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Methodology of business ecosystems network analysis: A case study in Telecom Italia Future Centre

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ABSTRACT

The paper proposes a method for analysing, modelling and foresighting the business ecosystems as network structures interacting one with each other. The methodology's name is "methodology of business ecosystem network analysis" (MOBENA). The paper shows how it is possible to systematically study the structure and fluxes of a business ecosystem. The main problems of other modelling languages for firm interactions that MOBENA tries to overcome are that (1) the methodologies tailored for BEs are very few, the others neglect interdependences or focus only on tangible or intangible aspects, and (2) they limit potential for strategic analysis and they do not take in a future-perspective. The paper includes an analysis of literature on Strategic Management (in particular, strategic models on relationships), Network Analysis and Foresight, from whence the theoretical proposal of the MOBENA is born. Then, the authors illustrate its application via a case study conducted inside the Telecom Italia Future Centre, and in particular taking as example the digital imaging ecosystem. The original aspects are the mapping of tangible and intangible relationships, the dynamic and foresight analysis, the possibility to set strategic guidance thanks to specific indicators.

1. Introduction

Technological innovations produced significant impacts on global production structures. In fact, they did not have an impact only on new products and services and their ideation, design, manufacturing and delivering, but also radically changed the concept of value for companies and organizations. In this sense, whilst traditional and consolidated strategic models (such as the value chain [1]) and more innovative models (such as the value network – [2]) focus on the process of value creation, the business ecosystem (BE) model [3,4] analyses and underlines the value of the relationships amongst actors and the key elements (physical structure, revenues attraction, attractiveness, assets and technologies) which foster the ecosystem survival and development [5]. The BE comprehends all the agents that directly and indirectly contribute to the development of a business, product or process influencing its success in a short or longer time [4].

The concepts and the terminology derive from ecology (Tansley [6] proposed the term biological ecosystem): a biological ecosystem is a complex system of organisms (physical agents of the environment where they live and develop) and relationships amongst them. Moore [3] coined the term "business ecosystem" that gained popularity with the research of Iansiti and Levien [4]. In their work they affirm: "Like biological ecosystems, business ecosystems are formed by large, loosely connected networks of entities. Like species in biological ecosystems, firm interact with each other in complex ways, and the health and performance of each firm is dependent on the health and performance of the whole. Firms and species are therefore simultaneously influenced by their internal capabilities and by their complex interactions with the rest of the ecosystem." (p. 35).

If an organization would like to know the complex dynamics intercepting its ecosystem [7] or if it would like to

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enter and live in a new one, it has to rely on a deep knowledge and analysis of the ecosystem itself. It is a matter of identifying the ecosystem components and the relationships amongst them, understanding what guarantees their existence and taking advantage from the balance of power. All these elements together define the shape and behaviour pattern: how the ecosystem "lives". Also the time variable is fundamental: the relationships amongst the constituent elements may change the ecosystem structure. So, understanding the ecosystem means not only drawing the shape and relationships amongst the constituent elements in a certain moment in time, but understanding how it evolves by monitoring evolutionary trends. It is thus important that companies establish monitoring processes for their ecosystem, both from a static and dynamic point of view, and analyse BEs by investigating how the relationships and the dynamics can potentially positively and/or negatively impact their businesses. Clearly, these analyses need to be supported by appropriate tools and methodologies to work on.

But, despite the importance of the practical application of the BE concept as a representation of the real business context, literature on methodologies for BEs' strategic analysis is still in its infancy: as a matter of fact, the majority of the contributions are focussed on the discussion of BEs per se (i.e. comparisons between natural ecosystems and BEs, differences between value chain and BE, BEs properties, BEs strategies, etc.). The scope of this paper is to propose a methodology for analysing and modelling the ecosystems as network structures interacting one with each other and to illustrate its application in a case study conducted inside Telecom Italia Future Centre. The name of the proposed methodology is *Methodology of Business Ecosystem Network Analysis* (*MOBENA*).

Section 2 discusses the current literature on business ecosystems showing the actual gaps. After introducing the research strategy in Section 3, Section 4 presents the theoretical framework of the MOBENA methodology and Section 5 shows its application in a peculiar business ecosystem for Telecom Italia: the digital photography ecosystem. Finally, Section 6 discusses the findings and draw conclusions and research directions.

