# The Health Measurement of a Business Ecosystem

## Erik den Hartigh[1], Michiel Tol and Wouter Visscher
## Delft University of Technology

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**Abstract**

In this paper we present a health measurement instrument for business ecosystems. We demonstrate the use of this instrument in the Dutch IT industry. The instrument enables managers to monitor the financial and network health of their business ecosystem, different cross-section of the ecosystem and of individual partners in the ecosystem. As such it is helpful in benchmarking and improving business ecosystem performance, in the partner engagement process and in business ecosystem governance.

**Note**

This paper is part of the result of a research project conducted by the Delft University of Technology in cooperation with a large company in the Dutch IT industry. For reasons of confidentiality this company remains anonymous. Some of the empirical data presented in this paper have also been made anonymous.

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[1] Contact data: dr. Erik den Hartigh, Delft University of Technology, Faculty of Technology, Policy and Management, Department of Technology, Strategy and Entrepreneurship, PO Box 5015, 2600GA, Delft, The Netherlands, phone: +31 15 2783565 (secretary 2781150), email e.denhartigh@tbm.tudelft.nl

## 1. Business ecosystem

A business ecosystem is a network of actors around a core technology, who depend on each other for their success and survival (Den Hartigh and van Asseldonk, 2004). The essential characteristic that distinguishes the business ecosystem concept from sectors or supply networks is the explicit modeling of the mutual dependence of the actors: when one actor leaves the network, the value of the network for the other actors declines. When a new actor enters the network, the value of the network for all actors rises. Each member of a business ecosystem ultimately shares the fate of the network as a whole.

The term Business Ecosystem was coined by Moore (1993) in his Harvard Business Review article "Predators and Prey" and further conceptualized in his book "The Death of Competition" (Moore, 1996). Iansiti and Levien (2002; 2004a; 2004b) extended the business ecosystem concept in a working paper, in their Harvard Business Review article "Strategy as Ecology" and in their book "The Keystone Advantage".

In the IT market, where this project was conducted, companies do not engage the competitive battle on their own, but they are part of a coalition of companies around a "platform" technology. A key mechanism in IT and software markets is the presence of network effects. This means that a product becomes more attractive as more customers start using it and as more supplier offer complementary products and services. The consequence is that in the IT market, competition takes place on the platform level.

Such networks around a technology platform are not unlike biological ecosystems. They consist of multiple partners – or species – performing different roles, they need each other for success and survival, they co-evolve and they cooperate to create a fertile business environment as well as compete for their share of resources. Because of the strong analogy with biological ecosystems, the term 'business ecosystems' is increasingly used for these networks.

## 2. Business ecosystem health

Similar to a natural ecosystem, a business ecosystem and the partners in it are more or less "healthy". Health is a term from biology, which refers to the status of the system or the status

of a specific species. Like with natural ecosystems, health of a business ecosystem tells us something about the system's longevity and propensity for growth.

Iansiti and Levien (2002) have introduced the "health" as an overall performance indicator of business ecosystems. According to them, the three determinants of business ecosystem health are:

- robustness, the capability of an ecosystem to face and survive disruptions
- productivity, the efficiency with which an ecosystem converts inputs into outputs
- niche creation, the capacity to create meaningful diversity and thereby novel capabilities

Besides defining robustness, productivity and niche creation as the determinants of business ecosystem health, Iansiti and Levien (2002) made a list of the factors that make up those determinants (see figure 1).

| Productivity | Robustness | Niche creation |
|---|---|---|
| -Total factor productivity<br>-Productivity improvements<br>-Delivery of innovations | -Survival rates<br>-Persistence of structure<br>-Predictability<br>-Limited obsolescence<br>-Continuity | -Variety<br>-Value creation |

*[Figure 1: Iansiti and Levien's (2002) determinants and factors of business ecosystem health]*

With defining the determinants and identifying the factors making up these determinants, Iansiti and Levien (2002) made a valuable first step in conceptualizing business ecosystem health. They do not, however, provide operational measures of business ecosystem health that can be readily used by managers.

Iansiti and Levien (2002) do give some advice on measuring meso level data for the health scores. Meso level measurements could be based on data available from census bureaus, e.g., the average growth per sector or amounts of startups per sector. When health measurements need to be available on the micro (company) level such census data provide insufficient information. Measuring business ecosystem health on the company level requires more detailed data.

Our goal for this paper is to contribute to the concept of business ecosystem health exactly by designing such operational measures at the company level. We aim at creating measures that are:

- usable in management practice, i.e., user friendly, measurable with commonly available data and usable over the longer term
- usable on multiple levels: for individual companies in ecosystems, for cross-sections of ecosystems and for ecosystems as a whole

To do so, we will first make an inventory of possible operational measurements in the next section, structured according to the factors proposed by Iansiti and Levien (2002). This inventory is based on interviews with 5 industry experts and on literature from network theory and financial performance theory. The measurements identified this inventory are tested against the criteria of usability in management practice and usability on multiple levels in section 4. On this basis we present our concept of business ecosystem health in section 5. In section 6 we make the instrument operational and we take some preliminary steps in validating it. We illustrate the application of the instrument to the Dutch IT industry in section 7 and we discuss management implications and further research issues in section 8.

## 3. An inventory of operational measures of business ecosystem health

To structure the process of inventorying operational measurement for business ecosystem health, we use the three determinants and the underlying factors defined by Iansiti and Levien (2002) as a starting point. Per factor we will quote the explanation given by Iansiti and Levien (2002). Then, the proposed measurement will be clarified on two levels:

- business ecosystem level
- company level

For each contributing factor the operational measures are numbered for later comparison.

## Robustness

Iansiti and Levien (2002) state five different factors that contribute to the robustness of a business ecosystem: survival rates, persistence of ecosystem structure, predictability, limited obsolescence and continuity of use experience and use cases.

> *"Survival rates: Ecosystem participants enjoy high survival rates, either over time, or relative to other, comparable ecosystems."* (Iansiti and Levien, 2002, p34)

Business ecosystem level

Survival rates; the survival rate of the business ecosystem members is relatively easy to measure, by counting the number of new (young) companies in a business ecosystem. For a longitudinal measurement the number of bankrupt or startup companies can be counted.

- R01 Number of startups and bankrupt companies over multiple years.

Company level

Survival rates can be measured at the company level as the financial status of the company. Investment banks use various ways to measure chances on bankruptcy of individual companies. These bankruptcy models have a high accuracy of predicting bankruptcy within 5 years (up to 95%).

- R02 Z-score; bankruptcy model to test the creditworthiness and solvency of the individual company (Altman, 1968).[2]

- R03 ZETA model; which is a bankruptcy classification score model (Altman, Haldeman and Narayanan, 1977).[3]

- R04 Liquidity, an indication whether the company is able to meet its short-term obligations.

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[2] Altman's Z-score is a set of 5 financial ratios, EBIT / Total Assets, Net Sales / Total Assets, Market Value of Equity / Total Liabilities, Working Capital / Total Assets and Retained Earnings / Total Assets. These are multiplied and weighted to provide a score reflecting a company's probability of bankruptcy.
[3] The ZETA is a much revised version of the Z-score, which is claimed to be more accurate in bankruptcy classification in years 2 through 5 with the initial year's accuracy about equal. The ZETA model is based on return on assets, stability of earnings, debt service, cumulative profitability, the liquidity or current ratio, capitalization (five year average of total market value) and company size (total tangible assets). The coefficients of the model are not given as they are property of ZETA Services, Inc.

