shows that individual and organizational knowledge and internal relationships are critical to achieve the CA in the agency, but they have been largely undervalued in the past, also in consideration of the normative

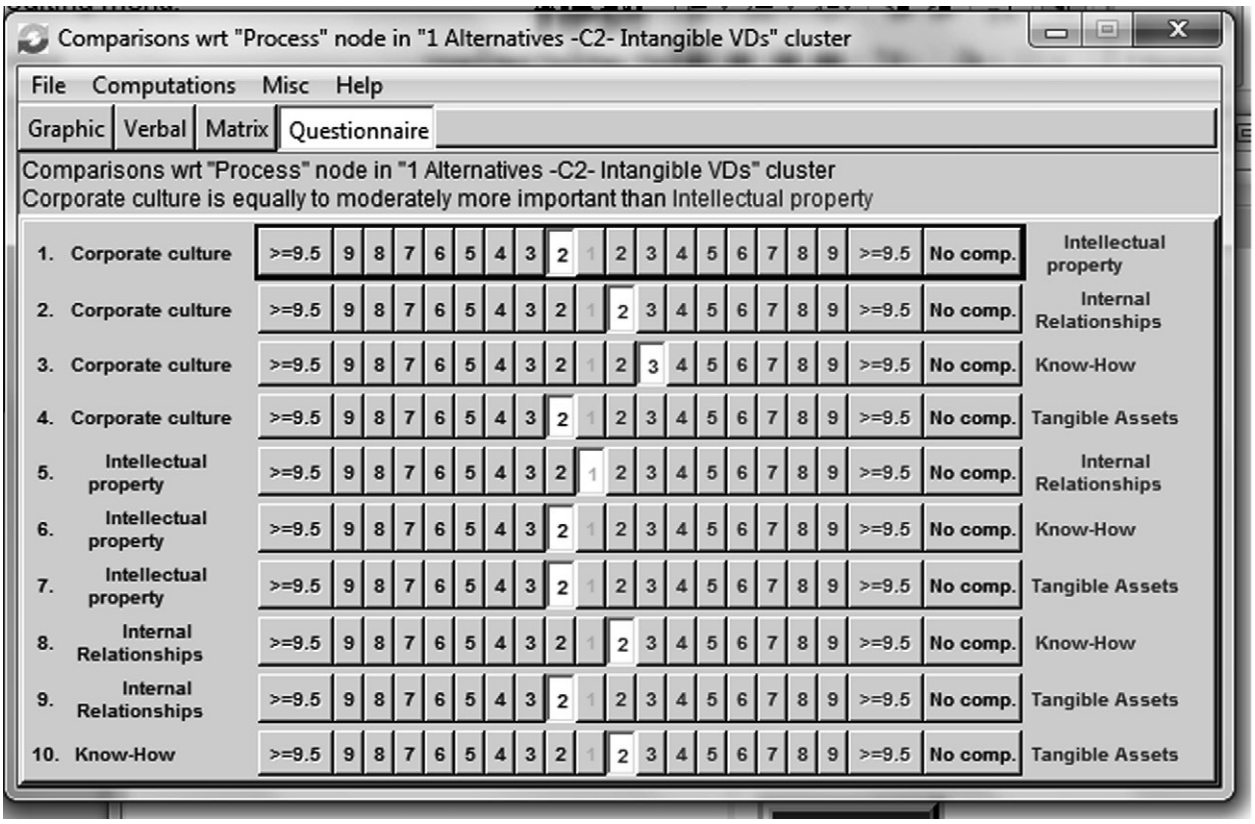

Figure 7 Super decisions screen shot of the comparisons with respect to the ''process'' node.

Table 4 Comparison between the vectors of Impact on CA and Cumulative investments.

		Impact on CA	Cumulative investments
VD.2.	Institutions	0.04366	0.05738
VD.3.	Local government	0.06521	0.06229
VD.4.	Suppliers	0.06337	0.15632
VD.5.	Internal relationships	0.19000	0.03609
VD.6.	Corporate culture	0.16365	0.01872
VD.7.	Know how	0.11758	0.05785
VD.8.	Intellectual property	0.10625	0.02180
VD.9.	Process	0.16711	0.19496
VD.10.	Tangible assets	0.08317	0.39460

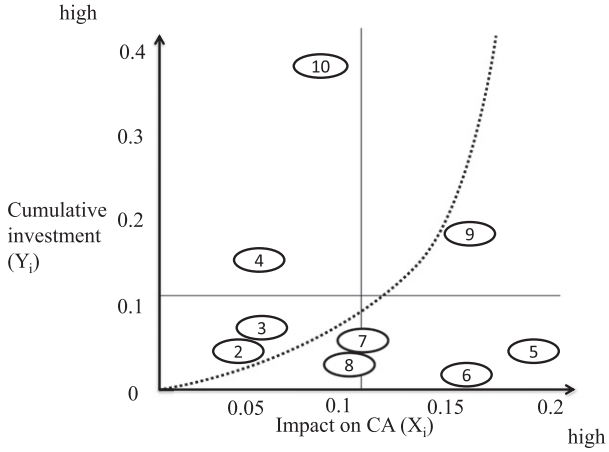

Figure 8 Synoptic strategic analysis.