2. Theoretical background

2.1. Business ecosystems

Complex inter-firm relationships are the fibre of the value creation process in a BE. The reason lies in the concepts of community and "shared fate": the combination of all the efforts of all players of the *community* (large and small–medium manufacturers, retailers, government, technological parks, universities, consultants, etc.) guarantees the survival and the success of the BE. In BEs companies can have a *coopetition* strategy: they compete in gaining market, but at the same time cooperate for the defence, the development and the growing of their ecosystem [8]. Firms can cooperate in many different ways, for instance defining technical standards, promoting business and technical best practices, sponsoring market studies or researches, lobbying public government, etc. They share their final aim of long-term sustainability with the whole community (*shared fate*): whilst value chains are based on volatile supplier/buyer relationships, the BEs are based on a network of multi-directional relationships with organizations that unconsciously share values and interests. These qualitative intangible interactions (networks, common norms, values and trust, comparable expectations) amongst actors in a BE create an intangible value that all participants share: the *social capital* [9–12]. Nahapiet and Ghoshal [13] define it as "the sum of actual and potential resources embedded within, available through and derived from the *network of relationships* possessed by an individual or social unit" (p. 243). In fact, relationships in BEs can be tangible (monetary) and intangible (not monetary — cultural and social). Whilst value chains create value, BEs generate value and social capital, resulting in a long-term and sustainable relationship.

Prior work on business ecosystems is focussed on the discussion of strategies of single ecosystems (e.g. Amazon ecosystem [14]; Cisco ecosystem [15]; Intelligent Mobile Terminals [16]; the mobile network operators [17]; cases in high tech industry [18]), on the strategies of coopetition [19–21], value created [22], enablers (standardization [23]; timing [24]; IT [25]), problems of trust, information asymmetry and coordination [26–28], knowledge sharing [29], on a or on the links with biology and other sciences. Finally, some papers discuss the evolution from a value chain view to a BE view [30,31].

Recently, scholars develop the concept of BEs toward the concepts of digital business ecosystems [32–35], innovation ecosystems [36], service ecosystems [37,38], etc. Digital business ecosystems have dynamic hubs and have loosely-coupled and self-organizing properties. In this line, literature proposes new approaches especially for SMEs [39] and new approaches of open business network platforms [40–44]. Finally, some authors focus their attention on intellectual properties, customer relationship system, education, negotiation mechanisms, etc. [45–47].

2.2. Modelling approaches of networks and ecosystems

Literature proposes various approaches to create a modelling language for firm interactions. In the view of value network, they are for example the e3-value model [48], the c3-value [49] and the value network's model of intangibles [2]. In the perspective of BE analysis, first works are all based on agent-based modelling, such as the works of den Hartigh, Tol, Wei, Visscher and Zhao [50], Marin, Stalker and Mehandjiev [51] and Tian, Ray, Lee, Cao and Ding [52] called business ecosystem analysis methodology — BEAM).

Table 1 shows a synthetic description of such methodologies, their main characteristics and the main critiques that are overcome by the proposed methodology. The main problems are that (1) the methodologies tailored for BEs are very few, the others neglect interdependences or focus only on tangible or intangible aspects, and (2) they limit potential for strategic analysis and they do not take in a future-perspective.

3. Research strategy

This research attempts to answer the following research question:

How is it possible to systematically study the structure and fluxes of a business ecosystem?

The present work is meant to help widen the knowledge basis on management of ecosystems and proposes a

Table 1
Modelling approaches of value networks and business ecosystems.