*"Persistence of ecosystem structure: Changes in the relationships among ecosystem members are contained; overall the structure of the ecosystem is unaffected by external shocks. Most connections between firms or between technologies remain."*
(Iansiti and Levien, 2002, p34)

Business ecosystem level

Persistence of business ecosystem structure; the persistence is the unchanged structure of the business ecosystem. Changes of partners and the relationships between them can be measured by comparing data of multiple years of a business ecosystem.[4]

- R05 Number of relations and number of agents measured per year subject to structural changes. These changes can be measured over multiple years (Carley, 1991).

Company level

On the company level the individual relations of a company can be considered. Different graph theory and social network theory measurements can be used to do so.

- R06 Connectedness of the business ecosystem of the individual agent, i.e., number of relations the partner has
- R07 Group stability can be measured. Three different concepts are available: perfect stability, time to stability and endurance. To calculate these concepts the cultural homogeneity of the group is considered: connectedness and diversity (Carley, 1991).

*"Predictability: Change in ecosystem structure is not only contained, it is predictably localized. The locus of change to ecosystem structure will differ for different shocks, but a predictable 'core' will generally remain unaffected."* (Iansiti and Levien, 2002, p34)

Business ecosystem level

Predictability; when considering a business ecosystem the outbound links can be counted (companies that are member of more than one business ecosystem). These outbound links can be measured over time and differences can be detected. The

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[4] Barabasi (2002) has done a thorough analysis testing this for the structure of the internet.

companies with no or relatively few outbound links will probably remain in the ecosystem when the system is hit by a, because they are not bound to other business ecosystems.

- R08 Outbound links from the business ecosystem towards other business ecosystems. The numbers can be counted over the multiple consecutive years to measure the predictability.

- R09 Connectedness is important for the persistence of the business ecosystem network (Dekker and Colbert, 2004). They conclude that the most robust networks are highly connected and therefore more persistent. The connectedness can be measured for the entire business ecosystem and for individual companies.

Company level

Company specific persistence is about (Granovetter, 1973) partners that are very strongly related to an individual company. When participating in a clique or cluster the persistence of the individual company is considered high because it is regarded as a secure environment ensuring business continuity.

- R10 A measure is the count of participation in clusters or the number of cliques for an individual company in a business ecosystem (Wasserman and Faust, 1994).

- R11 Centrality: the more central a company is in the business ecosystem, the more persistent it is (Freeman, 1977).

*"Limited obsolescence: There is no dramatic abandonment of "obsolete" capacity in response to a perturbation. Most of the installed base or investment in technology or components finds continued use after dramatic changes in the ecosystems environment."* (Iansiti and Levien, 2002, p34)

Business ecosystem level

Limited obsolescence can be interpreted as the change in market share of a technology. Are the users loyal to the technology when a new technology of a competing business ecosystem makes his entrance? Differences between market shares are measurable. According to Abrahamson and Rosenkopf (1993) the change in

market share is dependent on the diffusion of innovation and bandwagon pressure within networks. More users of a new technology increase the pressure upon the non-adopters to adopt (Abrahamson and Rosenkopf, 1993). Measuring the diffusion of a new technology in time is an indicator of the obsolescence of the old standard.

- R12 Market shares for each technology, measured over multiple consecutive years.

Company level

At company level obsolescence can be measured as the changes in market share of individual products or the numbers of re-issues of improved versions of products. Baum and Korn (1996) have used the multi-market contact and market entrance with dominant players to measure these market shares.

- R13 Market shares of products or product groups marketed by individual companies, measured over multiple consecutive years.

*"Continuity of use experience and use cases: The experience of consumers of an ecosystem's products will gradually evolve in response to the introduction of new technologies rather than being radically transformed. Existing capabilities and tools will be leveraged to perform new operations enabled by new technologies."* (Iansiti and Levien, 2002, p34)

Business ecosystem level

Continuity of use experience and use cases; one possible measure is the transition costs when upgrading or changing to another technology, but this is difficult considering the detailed information needed. Other measures are:

- R14 Total amounts spent on technology-related education within a business ecosystem.
- R15 Costs of change and upgrade to be able to keep up with new technologies over multiple consecutive years.
- R16 According to one of the interviewed experts, labor stability within the business ecosystem is a used measure for the continuity. The measurement of unemployment per industry and stability of labor productivity are possibly useful. Longitudinal measures are needed to create the benchmark.

<u>Company level</u>

The more detailed measurement would be the costs per technology per specific company. This measure would enable to compare the individual technology suppliers within a business ecosystem and the maintenance (upgrading and education) costs of their technology.

- R17 Maintenance (education and upgrading) costs per product or technology per individual supplier over multiple consecutive years.


## Productivity

The three factors contributing to productivity as formulated by Iansiti and Levien (2002) are: total factor productivity, productivity improvement over time and delivery of innovations.

*"Total factor productivity: Leveraging techniques used in traditional economic productivity analysis, ecosystems may be compared by the productivity of their participants in converting factors of production into useful work."* (Iansiti and Levien, 2002, p36)

<u>Business ecosystem level</u>

Total factor productivity (TFP); this can be measured using economic techniques (Solow, 1957). Basically the measure is about the efficiency of the relation between the amount of labor and capital employed and the additional value that is created.

- P01 TFP should be measured relating the added value created to the amount of labor and capital employed (Zegveld, 2000).
- P02 Analyzing total factor productivity with return on investment (ROI) (Miller, 1987). The TFP is calculated using sales, costs and investments over a given time period.

<u>Company level</u>

The TFP measure can be made company specific using individual company data (Zegveld, 2000).

*"Productivity improvement over time: Do the members of the ecosystem and those who use its products show increases in productivity measures over time? Are they able to produce the same products or complete the same tasks at progressively lower cost?"* (Iansiti and Levien, 2002, p36)

Business ecosystem level

Productivity improvement over time; applicable are largely the same measures as stated for "productivity", but now measured longitudinally.

- P03 The TFP over multiple consecutive years.
- P04 Analyzing total factor productivity with return on investment (ROI) as described by Miller (Miller, 1987). For differences over time the data over multiple consecutive years needs to be measured.
- P05 Productivity will cause growth of the company and buildup of assets over time, e.g., growing value of technologies, patents, brands, increasing amounts of cash and securities.

Company level

For the company level approach the same measurements can be used with individual company data over multiple consecutive years.

*"Delivery of innovations: Does the ecosystem effectively deliver new technologies, processes, or ideas to its members? Does it lower the costs of employing these novelties, as compared with adopting them directly, and propagate access to them widely throughout the ecosystem in ways that improve the classical productivity of ecosystem members?"* (Iansiti and Levien, 2002, p36)

Business ecosystem level

The delivery of innovations within a business ecosystem is measured by effectiveness of the process of sharing innovations. According to Sydow and Windeler (1998) the effectiveness of network processes can be measured based on the relationships companies have. More social embeddedness i.e., more relations with others, creates opportunities for companies. The more sophisticated the network structure is, the less necessary the direct exercise of power of the central company. To optimize network effectiveness Sydow and Windeler (1998) mention three influencers:

- Effective resource usage

- Application of norms to guarantee accountability

- Significant rules that influence effectiveness

These criteria are usable for a business ecosystem effectiveness measure.

- P06 Amount and availability of the three factors as stated above

A second possible measure is the product innovation of the business ecosystem. The points of interest would be the exploration and exploitation of new markets together with product differentiation. Ahuja mentioned the relation between innovation and the number of direct ties within a network structure (Ahuja, 2000).

- P07 For product or technology innovation, the number of patents registered per industry segment over a period can be measured. Ahuja (2000) related this to the total number of relations in the specified industry network. A longitudinal data set consisting of a selection of companies was used for the test. The test creates insight in the positive relation between (direct and indirect) network ties and innovation.