constraints limiting the General Manager's chances to promote motivational policies. The synoptic analysis allows hypothesizing that further investments on such VDs may increase the organizational performances. Surprisingly the VD3-relationships with local government and VD2-relationships with institutions did not emerge as important, and correctly the organization did not invest much on them. In fact, the organization simply turns the political plans into real projects, thus it could not take any advantage spending efforts in lobbying initiatives. Finally, huge investments on the VD10-tangible assets have been made in the past (almost 40% of the total), and even though they have a relevant impact on CA, further investments should be better focused on Flagships and Runner-ups. Indeed, TA such as information and telecommunication technologies and facilities are fundamental enablers of the organizational success, but their value, rarity, inimitability, and non-substitutability is below the average with respect to other VDs.

Results shown in Figure 8 can be interpreted very easily by the interviewed manager: VD.6-corporate culture and VD.5-internal relationships should be improved through motivational initiatives; courses regarding team-building,

Table 5 Correlation analysis between the VDs' impact on CA and cumulative investments.

			Impact On CA	Cumulative Investments
Kendall's Tau	Impact on CA	Correlation coefficient	1.000	−.167
		Sig. (2-tailed)	—	.532
		N	9	9
	Cumulative investments	Correlation coefficient	−.167	1.000
		Sig. (2-tailed)	.532	—
		N	9	9
Spearman's Rho	Impact on CA	Correlation coefficient	1.000	−.250
		Sig. (2-tailed)	—	.516
		N	9	9
	Cumulative investments	Correlation coefficient	−.250	1.000
		Sig. (2-tailed)	.516	—
		N	9	9

leadership and conflict resolution; as well as the definition of common vision, mission, purpose, values, and ethical code. The organization could also invest on VD.7-know how and VD.8-intellectual property, through courses aimed to improve the human resources' know how (both regarding soft-skills and technical skills) as well as the implementation of a knowledge management system aimed at converting tacit knowledge of workers into explicit knowledge owned by the organization.

The statistical analysis (Table 5) showed that both ISC were not statistically significant; the results may have been caused by the lack of a long-term strategic plan focused on the achievement of CA.

We conducted the statistical analysis through IBM© SPSS© Statistics Version 20. SPSS is sophisticated computer program that allows an extremely wide range of statistical analysis. The reader may want to get started with the software retrieving the ''IBM SPSS Statistics 20 Brief Guide'' (IBM., 2011a,b).

Conclusions

In order to answer to Q1, we defined a framework to support the management in the strategic planning of investments on the organizational VDs. We proposed a step-by-step procedure based on the ANP that supports managers in assessing the importance of each VD in their organization, according to their expected impact on CA. The ANP allows considering mutual influences among VDs, providing overall values that enable answering to the sub question Q1.1. Finally, the framework allows assessing the relative investments made on each VD with respect to the others, without necessarily converting them into monetary terms, thus answering to our sub-question Q1.2.

The implementation of the framework in an organization creates an ''As-is'' outlook of its current strategic coherence when dealing with the achievement of sustainable CA. A periodical application of the framework in the same organization can measure the tendencies in its strategic management. Moreover, it can be applied in order to compare the importance of the investments on VDs in different organizations within the same industry and among different industries. Indeed, we presented an implementation of the framework, which has shown its adaptability also to very peculiar organizations. In fact, the framework is kept as simple as possible in order to avoid redundancies and to facilitate its application to organizations competing in virtually any industry, including nonprofit ones. Nonetheless, it is also customizable, thus managers may want to add organization-specific VDs in Cluster 2, or to modify existing VDs in order to describe their organization more accurately. The first step of the methodology may be conducted also with customers, suppliers and strategic stakeholders in order to compare their perception of the VDs with that of the managers.

The framework can be conveniently modified in order to support the management in the planning of future investments, for example in start-up organizations. In that case, Step 2 would be used to analyze the ''expected cost of an investment in the VDs'', allowing to perform a traditional benefit/cost analysis on the two resulting vectors of strategic impact on CA (benefits) and expected investments (costs).

Further researches may be focused on the long term analysis of the relationships among the implementation of strategic recommendations and the organization's economical and financial performance after an adequate time interval. Finally, a large scale analysis of the VDs could provide useful information about standard ''target values'' of the VDs weights in different industries.

References

Adams, N., & Creative decision foundation (2009). Super decisions version 2.0.8, USA.