Model or methodology	Investigated object	Critiques
e3-value modelling (Gordijn et al. [48])	Value network (theoretical basis: industrial view)	The lack of a clear strategic focus in the model weakens its ability for prescriptive strategic insights.
c3-value model (Weigand et al. [49])	Value network (theoretical basis: resource-based view)	It focusses on the direct competitor and the direct customer. It neglects the inter-dependencies and the potential given by the network perspective.
Value network model of intangibles (Allee [69])	Value network	Analysis is mostly visual. It assumes that value is created through exchanges. It is focussed only on intangibles exchanges. It does not assign a purpose to the network. It assumes that the network is not manageable. It limits potential for strategic analysis.
Agent based methodology (Marin et al. [51])	Business ecosystem	It is focussed only on tangible exchanges.
BEAM: business ecosystem analysis and modelling (Tian et al. [52])	Business ecosystem	It lacks a strategic focus.

methodology based on network analysis and foresight. Foresight is a set of techniques to anticipate and imagine possible future scenarios, identify trends and anticipate weak signals and discontinuous changes [53], in order to have not only a static picture of the BE, but also to have a dynamic overview of its possible evolution.

The research includes an analysis of literature on strategic management (in particular strategic models), network analysis and foresight, from whence the theoretical proposal of the *Methodology of Business Ecosystem Network Analysis* (*MOBENA*) is born. The themes connected to implementation of a BE methodology need to be deeply explored, because of limited previous research. The research needs to be wide and to consider also the complex system of variables characterizing the observed phenomenon. The single case study design is opportune for presenting a relevant overview of the importance and applicability of a methodology and for new and explorative investigations [54–56]. *The object of the case study is the test of the proposed methodology of business ecosystem network analysis*. As described by Yin [57], the case study research design can be used to describe an intervention and its context. In the test in this study, the intervention is the application of the proposed methodology, and the context is the company studied and in particular one of its ecosystems (the digital image ecosystem).

The industry selected for this study is the telecommunication industry sector. The telecommunications industry has been facing many changes, as the passage from the circuits to the all-IP communication, the "publish-subscribe" use of the network, etc. Increasingly, the technological innovations headed by information and communications technology and telecommunications go beyond the value chain where they have been originated. They attract the interest of other value chains which are so far remote, with different actors, interests and market objectives. Therefore actors interact now in a real and complex BE. In this new context, previous business models can change and latent or even not-existing markets (and consequently new business models) can emerge. That is why we decided to focus our research on the telecommunications industry. The exemplar case is the most important telecommunications company in Italy, Telecom Italia (and in particular its unit focussed on economic studies and investigation of the future, the Telecom Italia Future Centre).

Telecom Italia Future Centre aims to study how the economic systems of the next decade can evolve varying the technological availability and the impact on market structures. These structures are in fact evolving toward a context where the offer is created also by new actors. Sometimes, small-medium companies, organizations but also individuals participate in the creation of a market proposing their complementary offer to a product or service of the traditional value chain. Therefore, the telecommunications, polling down costs and involving other companies, build an environment where technology/market relationships evolve with mechanisms of change that can be compared to the natural ecosystems ones. Telecom Italia Future Centre had the problem of having a deeper comprehension of this evolution and taking into account the change and its impact on traditional business models. The criticalities are (1) to link the new applications and technologies to a sustainable economic system, taking as a reference the ecosystem in order to comprehend the drivers of the technology and market evolution (2) to study the potential or actual BE in terms of revenues and relationships and (3) to foresight its possible dynamics.

Amongst the ecosystems studied by the Future Centre, we chose to focus on the digital imaging ecosystem. Here Telecom Italia studies the future and the evolution of the digital photography as a complex ecosystem where the image/picture of a place or a person represent the fundamental element of new service classes realized thanks to the fixed and mobile high-bandwidth networks. These service classes will refer to the interpersonal communication, the access to context aware contents on the basis of contextual information as geographical localization, time, characteristics and personal activities [58] and the dialogue with machines. The choice was due to two main reasons: the recent changes in this industry and the complexity of its ecosystem structure. These two elements conduct to difficulties in identifying the fluxes of value exchanged and embedded in the ecosystem relationships and the need to find a new logic to analyse and evaluate it.

4. A proposal of a methodology for business ecosystems analysis

The *Methodology of Business Ecosystem Network Analysis* (*MOBENA*) aims to provide a theoretical and operational framework for analysing the BEs. MOBENA is designed to support the identification and understanding of the BEs by providing the criteria to define its structure and analyse and evaluate the relevant behaviour. The methodology is based on four steps of analysis: (1) ecosystem perimeter, elements and relationships; (2) ecosystem model representation and data validation; (3) ecosystem analysis; and (4) ecosystem evolution.