Company level

A company level approach is given by Gulati who gives the time varying influences of network resources on alliance behavior (Gulati, 1999). Network resources can be found within the direct network of the company. According to Burt (Burt, 1992) the creation of new alliances occurs through three different means: access, timing and referrals.

- P08 Calculation can be performed by rating the strength of the relation according to the governance structure. The centrality can be measured by counting clique memberships and centrality closeness. Also alliance formation capabilities can be calculated using the Herfindahl index[5]. The solvency and the performance (measured in return on assets) of the company are used as control variables. For calculations the UCINet program can be used (Borgatti, Everett, and Freeman, 1992).

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[5] The Herfindahl index is a measure of the distribution of the market shares of companies in an industry. A low index indicates a more competitive industry structure (many smaller firms, market share equally distributed) whereas high index indicates a more monopolistic industry structure.

## Niche creation

The final determinant of the health measurement according to Iansiti and Levien (2002) is niche creation. They formulated two contributing factors: the variety within the business ecosystem and the value creation.

*"Variety: The number of new options, technological building blocks, categories, products, and/or businesses being created within the ecosystem in a given period of time."* (Iansiti and Levien, 2002, p37)

Business ecosystem level

Variety; due to the rather broad interpretation Iansiti and Levien (2002) give to niche creation, multiple measurements are possible. An interpretation of variety of a business ecosystem is the equality of the division of members over the species, i.e., the distribution between numbers of resellers, numbers of system integrators, etc. Second the variety of technologies could be measured. A different approach would be to specify the distribution of targeted market segments within a business ecosystem.

Another approach, presented by Miles, Snow and Sharfman (1993), is the industry variety, i.e., different strategic competition models used. The research concludes that such industry variety is related to industry performance.

- N01 Variety scores can be compared and optimized measuring Euclidean distances towards the overall mean of the business ecosystem (Ahuja, 2000). This measurement can also be performed on a company level scale, comparing the company specific variety to a reference value from the entire business ecosystem or the entire market.

Company level

On company level the variety in targeted markets (e.g., Baum and Korn, 1996) or the variety in product the company offers can be measured..

- N02 Company level measurements on numbers of markets the company is active in, together with market domain overlap and the performance of the companies. Longitudinal data of consecutive years can be used for the measurements.

Chellappa and Saraf (2002) concluded that the variety of markets is dependant upon the alliances of companies with other companies, and that the prominence in the alliance network drives the performance.

- N03 The measurements can be done using company specific data sources and calculating the multi market contact together with performance.

Another approach of the variety in company perspective is the variety in partners a company collaborates with. Variety in partnerships increases performance of the central company (Dalziel, 2005). Dalziel (2005) describes a niche variety measure of partners, based on 1) their proximity to the customer and 2) their knowledge novelty. The company level measurement of Dalziel (2005) is only theoretical, but can be easily reformulated to measurable calculations.

- N04 Two possibilities of calculating the variety are present, based upon the number of different species in the ecosystem and based on the role a species fulfills in the business ecosystem.

*"Value creation: The overall value of new options created."* (Iansiti and Levien, 2002, p37)

Business ecosystem level

Value creation; the value of newly created options is expressed in the growth of the total turnover of the business ecosystem or in the growth of ecosystem profits. To capture the specific overall value of new options, value created by newly introduced technologies or solutions should be measured.

- N05 Measurements of turnover or profit growth caused by newly introduced technologies for the whole business ecosystem.

Company level

At the company level the financial figures are important measures because they represent the value creation. The new options created are the new technologies that are recently introduced.

- N06 Value of new technologies expressed in added value or company turnover, measured by specific product or service.
- N07 Solvency, the growth of equity over debts. Equity represents the value the company creates over time.

From the theory about business ecosystems, the related network theories and interviews with industry experts, we have now identified 29 possible measures for business ecosystem health. Undoubtedly, a larger number of measures could be found, but we think the present inventory gives a good image:

- The set of measures identified here was tested with 5 industry experts; they indicated that they could not think of any further additions to make.
- Additional measures we identified in the process were often subdivisions or slightly different interpretations of measures identified above.
- Additional measures we came across in the process were found to come from research fields that were increasingly further distanced from business ecosystems theory.

## *4. Criteria and selection*

After having determined the available measurements, the next issue is assessing the availability of data and the usability of these measurements. To this end, we formulate criteria to which health measurements have to conform. Second, we test the identified measurements to those criteria and we make a selection.

## Criteria

The criteria are based on the goals of this paper, i.e., to construct a measurement instrument that is usable for managers and usable on the company level as well as the ecosystem level.

### User friendliness and understandability

Measurements for the health calculation should be logical and easy to use for managers. This criterion was also stressed by the industry experts we interviewed. The user of the health measurement tool should be able to understand how a health score is composed. A frequent

problem with complex measurement models is that they are not used because managers are unable to clearly or logically trace the measurement to its outcomes.

Availability of data

One of the most important criteria for management use of health measures is that the data should be available to feed them. Measurements of health should consist of data points which are available from existing and accessible databases. No new research or data mining exercises need to be undertaken to conduct the calculations.

Long term usage

Another criterion for the management use of health measures is that they should be usable not just once, but over the longer term. This will enable managers to track development of business ecosystem health over time. Some of the measurements identified above are very difficult to reproduce.

Company level measurement possibilities

The measurement of the health should be applicable for individual companies, for cross-sections of ecosystems and for ecosystems as a whole. The industry experts indicated that the ideal measurement should be scaleable to different cross-sections or different levels or of analysis. The experts strongly advised against a solution of conceptualizing different health measures for different levels of analysis or different cross-sections. This advice is also related to the first two criteria: multiple measures would be significantly less user friendly and significantly more demanding to data availability.

## Selection

The 29 possible health measurement variables that were identified in the previous section are tested against the specified criteria in the table below. Only measures that conform to all four criteria are selected (a "V" under total score).

| Health category | Short description | User friendliness | Availability of data | Long-term usage | Company level measure-ments | Total score |
|---|---|---|---|---|---|---|
| **Robustness** | | | | | | |
| R01 | Startups and bankruptcies | V | | V | | |
| R02 | Z-score | V | V | V | V | **V** |
| R03 | ZETA model | V | V | V | V | **V** |
| R04 | Liquidity | V | V | V | V | **V** |
| R05 | Number of relations | V | | V | V | |
| R06 | Connectedness | V | V | V | V | **V** |
| R07 | Group stability | | | V | V | |
| R08 | Links with other ecosystems | V | | V | | |
| R09 | Connectedness of company | V | V | V | V | **V** |
| R10 | Participation in cliques and clusters | | V | V | V | |
| R11 | Centrality of a company | V | V | V | V | **V** |
| R12 | Technology market share | V | | V | V | |
| R13 | Product market share | | | V | V | |
| R14 | Spendings on technology education | V | | | V | |
| R15 | Costs of change and upgrade | V | | | V | |
| R16 | Labor stability | V | V | V | | |
| R17 | Maintenance cost | | | V | V | |
| **Productivity** | | | | | | |
| P01 | TFP | V | | V | V | |
| P02 | TFP with ROI | V | | V | V | |
| P03 | TFP over time | V | | V | V | |
| P04 | TFP with ROI over time | V | | V | V | |
| P05 | Asset buildup | V | V | V | V | **V** |
| P06 | Network effectiveness | | V | V | | |
| P07 | Number of patents | V | | V | V | |
| P08 | Network resources | V | V | V | V | **V** |
| **Niche creation** | | | | | | |
| N01 | Variety within ecosystem and partners | V | V | V | V | **V** |
| N02 | Number of markets | V | | V | V | |
| N03 | Alliances with other manufactures | | | V | V | |
| N04 | Niche variety of partners | V | V | V | V | **V** |
| N05 | Technologies introduced | V | V | V | | |
| N06 | Value of new technologies | | | | V | |
| N07 | Solvency | V | V | V | V | **V** |

*[Table 1: Selection of health measurement variables]*

From this selection we are left with 11 measures that are fit for our goals and that can consequently be used in our business ecosystem health concept, namely:

- The Z-score bankruptcy model
- The ZETA bankruptcy model

- Liquidity

- Company connectedness (2x)

- Company centrality

- Asset buildup

- Network resources (= centrality, solvency and return on assets)

- Variety of partners (2x)

- Solvency


## 5. Business ecosystem health concept

At this point, we leave the classification of business ecosystem health made by Iansiti and Levien (2002) from the analogy with biological ecosystems in the determinants of robustness, productivity and niche creation. While we do not question the theoretical value of this classification, we propose to take a more managerial stand, developing a concrete measurement tool that can be used by managers in governing the business ecosystem their company is part of.