Amit, R., & Schoemaker, P. (1993). Strategic assets and organisational rent. *Strategic Management Journal, 14*(1), 33—46.

Andriessen, D. (2004). IC valuation and measurement: Classifying the state of the art. *Journal of Intellectual Capital, 5*(2), 230—242.

Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes, 82*(1), 150—169.

Ariely, D. (2009). *Predictably irrational: The hidden forces that shape our decisions*. New York, NY: HarperCollins.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99—120.

Barney, J. B., Ketchen, D. J., Jr., & Wright, M. (2011). The future of resource-based theory: Revitalization or decline? *Journal of Management, 37*(5), 1299—1315.

Blumenthal, A. (1977). *The process of cognition*. Englewood Cliffs, NJ: Prenctice Hall.

Boisot, M. (1998). *Knowledge assets: Securing competitive advantage in the information economy*. New York, NY: Oxford University Press.

Bontis, N. (1998). Intellectual capital: An exploratory study that develops measures and models. *Management Decision, 36*(2), 63—76.

Calabrese, A., Gastaldi, M., & Levialdi, N. (2005). Real options model to evaluate infrastructure flexibility: An application to photovoltaic technology. *International Journal of Technology Management, 29*(1—2), 173—191.

Calabrese, A. (2012). Service productivity and service quality: A necessary trade-off? *International Journal of Production Economics, 135*(2), 800—812.

Capaldo, G., Rippa, P., & Teta, V. (2008). Effects of technological change on the skills and competencies of software development professionals: A case study on the transition from ABAP to JAVA. *International Journal of Information Technology and Management, 7*(4), 440—451.

Capece, G., Cricelli, L., Di Pillo, F., & Levialdi, N. (2010). A cluster analysis study based on profitability and financial indicators in the Italian gas retail market. *Energy Policy, 38*(7), 3394—3402.

Carlucci, D., & Schiuma, G. (2009). Applying the analytic network process to disclose knowledge assets value creation dynamics. *Expert Systems with Applications, 36*(4), 7687—7694.

Carmeli, A. (2004). Assessing core intangible resources. *European Management Journal, 22*(1), 110—122.

Carmeli, A., & Tishler, A. (2004). The relationships between intangible organizational elements and organizational performance. *Strategic Management Journal, 25*(13), 1257—1278.

Collis, D., & Montgomery, C. (1995). Competing on resources: Strategy in the 1990s. *Harvard Business Review, 73*(4), 118—128.

Costa, R. (2012). Assessing intellectual capital efficiency and productivity: An application to the Italian yacht manufacturing sector. *Expert Systems with Applications, 39*(8), 7255—7261.

Costa, R., & Evangelista, S. (2008). An AHP approach to assess brand intangible assets. *Measuring Business Excellence, 12*(2), 68—78.

Cricelli, L., & Grimaldi, M. (2008). A dynamic view of knowledge and information: A stock and flow based methodology. *International Journal of Management and Decision Making, 9*(6), 686—698.

Cricelli, L., & Grimaldi, M. (2010). Knowledge-based inter-organizational collaborations. *Journal of Knowledge Management, 14*(3), 348—358.

Cricelli, L., Grimaldi, M., & Levialdi, N. (2011). The competition among mobile network operators in the telecommunication supply chain. *International Journal of Production Economics, 131*(1), 22—29.

Durnev, A., Morck, R., & Yeung, B. (2004). Value-enhancing capital budgeting and firm-specific stock return variation. *The Journal of Finance, 59*(1), 65—105.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *The Academy of Management Review, 23*(4), 660—679.

Edvinsson, L., & Malone, M. S. (1997). Intellectual capital: The proven way to establish your company's real value by measuring its hidden values. London: Piatkus.

Eom, S., & Kim, E. (2005). A survey of decision support system applications (1995—2001). *Journal of the Operational Research Society, 57*(11), 1264—1278.

Falsini, D., Fondi, F., & Schiraldi, M. (2012). A logistics provider evaluation and selection methodology based on AHP, DEA and linear programming integration. International journal of production research (Date online: 26.04.2012).

Flamholtz, E., & Hua, W. (2003). Searching for competitive advantage in the black box. *European Management Journal, 21*(2), 222—236.

Fletcher, A., Guthrie, J., Steane, P., Roos, G., & Pike, S. (2003). Mapping stakeholder perceptions for a third sector organization. *Journal of Intellectual Capital, 4*(4), 505—527.

Grant, R. (1991). The resource-based theory of competitive advantage: Implications for strategic formulation. *California Management Review, 33*(3), 114—135.

Green, A., & Ryan, J. (2005). A framework of intangible valuation areas (FIVA): Aligning business strategy and intangible assets. *Journal of Intellectual Capital, 6*(1), 43—52.