Table 2 synthesizes the four phases, giving a brief description of objectives, contents and deliverables.

4.1. Ecosystem perimeter, elements and relationships

The objective of this first step is to identify the perimeter and constituent parts of the ecosystem. The very first step is to recognize the *seed* around which the ecosystem is based and grows. The seed has the potential to attract the interest of different players because it might be the leverage to develop new business. For example the seed could be (1) the element that helps feeding the interest of the players to enter, participate and/or to build an ecosystem, (2) the element to which the consumers recognize an economical value and are willing to pay for a product or a service and (3) the element whose absence affects more the ecosystem. The seed helps in the identification of the boundaries of the ecosystem: this is one of the main decisions of the analysts.

Another important point for the decision about the boundaries is the constitutive elements of the ecosystem and the relationships amongst them. The objective is the identification of the relevant information to be collected to identify and describe each element of the ecosystem and the existent ties to be identified in the so-called connections matrix. The key categories of elements are actors/players (in reference to products and services) and enabling technologies. For some

Table 2
MOBENA phases.

Phase and objectives	Actions/content	Output
1. Ecosystem perimeter, elements and relationships • Define the meaning of the ecosystem, decide what identifies it and define its boundaries. • Detail the information to be collected as regards the constitutive elements and their relationships.	• Identify the seed — the actors' attractor and the leverage for business. • Identify the elements and their connections. Elements: players, technologies, products/services and environment (market, constraints and regulation forces). • Players: (1) revenues, employees, EBITDA, investments, cash flow, (stock, trend, cagr, expected trends) (2) share trends, market capitalization (3) geographical presence (4) current market positioning and strategy (5) research strategy. o Products/services: (1) service concept (2) business model (3) economics: users, revenues, margins, Compound annual growth rate (CAGR), Average Revenue Per Unit (ARPU); o Relationships amongst actors — different kind of flows through the ecosystem: exchanged information. • Technologies. • Transactions o connections matrix: per each couple of variable it will be indicated: 1 — if a link already exists and is intangible, 2 — if a link already exists and is tangible, 3 — if a possible relation can be formed in a near future.	A. *Technology workbook* B. *Players information* C. *Connection matrix*
2. Ecosystem model representation and data validation • Develop a representation model. • Obtain criteria to validate the model.	Graphical representation of the connections matrix in an oriented graph with links and nodes characterized in a quantitative way (weight to each kind of relationship). • Data gathering and analysis: brainstorming; existing literature; research conducted by specialists from reference markets; official documents (budgets, communication to the financial community, business plans, etc.); direct contact with the actors that belong to the potential ecosystem; consulting experts in modelling complex systems.	A. *Ecosystem representation model* B. *Ecosystem representation model validated*
3. Ecosystem analysis • Evaluation of the ecosystem's behaviours (last, current, future) and relevant key indicators.	Ecosystem value analysis in terms of: • revenues: quantify the economic dimension of the ecosystem; • economic structure: understand how this value is shared amongst the various players: physical structure, revenues attraction, attractiveness, relationship, assets & technologies. Ecosystem control point analysis in terms of: • identification of control points ("points at which management can be applied" — business strategy, regulation, and/or technology); control points constellation: put control points in a logical sequence, represent integrated control points as joined together; check for lock-in; show multiple offering outcomes if applicable.	C. *Ecosystem analysis*
4. Ecosystem evolution • Simulation of different scenarios aimed to perform what-if analysis, trend analysis, classification, forecasts.	• List of trends and uncertainties; early signs; scenarios graph; scenarios narrative; definition of possible scenarios; list of implications and options of responses.	G. *Ecosystem scenarios analysis*

ecosystems, also legislative and regulatory assets of reference can be very important. This step results in releasing the *players' information deliverable* (information about main players) and the *technology workbook* (information about technologies).