As such, we define business ecosystem health as long-term financial well-being of the business ecosystem and the long-term strength of the network. In our view the health of a business ecosystem therefore has two main components: partner health, reflecting the financial well-being and network health, reflecting the network strength.

Partner health

Partner health is a long-term financially-based representation of a partner's strength of management and of its competencies to exploit opportunities that arise within the ecosystem. As such it is strongly related to what Iansiti and Levien (2002) call productivity. Healthy business ecosystems are composed of productive companies. Unproductive companies will have difficulty to survive and will therefore ultimately lower the health of the ecosystem. The survival aspect (robustness) is very important here, therefore measurement should reflect short-term and long-term survival. Operational measures like bankruptcy models, solvency and liquidity are very suitable for partner health, because those measure take short-term and long-term survival explicitly into account.
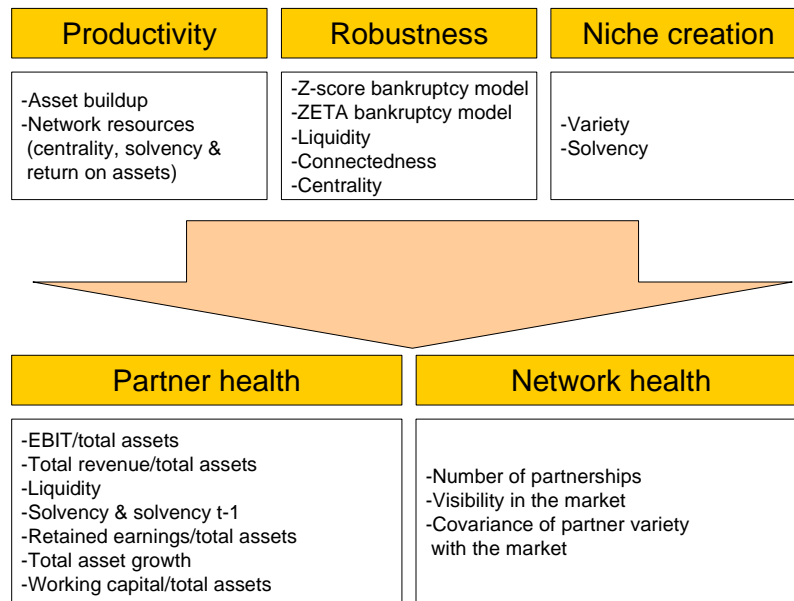
Network health

Network health is a representation of how well a partner is embedded in the ecosystem as well as the impact the partner has in its local network. Healthy business ecosystems show many relations between the partners, a tight knit that is not easily destroyed or broken in upon (robustness). Partners with low connectivity to the system have less commitment to the platform, increasing the risk that the partner switches to another ecosystem. This would reduce the health of Microsoft's ecosystem versus that of a competitor.

Further, healthy ecosystems show clusters of different types of partners that are intensely related. Such clusters act as niches in which innovations emerge (niche creation). This will only work when there is a sufficient variety of partners in such a niche. A cluster of three partners of the same species will not contribute to partner or ecosystem health, because these partners will mainly compete instead of cooperate. With little variety in types of partners, the business ecosystem will become less innovative and slowly stagnate.

Finally, healthy ecosystems have many partners that are central players and hence possess a high visibility in the market. Those partners have a high impact and therefore a positive influence towards customers and towards other partners. An ecosystem composed of low-visibility partners is less healthy.

Having sketched our concept of business ecosystem health measurement, we can identify the measurement variables needed from the inventory and selection in the previous section. We show the way in which the classification of Iansiti and Levien (2002) and the selected measurement variables relate to our concept of business ecosystem health and the operational measurements used in figure 2 below.

| Productivity | Robustness | Niche creation |
|---|---|---|
| -Asset buildup<br>-Network resources<br>(centrality, solvency &<br>return on assets) | -Z-score bankruptcy model<br>-ZETA bankruptcy model<br>-Liquidity<br>-Connectedness<br>-Centrality | -Variety<br>-Solvency |

| Partner health | Network health |
|---|---|
| -EBIT/total assets<br>-Total revenue/total assets<br>-Liquidity<br>-Solvency & solvency t-1<br>-Retained earnings/total assets<br>-Total asset growth<br>-Working capital/total assets | -Number of partnerships<br>-Visibility in the market<br>-Covariance of partner variety<br>with the market |

*[Figure 2: The relation between Iansiti and Levien's classification, the selected measurement variables and our concept of business ecosystem health]*

## 6. Making the measures operational

A next step that needs to be taken is to make the measures operational by the defining the formulas to measure them and by defining the data that will serve as input.

### Partner health measures

Partner health is measured as an index of solvency (in period t and t-1), liquidity, total asset growth, working capital over total assets, retained earnings over total assets, EBIT over total assets and company revenue over total assets:

- Solvency is a ratio that gives information about a company's ability to pay its debts. It is calculated by dividing the company's equity by the company's liabilities (long term plus short term). The normal score for this ratio is between 0 and 1, though it can become negative (negative equity) or much higher then 1 when the company is conservatively financed. Generally, a score is below 1/3 is an indication the company may be in financial problems.[6] The reasons to include the solvency in t-1 are that solvency is an important variable in the model (mentioned multiple times in

our inventory) and that by taking two consecutive years the danger of distortions due to coincidental high or low scores is greatly diminished.

- Liquidity is a ratio that gives information about a company's ability to meet it short-term obligations. It is calculated as short term assets divided by the short term liabilities. A score below 1 is considered dangerous for a company, a score between 1 and 2 is considered normal and a score above 2 is good.[7]

- Total asset growth or growth of balance sheet total (in a percentage of last year's balance sheet total) provides insight in the relative growth of the company's business, taking investments and new loans to be made for this growth into account.

- Working capital / total assets: this variable is taken from Altman's Z-score model (Altman, 1968) and was developed to indicate the company's financial health. The model indicator was used to forecast the bankruptcy of specific companies. It is calculated as current assets minus current liabilities, divided by balance sheet total.

- Retained earnings / total assets: this ratio exposes business age. This ratio imputes factors as the age of the company, dividend policy and profitability record over time. Originally the ratio is taken from the ZETA model (Altman, Haldeman and Narayanan, 1977), which is used for investment banking in predicting the bankruptcy of companies.

- EBIT / total assets: taken from the ZETA model, this is an index indicating the company performance.

- Total revenue / total assets: taken from the Z-score model, this score indicates the efficiency and productivity of the company's business.

## Network health measures

Network health of a partner is measured as an index of its number of partnerships (network relations), its visibility in the market and the variance of partner types it has relations with:

- Number of partnerships: this says something about a company's connectedness. A higher connectedness means a higher health (Wasserman and Faust, 1994). This was confirmed by industry experts.