Grimaldi, M., Cricelli, L., & Rogo, F. (2012). A methodology to assess value creation in communities of innovation. *Journal of Intellectual Capital, 13*(3), 305—330.

Grimaldi, M., & Rippa, P. (2011). An AHP-based framework for selecting knowledge management tools to sustain innovation process. *Knowledge and Process Management, 18*(1), 45—55.

Hall, R. (1992). The strategic analysis of intangible resources. *Strategic Management Journal, 13*(2), 135—144.

IBM (2011a). IBM SPSS Statistics 20 Brief Guide. Retrieved from: ftp://public.dhe.ibm.com/software/analytics/spss/documentation/statistics/20.0/en/client/Manuals/IBM_SPSS_Statistics_Brief_Guide.pdf.

IBM (2011b). SPSS statistics version 20, USA.

Jhunjhunwala, S. (2009). Monitoring and measuring intangibles using value maps: Some examples. *Journal of Intellectual Capital, 10*(2), 211—223.

Kristandl, G., & Bontis, N. (2007). Constructing a definition for intangibles using the resource based view of the firm. *Management Decision, 45*(9), 1510—1524.

Lev, B. (2001). *Intangibles: Management, measurement, and reporting*. Washington, DC: Brookings Institution Press.

Low, J. (2000). The value creation index. *Journal of Intellectual Capital, 1*(3), 252—262.

Marr, B. (2008). *Impacting future value: How to manage your intellectual capital*. Mississauga, ON: CMA.

Matthyssens, P., & Vandenbempt, K. (1998). Creating competitive advantage in industrial services. *Journal of Business and Industrial Marketing, 13*(4/5), 339—355.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *The Academy of Management Review, 23*(2), 242—266.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14—37.

Porter, M. E. (1985). *Competitive advantage: Creating and sustaining superior performance*. New York, NY: The Free Press.

Powell, T. C., Lovallo, D., & Caringal, C. (2006). Causal ambiguity, management perception, and firm performance. *Academy of Management Review, 31*(1), 175—196.

Saaty, R. W., & Saaty, T. L. (2002). *Decision making in complex environments. The analytic network process (ANP) for dependence and feedback*. Pittsburgh, PA: RWS.

Saaty, T. L. (1980). *The analythic hierarchy process*. New York, NY: McGraw Hill.

Saaty, T. L. (1996). *Decision making with dependence and feedback: The analytic network process*. Pittsburgh, PA: RWS.

Saaty, T. L. (2004). Fundamentals of the analytic network process-dependence and feedback in decision-making with a single network. *Journal of Systems Science and Systems Engineering, 13*(2), 129—157.

Saaty, T. L. (2005). *Theory and applications of the analytic network process*. Pittsburgh, PA: RWS.

Saaty, T. L. (2006). *Fundamentals of decision making and priority theory with the analytic hierarchy process*. Pittsburgh, PA: RWS.

Sipahi, S., & Timor, M. (2010). The analytic hierarchy process and analytic network process: An overview of applications. *Management Decision, 48*(5), 775—808.
Sveiby, K. (1997). *The new organizational wealth: Managing & measuring knowledge-based assets*. San Francisco, CA: Barrett-Kohler.
Tavana, M., & Banerjee, S. (1995). Strategic assessment model (SAM): A multiple criteria decision support system for evaluation of strategic alternatives. *Decision Sciences, 26*(1), 119—143.
Teece, D. (2000). *Managing intellectual capital: Organizational, strategic, and policy dimensions*. Oxford: Oxford University Press.
Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319—1350.
Teece, D. J. (2009). *Dynamic capabilities and strategic management: Organizing for innovation and growth*. New York, NY: Oxford University Press.

LIVIO CRICELLI is Associate Professor at the University of Cassino and Southern Lazio. Graduated with honors in Aeronautical Engineering at the ''Federico II'' University of Naples, he gained the Ph.D. degree in Business and Economic Engineering at the ''Tor Vergata'' University of Rome. His research activity explores three topics: the competition in oligopolistic markets, the assessment of intangible assets and intellectual capital, the analysis of knowledge management processes.

MARCO GRECO is Assistant Professor at the University of Cassino and Southern Lazio. Graduated with honors in Business Engineering at the ''Tor Vergata'' University of Rome, he gained the Ph.D. degree in Business and Economic Engineering at the ''Tor Vergata'' University of Rome. His research interests covered three disciplines: negotiation models, electronic commerce, and strategic management.

MICHELE GRIMALDI is Assistant Professor at the University of Cassino and Southern Lazio. Graduated with honors in Business Engineering at the ''Tor Vergata'' University of Rome, he gained the Ph.D. degree in Business and Economic Engineering at the ''Tor Vergata'' University of Rome. His main research interests covered two topics: knowledge management in inter-organizational partnerships and assessment of intangible assets.