4.1.1. Players' identification

The actors' identification is performed in three levels: (1) macro-classes of actors, (2) classes/categories of actors and (3) main players. The list of players is a map of all categories of actors and their role in the ecosystem. The actors are divided into the actual ones and those who are not directly related but have an interest to join in the ecosystem. The definition is related to the identification of categories (e.g. telecom operators, vendors, etc.) and the single players (e.g. HP, Telecom Italia, CISCO, etc.) where the company is interested or wishes to play a role. The players information template comprehends (1) the main players (with the key financial data as revenues, sales volume, employees, EBITDA, investments and cash flow and the role), (2) the main offers (products or services) per players (with number of customers, revenues, gross margin, CAGR, ARPU, value proposition, market segment, ecosystem structure, revenue generation and margins, position in value network and competitive strategy) and (3) connection information with the quantity of tangible connections (per type: hardware provider, service provider, content provider, consumer, seller, …), the quantity of intangible connections (per type: hardware provider, service provider, content provider, consumer, seller, …) and the quantity of possible future relations (per type: hardware provider, service provider, content provider, consumer, seller, …) and (4) suggested actions.

4.1.2. Technologies

As regards technologies, they constitute the necessary tools through which the ecosystem activities can be deployed. The technology workbook template comprehends: technology description, related technologies, economic sectors involved, main applications, technology expected roadmap (today, 2015 and 2020), success drivers, R&D leaders and geographical references (international framework and expected investment).

The next step is the construction of the *Connections Matrix*, an adjacency matrix (nxn) which has the purpose to highlight the links between the constituent parts of the ecosystem. The rows and columns of this matrix report the list of BEs' constitutive elements. The classification of links is the following: "*0*" — *no relation*; "*1*" — *intangible relation*; "*2*" — *tangible relation*; and "3" — *possible future relation* (3–5 years).

4.2. Ecosystem model representation and data validation

The objective of this step is to develop a representative model of the ecosystem. An ecosystem is essentially a huge network of actors, products, services and technologies, representing nodes and relations between them. The information obtained in previous step helps to identify the nodes, their characteristics and links in their various configurations. This step will provide a classification of nodes and links that will enable the representation.

For *nodes*, a colour code is used to differentiate players who have a different role, and a dimension code to differentiate the weight of each actor. A parameter for the weight factor could be the size (turnover, number of employees) where applicable. For *links*, it is necessary to classify the different types of relationships with the criteria used in the connection matrix.

The initial model of the ecosystem is refined in order to check out for assumptions and data collected. The actions and materials for this "validation" can be different: for example existing literature, research conducted by specialists from different markets, official documents (budgets, communications to the financial community, business plans, etc.), direct contact with the actors that belong to the potential ecosystem, consulting experts in modelling complex systems, brainstorming with other staff of the company.

4.3. Ecosystem analysis

The aim of this step is to analyse the behaviour of the ecosystem in the past and in the present. This analysis involves understanding how the value is distributed in each ecosystem and the best places to target the positioning strategy to capture part of this available value and requires two separate steps: *Business Ecosystem Value Analysis* and *Business Ecosystem Control Point Analysis* (see Fig. 2).

1. *Business Ecosystem Value Analysis*
   This step quantifies the economic dimension of the ecosystem in terms of revenues (revenues) and helps understanding the value sharing amongst players (economic structure). Five clusters of indicators are useful:
   - physical structure: total number of actors, actors for industry, industrial turnover, geographical analysis;
   - revenues: revenues, selling, investments, free cash flow;
   - attractiveness: entry barriers, platform analysis;
   - relationships: network indicators of density, betweenness, in-degree and out-degree centrality;
   - assets and technologies: technological roadmaps, life cycle technologies, capital/labour analysis.
2. *Business Ecosystem Control Point Analysis*
   This step identifies the control points of the ecosystem. They are the "points at which management can be applied" [2] and represent opportunities for value creation and capture, and normally the control is rooted in business strategy, regulation, and/or technology. Here the constellation is the representation of the group of control points and their values in a logical sequence. The steps are:
   - identification of the functional elements of the ecosystem, list and description of the control points for every element;
   - control points organization and definition of the control point constellation;
   - analysis of the control point constellation and identification of the fundamental control points.