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[6] A low solvency is only an indication of possible problems. Solvency may also be low because a company is so trustworthy that it can afford to have more debts per euro of equity. In that case, low solvency is not a problem, but an indication of excellent financial management. In any case, low solvency is a reason for further inquiry.

- Visibility: this tells us something about the centrality of a company in the market. It can also be translated as the popularity or the chance the company is being seen relatively measured to other companies (Wasserman and Faust, 1994). To rate the visibility of a company in the market, a Google search was done for the company name and the number of hits were counted. An application was written to automatically acquire the hit counts for the whole dataset.

- Covariance with market: this indicates the variety of different partners a company has. Partners were by their characteristics classified into species. We first calculated the proportions of the species in the entire market as a reference point. We also calculated for each company the proportions of different species that it is related to. We then calculated the covariance between those the company proportions and the market proportions.

## Standardizing the measurements

For the project, these components were made operational into a health measure. This measure shows the financial health and the network health for an individual company in a number between 0 (extremely unhealthy) and 1 (extremely healthy). For every measurement variable, the very low scores were defaulted to 0, the very high scores were defaulted to 1. Then they were logarithmically transformed, to bring the range between 0 and 1.

The total score for Partner health is the unweighted average of solvency, solvency t-1, liquidity, total asset growth, working capital over total assets, retained earnings over total assets, EBIT over total assets and company revenue over total assets. The total score for Network health is the unweighted average of the number of partnerships, the visibility and the covariance of partner variety with the market.

Total health could be calculated as the unweighted average of partner health and network health. It is preferable, however, to keep partner health and network health separated. First, because this conforms to the health measurement concept we presented in section 5. Second, because also the industry experts indicated to have trouble interpreting the combined scores.

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[7] As with solvency, liquidity is only an indication of possible problems. Here, too, companies with excellent working capital management are sometimes able to keep liquidity ratios under 1. Here too, a score below 1 is a reason for further inquiry.

In the visualization of the ecosystem this shows as green (healthy), red (unhealthy), orange (in between) or grey (unknown), see figure 3. We took the market as a whole as the reference to determine the cut-off points (see table 2).

|  | Unhealthy | Healthy |
|---|---|---|
| Partner health | < 0,315 | > 0,435 |
| Network health | < 0,154 | > 0,225 |
| Total health | < 0,506 | > 0,650 |

*[Table 2: Health score cut-off points]*
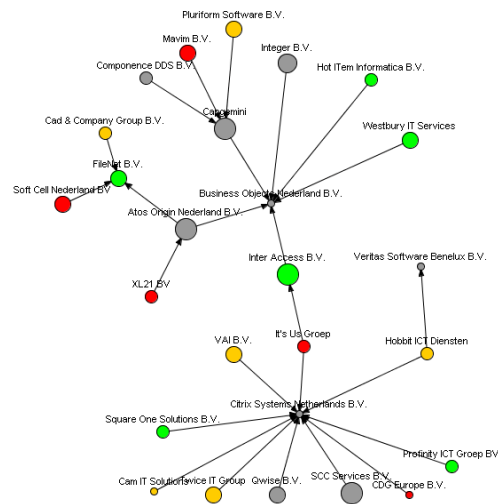


*[Figure 3: Business ecosystem health visualization]*

## Validation

We took the following preliminary steps to validate the health measures. First, we tested the concepts of the measures themselves with a two new industry experts, different from the ones that provided inputs in the earlier stages. They confirmed that the measures developed were usable for them and that they were able to logically trace the measurements to their outcomes.

Second, we tested the face validity of the measurement results with the entire group of industry experts. This was done by making pictures as shown in figure 3 for different cross-sections of the market, and of competing ecosystems. We challenged the experts to target individual companies and then to tell us whether or not they thought the color matched their expectations. We found that in around 80% of the cases, the expectations matched with the color. This is not a particularly high score, but considering that some of the variables may be interpreted in different ways it is not disappointing either. We researched a random sample of the non-matches, to find that in most cases the non-match was due to idiosyncrasies in the data and in some cases the non-match was due to misguided expectations by the experts. We conclude from this that face validity seems to be up and above 80%. However, much more research would have to be done to further substantiate this.

Third we performed a correlation analyses on the partner and network health measures to check whether we are not measuring the same thing twice. Ideally the partner and network health are independent. Still, we expected that some correlation between partner and network health would be inevitable. After all, would it not be the larger companies, that are financially healthier and at the same time have a higher network health, simply because they have more partners and are more visible in the market? The outcomes of the correlation analysis are shown in table 3.

| Correlation | Network health | |
| --- | --- | --- |
| **Partner** | Pearson correlation | 0.002 |
| **health** | Significance (2-tailed) | 0.922 |
| | N = 2692 | |

*[Table 3: Correlation between partner health and network health]*
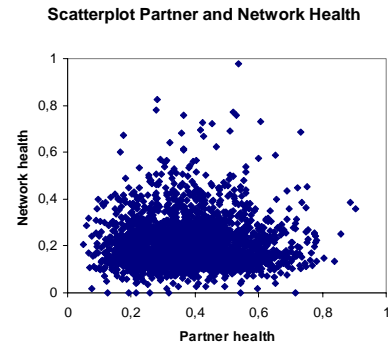


*[Figure 4: Scatter plot Partner and Network health]*

A visual inspection of a scatter plot of the data confirmed this image: there is no systematic relation between partner health and network health. This means that a company can be financially healthy, but not well embedded in the network and it can be well embedded in the network and not financially healthy. The explanation is that is it costly for companies to engage and maintain partner relations. In this way, putting a lot of energy in maintaining network health can go at the cost of partner health and vice versa.

## Data

In this project, we limited ourselves to partner ecosystems in the Dutch IT industry, more specifically the software segment of this industry. A further limitation is that we did not include customers in our research. A business ecosystem is defined to include both partners and customers, when only partners are considered we talk about a partner ecosystem.

The analyses in this paper are based on the following sources:

- MARKETONS network and profile data of Dutch IT companies; this database provided the bulk of the network data and the data to classify partners into species.

- REACH financial data of Dutch companies (Bureau van Dijk, 2005), based on Chamber of Commerce data; this database provided the financial data, mainly balance sheet data and for the larger companies also data from the profit and loss statements.

## 7. Analyses of business ecosystem health

To illustrate the applicability of our instrument, we made a number of analyses on ecosystems, different species of partners and on individual partners in the Dutch IT industry. Please consider that for reasons of confidentiality some of the analyses are made anonymous.