4.4. Ecosystem evolution

In this step the possible evolutionary scenarios are studied. The scenarios analysis is based on the following steps:

- List of trends and uncertainties (the driving forces that may affect the company or business);
- Graph of scenarios(the axes are the two most critical uncertainties, the uncertainties that have the higher level of uncertainty and the higher level of impact);

• Description of scenarios (define a narrative for each scenario a story describing the hypothesis of future analysed), define the factors that led the present situation to the listed future scenario and list the possible implications or consequences of each scenario and options of answers).

5. Results of the MOBENA application in the digital ecosystem analysis

5.1. Ecosystem perimeter, elements and relationships

The seed of the digital imaging ecosystem is the *service*, based on the psychology of the "management of the memories" and the "digital translation" of the reality, that permit new possibilities and functionalities for the personal sphere of the individual.

5.2. Players' identification

For the digital imaging ecosystem, the research team preliminarily identified two macro-classes of actors in the ecosystem and listed the component actors and the main players for each one:

Manufacturers: class of actors connected to the consumer-electronics production. They are: camera and camcorders manufacturers, storage manufacturers, printer manufacturers, camera-phone manufacturers. Then there are the intermediaries and the sellers of the hardware parts.

Service Providers: their offer is connected to services and not-tangible functionalities for users. They are: on line storage providers; photo-album providers; social network providers; on line printing providers; mobile applications providers; software vendors providers; telecommunication operators providers; and retailers providers.

5.3. Enabling technologies

The digital imaging ecosystem is subdivided into eleven categories of enabling technologies: *computational photography*, *sensors resolution and quality*, *still/motion convergence*, *barcode/QR code*, *RFID/NFC*, *GPS*, *Wireless/Mobile*, *Metadata Exif*, *3D*, *digital pictures and video playback*.

5.4. Connection matrix

Finally, the connection matrix of the digital imaging ecosystem can be found in Table 3. The connection matrix is an adjacency matrix (nxn symmetric matrix) where actors are subdivided in the three categories described above: manufacturers, service providers and enabling technologies.

6. Ecosystem model representation and data validation

This step represents all the data from the previous step using software for network visualization in order to have a graphical view of the digital imaging ecosystem. Fig. 1 shows the network representation.

We also studied the transformation of the Imaging Business from a value chain point of view to an ecosystem point of view (Fig. 2). The system was based in two different value chains: the home picture and the professional picture. The home picture was of less quality, the production was at home for photography amateurs or in a professional studio and the use was amongst family and friends, whilst the professional picture was produced only by professionals and distributed through mass media for the customers. With the big disruptions of the digitalization of the image and of the internet, the producers are not only professionals, but also normal people and the customer can become itself a producer (prosumer). Besides, with the internet technologies, the diffusion of the product is faster and easier, through for example blogs. This permits also the mush-up, e.g. to have the pictures associated to other information (as a text, a point into a map, etc.). Finally, new services have born, as for example the online printing service. This revolution conducted some firms to fail or lose big business segments (e.g. Kodak) or to be forced to strongly renew themselves.

6.1. Ecosystem analysis

6.1.1. Business ecosystem value analysis

6.1.1.1. A. Physical structure. The manufacturers' class includes 90 actors. The majority can be found in the cameraphone manufacturers class (more than 40% of the total number), but the number of the main players that have the control of the majority of the resources and have the stronger power is limited (8). Therefore, to enter as a new market entrant is difficult, but the Smartphone sector (strongly linked to the digital imaging ecosystem), with a market-share of 21% to "secondary" competitors, is dynamic and still full of possibilities. In general, the structure of the manufacturers' class is consolidated and quite closed to new entrants. Only the cameraphone class seems to be the opener to new structural modifications. (See Table 4).

Analysing the actual turnover, and doing a foresight study about the dynamism in the future two years, the results show that a substantial statiticity of the manufacturing classes will be: for the interviewees, all the classes represent a limited structural dynamism, because of a substantial saturation of the environment. Only the cameraphone manufacturers' class seems to be possible of a more consistent development, linked to the expansion of the smartphone functionalities in the ecosystem and to the new technological horizons of the device for the producers. In other words, the enlargement of the boundaries coming from the use of the smartphone device brings together new opportunities for the manufacturers.

As regards then the Service Providers, they can be divided into Mobile Applications Providers and Web Services and Software Providers. The first ones are a really huge number, as the applications can be developed from everyone with a very limited budget. The application phenomenon is having a global impact in the growth of the sector. The Web Services and Software Providers can be subdivided into web photoalbum services, online storage services, social network services, online printing services, and software vendors (see Table 5). Web photoalbum services are the majority (25.34%), then the online storage services, due to a not difficult access to the segment (only hardware infrastructures for data storage). Anyway, only a little fraction of the actors is able to have a significative

Table 3
Digital imaging ecosystem connection matrix [Legend: "0" — no relationship, "1" — intangible relationship, "2" — tangible relationship, "3" — possible future relationship].

		MANU FACTURER				SERVICE PROVIDER								TECHNOLOGY										
		Camera & camcorders manuf.	Storage manuf.	Printers manuf.	Cameraphone man	On line Storage	Photoalbum	Social Network	On line printing	Mobile apps	Sw vendor (editing, applet, plug-in)	Telco operator	Retailers	Computational photography R&D player	Image recognition R&D player	Sensors resolution and quality	Still/motion convergence	Barcode / QR Code	RFID/NFC	GPS	Wireless/Mobile	Metadata/EXIF	3D	Digital pictures and video playback
MANUFACTURER	Camera & camcorders manuf.	–	1	2	2	1	1	1	1	3	1	3	2	3	3	2	2	0	0	2	3	1	1	3
	Storage manuf.	1	–	1	1	2	2	1	1	0	0	3	2	0	0	1	0	0	0	0	1	1	0	2
	Printers manuf.	2	1	–	3	0	1	0	2	0	1	3	2	1	0	1	0	1	0	0	1	0	3	1
	Camera–phone manuf.	2	1	3	–	1	1	1	3	2	2	2	2	3	3	2	2	2	3	2	2	2	0	3
	On line Storage	1	2	0	1	–	2	1	1	1	0	3	0	0	0	0	0	0	0	0	2	0	0	2
	Photo–album	1	2	1	1	2	–	2	2	2	2	2	0	0	2	0	1	0	0	1	1	1	3	1
	Social Network	1	1	0	1	1	2	–	1	1	3	2	0	0	1	0	3	0	0	1	1	1	3	3
SERVICE PROVIDER	On line printing	1	1	2	3	1	2	1	–	3	1	3	2	0	0	1	0	0	0	0	1	1	1	0
	Mobile apps	3	0	0	2	1	2	1	3	–	2	2	0	1	2	0	0	1	1	1	1	1	3	1
	Software vendor	1	0	1	2	0	2	3	1	2	–	0	2	1	1	1	0	0	0	1	0	1	1	1
	Telco operator	3	3	3	2	3	2	2	3	2	0	–	2	3	1	1	1	2	2	2	2	2	1	1
	Retailers	2	2	2	2	0	0	0	0	0	2	2	–	0	0	1	0	2	2	0	0	0	0	0
ENABLING TECHNOLOGIES	Computational photography R&D player	3	0	1	3	0	0	0	0	1	1	3	0	–	2	2	2	0	0	0	0	1	3	1
	Image recognition R&D player	3	0	0	3	0	2	1	0	2	1	1	0	2	–	1	1	2	3	2	2	1	1	1
	Sensors resolution and quality	2	1	1	2	0	0	0	1	0	1	1	1	2	1	–	1	1	0	0	0	1	0	2
	Still/motion convergence	2	0	0	2	0	1	3	0	0	0	1	0	2	1	1	–	0	0	0	0	0	3	2
	Barcode / QR Code	0	0	1	2	0	0	0	0	1	0	2	2	0	2	1	0	–	1	0	0	0	0	0
	RFID/NFC	0	0	0	3	0	0	0	0	1	0	2	2	0	3	0	0	1	–	1	1	1	3	3
	GPS	2	0	0	2	0	1	1	0	1	1	2	0	0	2	0	0	0	1	–	2	2	2	1
	Wireless/Mobile	3	1	1	2	2	1	1	1	1	0	2	0	0	3	0	0	0	1	2	–	0	0	2
	Metadata/EXIF	1	1	0	2	0	1	1	1	1	1	2	0	1	1	1	0	0	1	2	0	–	3	1
	3D	1	0	3	0	0	3	3	0	3	1	1	0	3	1	0	3	0	3	2	0	3	–	1
	Digital pictures and video playback	3	2	1	3	2	1	3	0	1	1	1	0	1	1	2	2	0	3	1	2	1	1	–