### Ecosystems analysis

We reviewed the health of the largest ecosystems in the Dutch IT market, those around Microsoft, IBM, Oracle, Novell, Exact and SAP. We choose these since their platforms represent over 75% of the software market in the Netherlands. IBM and Microsoft are pure platform providers, Oracle, Novell and SAP are hybrids between platform and application providers and Exact is pure application provider. In the graphs you see the percentage of partners of each ecosystem that is healthy (red), unhealthy (green) or in between (orange).
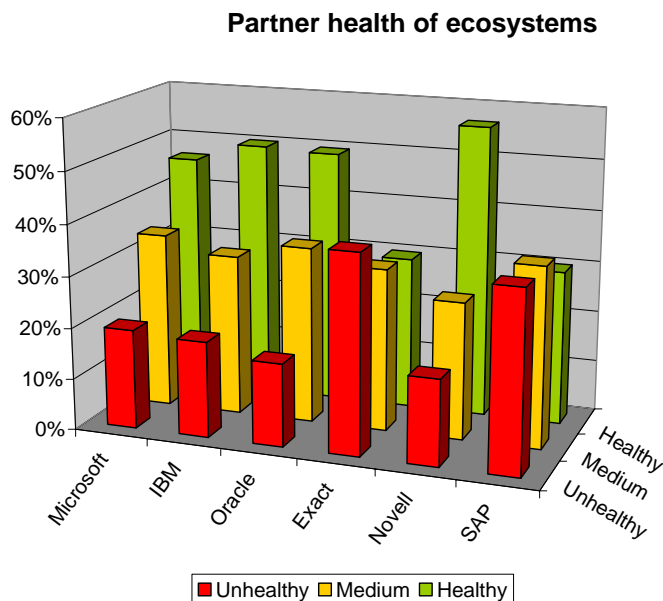


*[Figure 5: Partner health of major ecosystems in the Dutch IT industry]*

From the graph we notice that the percentages of healthy and unhealthy partners health is more or less the same across the three largest ecosystems (IBM, Microsoft and Oracle). This may be an indication that the largest ecosystems are all in the same phase of their lifecycle, namely "leadership" (maturity).[8] Among those three, there are no "expanding" ecosystems that have much higher partner health and therefore threaten to attract partners from others, nor "declining" ecosystems, that have much lower partner health and on which partners are turning their back. The data for Exact and SAP differ from those of the three largest ecosystems, in that they show significantly lower percentages of healthy partners and significantly higher percentages of unhealthy partners. The data for Novell can be explained from a recent reshuffle of their partnership relations.
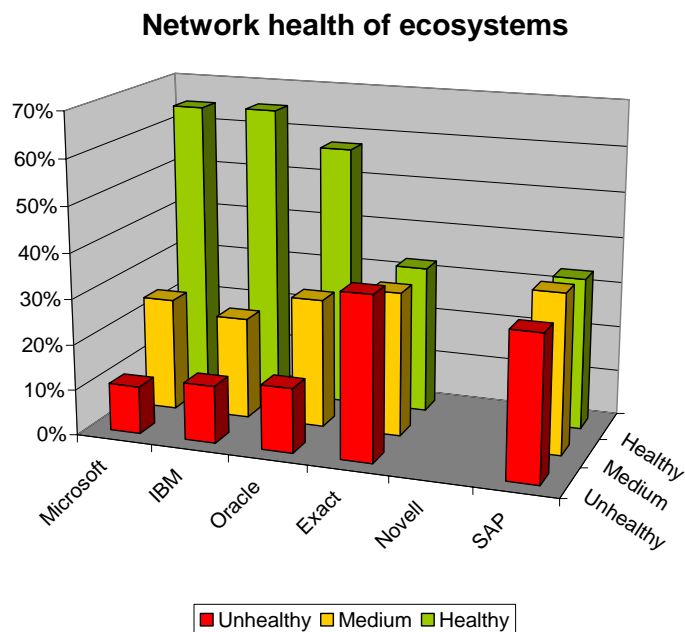


*[Figure 6: Network health of major ecosystems in the Dutch IT industry]*

From the graph of the network health we notice that the ecosystems around Microsoft, Oracle and IBM have a significantly higher percentage of network healthy partners than those of Exact, Novell and SAP. This may be an indication that Microsoft, Oracle and IBM are further advanced in their efforts to create a genuine business ecosystem, i.e., a tight-knit network of partners.

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[8] For the stages of development of ecosystems, see Moore (1996).

## Species analysis

As an example of the cross-sections of ecosystems that can be analyzed with our business ecosystem health concept, we present an analysis of the health of different species. Many other cross-section can be made, but are not presented here.

Like a biological ecosystem a business ecosystem is populated by a diversity of species: different types of partners each with their own unique functions, their own unique interests and each delivering a unique contribution to the survival and growth of the whole system. The reason for the existence of multiple partner species in the ecosystem is that the whole of their efforts is larger than the sum of the parts. In other words, partners possess complementary skills and assets that combined cause the value of the technology platform to rise. The types of species identified here are: system integrators (SI's), reseller (RES), value added resellers (VAR's), independent software vendors (ISV's) and others, e.g., consultants, application service providers, trainers or internet service providers.
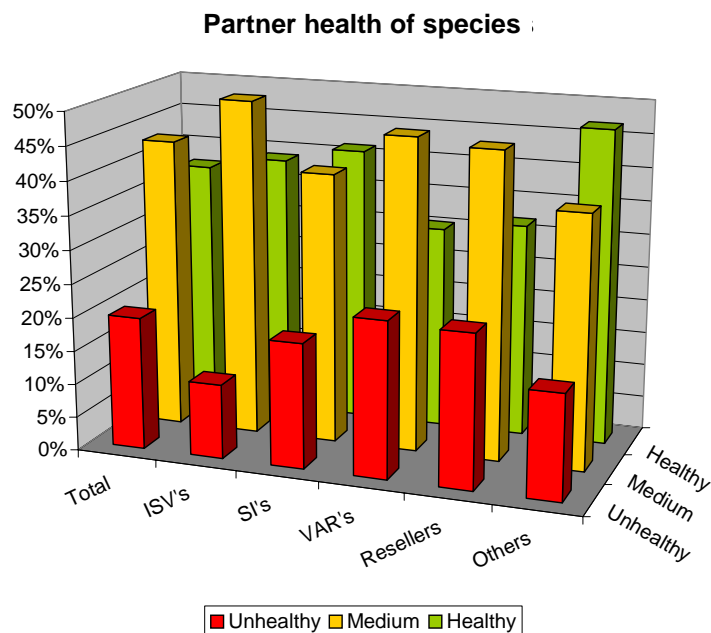


*[Figure 7: Partner health of the species in the Dutch IT industry]*

We see more variation here than with the ecosystems. Some species apparently have a much lower percentage of financially healthy companies. For Resellers and Value Added Resellers this can be explained because their business is often "run-of-the-mill" business, reselling

software or doing easy implementations, that has low margins. This likely translates into lower partner health. The business models of System Integrators that provide complete, bundled solutions, and Integrated Software Vendors that provide standardized or customized software packages, are much more sophisticated. Therefore their margins are higher, translating in a higher overall partner health. The high percentage of healthy partners in the category "others" is noteworthy. It is an indication that the IT sector is still developing and that some partner species are able to grow and profit from these developments.

**Network health of species**
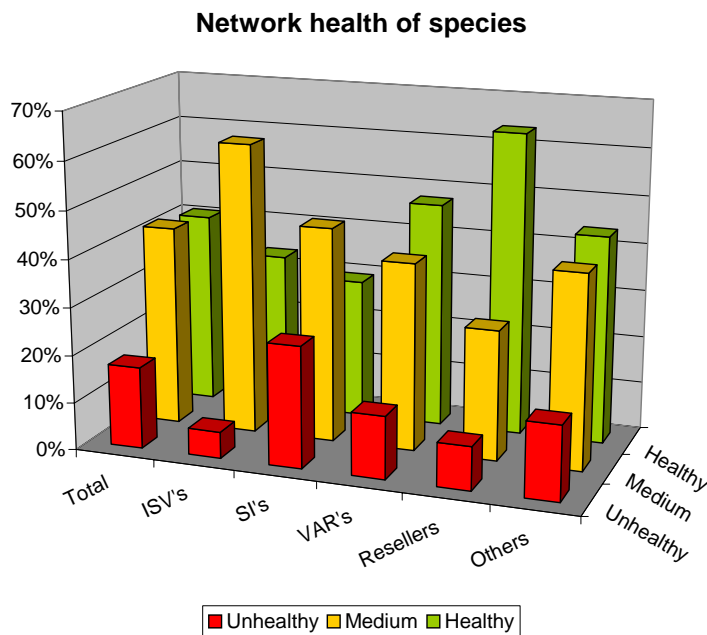


*[Figure 8: Network health of the species in the Dutch IT industry]*

For the network health, we can see that the differences between species are even larger. We see partly the opposite image here: many of the Resellers and Value Added Resellers have a high network health. They have many partners and are relatively visible in the market. With System Integrators and Integrated Software Vendors the percentage of network healthy companies is lower. An explanation for this, suggested by some of the industry experts, might be that though Resellers and Value Added Resellers have many partnerships and connections, these are often not of a strategic nature. It was suggested that these partnerships and connections are therefore less valuable.

## Individual company analysis

The health model can be applied to individual partners, indeed it was especially designed to do so. Different kinds of individual partner analyses are possible. The first one we already described in the validation section. With the help of a custom-made visualization tool, it is possible to visualize the network structure of the Dutch IT market, of separate ecosystems in that market or of many different cross-sections of the market and of the ecosystems in the market.[9] In this visualization, individual companies are visible, colored according to their partner health, their network health or their total health (green = healthy, red = unhealthy, orange = medium healthy, grey = no data available).
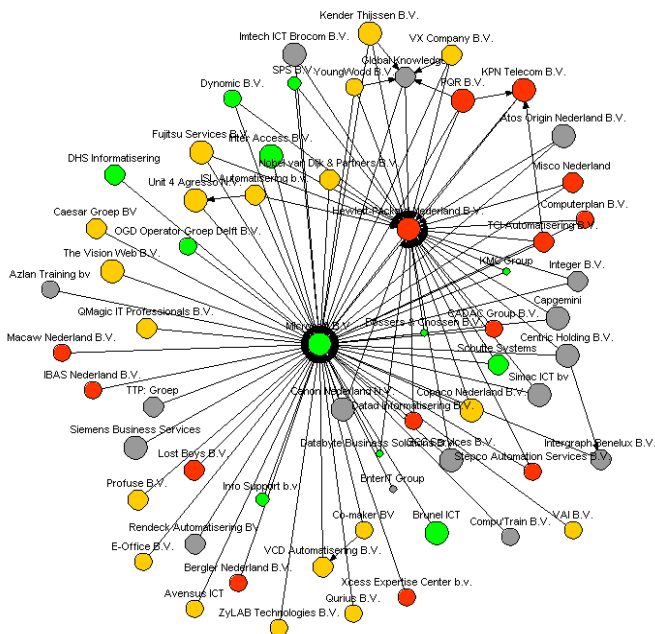


*[Figure 9: Example of visualization at individual company level]*

Another individual company analysis that can be made is plotting individual partners in a portfolio tool that can be used for partner management and for competitive recruitment. Such a tool could be used by keystones (e.g., Microsoft, IBM, Oracle) in addition to their existing partner programs. For existing partners, it could help them to determine which partners to part with, which partners to help grow their business, which partners to help grow their network and which partners to maintain healthy. In the figure below we show such a portfolio

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[9] We thank MSc student Eric Vos for the efforts he put into developing this tool.

management tool, filled in with real company data (made anonymous). The circles represent companies, the sizes of circles represents company size.
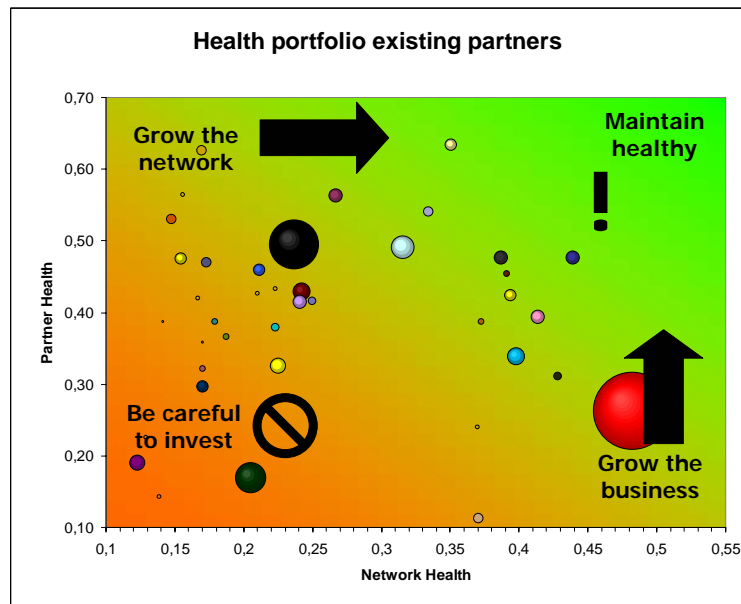


*[Figure 10: Partner engagement portfolios]*

## *8. Management implications and further research*

The business ecosystem health measurement tool presented in the paper has been developed with the objectives to make a tool that is usable in management practice and usable at the company level. To ensure this, industry experts were closely involved in all stages of the development and testing of the tool. Together with the, we identified three major areas in which this tool can be used:

- for benchmarking performance and identifying performance improvement areas
- for assisting in the partner engagement process
- as a possible compass for ecosystem governance

### Benchmarking ecosystem performance

To enable managers to benchmark their ecosystem, different cross-sections of their ecosystem or individual partners, it is first necessary that they incorporate business ecosystem data collection and health measurement in their partner program activities. On this basis, a number of different analyses can be made (see also section 7):

- Analyze the health of your own business ecosystem and compare it with competing ecosystems.
- Analyze the health of different cross-sections of your business ecosystem, e.g., for partner of different species, for partners of different sizes, for partners with different competencies, or for partners with links to multiple ecosystems.
- Analyze the health of individual partners and small partner networks in the business ecosystem.

Based on such initial analyses, more in-depth analyses may be needed when it is not immediately clear why an ecosystem, a cross-section or an individual company underperforms or overperforms. Complementary knowledge, e.g., the knowledge of the expert involved or the knowledge of external research agencies will often be needed to make such in-depth analyses.

After an in-depth analysis, it is possible for management to clearly identify the areas of improvement and to identify the actions to be taken to effectuate these improvements. Finally, it is necessary to periodically analyze the business ecosystem, the cross-sections and the individual partners to gain insight into the effects of improvement actions and to keep an eye on the mid-term and long-term development of the ecosystem.

## Selective partner engagement

As shown in section 7, measuring individual partner health and plotting it in a partner health – network health grid can be a helpful instrument for partner engagement. It emerged from the contacts with the industry experts that keystones should be selective in how they select and maintain partners. From the partner engagement portfolio, the following selective actions can be derived:

- Help partners that score low on partner health to improve and grow their business
- Help partners that score low on network health to improve the size and variety of their network and their presence in the market
- In partner recruitment, focus on recruiting healthy partners; maintain your existing healthy partners, e.g., by sharing opportunities and added value
- Reconsider partner relations with unhealthy partners

With the implementation of the health measurement tool, new possibilities arise to enhance partner portfolio management. It is important however, to note that health measurement is just one of the indicators to be used for portfolio management. Financial data may change from year to year. Databases may contain errors. Assessment of partner and network health should therefore always be done while keeping a keen eye on the in-depth information coming from the partner itself or from employees that are in direct contact with the partner. A partner that scores low or "strange" on the health measures should be further investigated.[10] The health measurement should not be treated as a stand-alone tool.

## A compass for ecosystem governance

Iansiti & Levien (2004) point out that companies that want to take a shaping role in a business ecosystem can do so in different ways: they can try to become 'dominator' or a 'keystone'. A 'dominator' is a company that shapes a business ecosystem by internalizing the larger part of the added value created in the business ecosystem. The dominator will eventually absorb the network, extracting maximum value in the short term, but destroying the business ecosystem in the long term. A 'keystone' is a company that shapes a business ecosystem by providing a common technology platform, by being an important hub in the network, by performing the task of connecting network participants and by continually trying to improve the business ecosystem as a whole. This keystone approach is the strategy that will enable the business ecosystem and the keystone itself to grow and prosper in the long run. It is also the strategy that will enable the ecosystem to evade death and instead to realize self-renewal by incorporating innovations from outside the system.

Being a keystone requires exercising "system governance" (see Van Asseldonk, Berger and Den Hartigh, 2002) instead of micro-management of partner relations. For managers of keystone companies, such as IBM, Microsoft or Oracle, it is important to understand how system governance is different from their traditional ways of partner management. Partner management is a very hands-on approach, steering on individual partners, enforcing them to conform to certain standards or to acquire certain diplomas or capabilities.

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[10] For example, take a partner that scores low on solvency and liquidity: is this because the partner is financially unhealthy, or because the partner has such excellent financial management that it can "afford" to show low ratios?

System governance is a more hands-off approach, but it is certainly not equal to "doing nothing". With system governance, the keystone does not provide the energy to the partners in a top-down way, but gives direction to the energy already available from partners, i.e., their willingness to make money with the keystone's technology platform.

With system governance, rather than giving each partner obligatory targets, the keystone creates a compass that provides direction for the system as a whole. It is here that the health measurement tool comes in. We suggest that the dimensions of the health measurement tool, i.e., partner health and network health, may be used as the business ecosystem compass (see figure 11): improving partner health and network health is in the interests of the ecosystem and of every individual company in the ecosystem.

**Ecosystem performance compass**
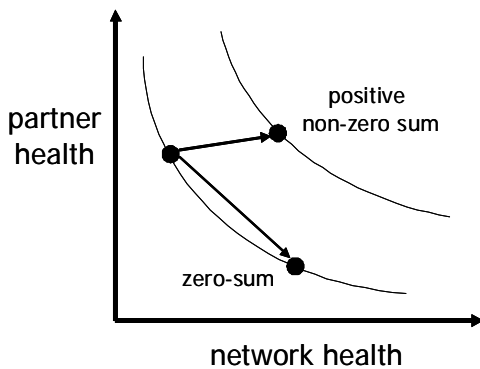


*[Figure 11: Business ecosystem compass]*

On such a compass, improvement in ecosystem and partner performance can never be realized through a zero-sum game, i.e., by improving partner health at the cost of network health or vice versa. Only the realization of a positive non-zero sum game is considered a performance improvement, i.e., moving to a higher iso-line on the compass.

Using such a compass in practice would require to:
- convince partners and collections of partners to manager their business on these dimensions
- continually measure the performance of the entire ecosystem, of meaningful collections of partners and of individual partners on this compass

- publish these data throughout the ecosystem

- identify improvement areas and suggest improvement actions

A word of caution: the idea of using the business ecosystem health dimensions as a performance compass has not been tested. It emerged from the research project as an appealing concept. However, before starting to use such a concept, it should be further developed, e.g., a more thorough reasoning through of the consequences of applying it and a more detailed translation to what it means for individual companies and small networks.

## Limitations and further research

This research is characterized by a number of limitations, which provide ample opportunities for further research.

Company-level measures

An implication of conceptualizing the health measurement at the level of the individual company, is that we do not specifically include dependencies or influences from the meso level (e.g., market growth, market size, market structure, sector-specific laws and regulations) or the macro level (e.g., investors climate, general laws and regulations). Further research should be conducted to investigate the intensity of such influences, and whether they have to be incorporated in the model or can be dealt with as "events", i.e., external shocks that are explicitly taken into account, but are not part of the model.

A second implication is that the health measures at higher levels of analysis, i.e., ecosystems or a cross-sections of ecosystems, are aggregated measures of individual companies. When we think of a business ecosystem as a complex system, in which the different levels of analysis are mutually influential, this may be a serious constraint. We will therefore have to be very careful of using our health measurement in such an aggregated way.

In further research, health measures should be constructed that will capture the meso-level and macro-level, while still conforming to the criteria of usability by managers and availability of data.

Strength of network relations

As a result of some surprising outcomes of the measurement for network health, see for example the discussion under figure 8, it was suggested that some partnerships and network connections are less valuable than others.

When we assume this to be true, it means that our network health measure is biased. We do not make distinctions between different partnerships. In out data set, each network link equals the other. This is not conforming to reality. Some network links, e.g., a company making a on-off small purchase with an other company are clearly less valuable or influential then others, e.g., a strategic partnership between companies. In an ideal situation therefore, network links should be weighted according to their importance.

Further research should be conducted to find out how network relations could be valued. Some suggestions for doing this are:

- value the network relation based on the amount of business (turnover or profit) it generates for the partners
- value the network relations based  the dedicatedness of the relation, e.g., the relation with a partner having 50% of its engineering or consulting personnel certified for or dedicated to your ecosystem is of higher value than a partner having no dedicated or certified personnel

The data for doing so are not directly available, but could, with some assumptions be calculated from a keystone's sales or partner databases.

Other sectors and countries

The business health model is built on the structure and data of the Dutch ICT sector. It has not been tested for other sectors or for the ICT sectors in other countries. This raises the question of generalizability. In principle the model is not built on any country-specific assumptions. Therefore, we think it is generally usable for the ICT sectors in other countries. In further research, the model should be applied to these sectors to test its validity.

The general usability of the model, especially of the network health part, is limited in our view by the sales models used in the sector under analysis. With only a few exceptions, the software sector is characterized by indirect sales models, in which partners and partner networks are very important to realize revenues. We could imagine the model to be applicable

in sectors that also have such an indirect sales model. For other sectors, applicability of the current model will be limited. In further research it could be investigated how the model could be adjusted to ensure a more general applicability.

Missing data

The databases we used for testing the model did not contain data on customers. We therefore chose to focus on the partner ecosystem only. Still, customers are an important part of the business ecosystem as a whole. In further research, the relevant database should be found or constructed and it should be investigated how customers could be included. Another group that was underrepresented in our databases is external influencers, e.g., independent websites, influential blogs, universities or government agencies encouraging open source.

Further validation

In this paper we took some preliminary steps towards validation of the health measurement instrument, i.e. involvement of industry experts, analysis of correlation between partner health and network health and an application of the instrument on ecosystems, species and individual companies in the Dutch IT sector. In further research, the following steps will have to be taken to validate the measurements.

- In-depth statistical analyses, including the influence of the separate variables on the partner and health measures, to assess the unidimensionality, reliability, within-method convergent validity and discriminant validity of the scales.
- Investigating the relations of the partner and network health with other performance related or innovation related variables.
- Recalculating the partner and network health over time, using the same databases, and then testing the outcomes with industry experts or by following specific cases of individual companies or networks over time

## Reflection

An interesting question that came up during the project is "What to do with unhealthy partners?" It is known from natural ecosystems that diversity of species is an important factor in their evolution. During this evolution, some individual specimens or even whole species may become extinct. This process is not "governed" or "managed" in any way.

Now a business ecosystem, although built on the metaphor of a natural ecosystem, is not equal to a natural ecosystem. Granted, like in a natural ecosystem, unhealthy companies will disappear by themselves because they go bankrupt. Should this process be "governed" in any way? Should a keystone company terminate its network relation with a company that is consistently plotted in the lower left corner of the health portfolio (low partner health and low network health)? Is energy being put in such a relation wasted? Or does even an unhealthy partner contribute to the capacity of the ecosystem?

We do not pretend in this stage of research to have answers to these questions. We welcome any suggestions for further research that could shed light on such issues.

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