economic impact in the industry. For example, for the photoalbum services the reason is that they are based on a freemium or ad-funded business model and need to build big users communities. The social network services and the online printing services have difficulties in gaining share as service suppliers. For the social network, services need in fact huge communities because their business model is often based on advertising. Finally, the software vendors are a small community. It is due to a move from a structure with many companies specialized in specialized software into a structure with less but big companies that acquire technologies from other ones.

The expected turnover is sensitively higher than the manufacturers' one: the services class is more accessible and structurally dynamic. This fact is due to low entry barriers, the web accessibility, the growth of the ecosystem and the consequent request for supporting services (future needs of more space for data storage and increasing digitalization of contents). The Online Printing and software vendors seem to be the most static ones, due to saturation of industries because of barriers and low development perspectives.

The geographical analysis highlights a dycotomic distribution: the Far East (Japan, China, South Korea, etc.) for hardware and consumer electronics (e.g. Sony, Samsung, Canon, Nikon) and the USA for software, applications and web services (e.g. Google, Yahoo!, Facebook, Adobe, Apple). Obviously the division is not so strict: the examples are HP (printers) and SanDisk (storage device) in the Silicon Valley.

6.1.1.2. B. Revenues. Amongst the camera and camcorders manufacturers, 11 main actors are present. The top competitors are three: Canon, Nikon and Olympus. Their markets are not only the professional and consumers, but also the

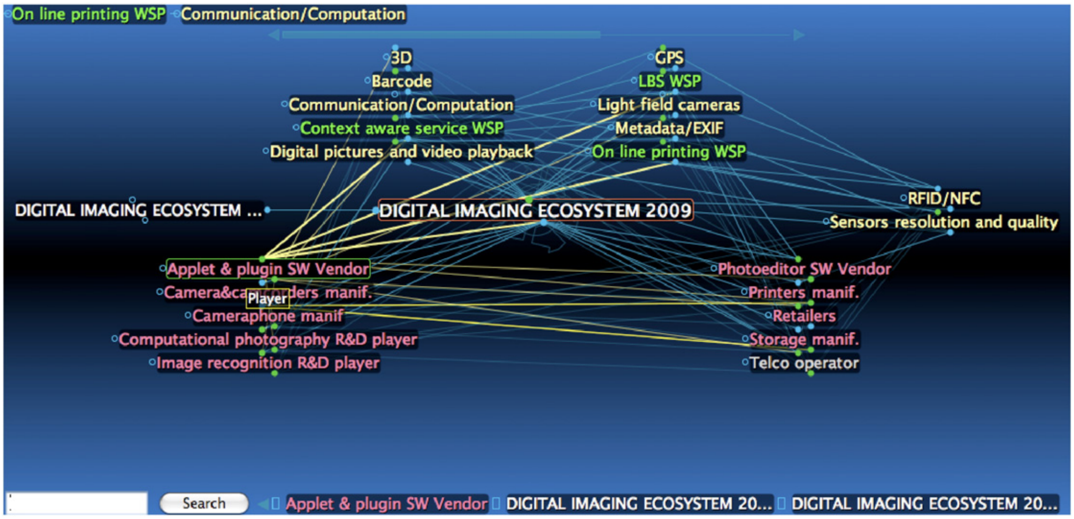

Fig. 1. DIE model representation [screenshot].

prosumers (the users who are consumers but with a strong attention to quality and professional e.g. with reflex digital cameras). The analysis shows the results of the crisis, e.g. Leica (an important brand in the professional photography).

The main actors of the storage manufacturers' class are four: Toshiba (11 million dollar in the semiconductor business), Lexar (Nikon group), SanDisk and Kingston. They are focussed in the flash memory business, whilst Seagate and Western Digital produce HD for laptops or servers. The printers manufacturing has two main protagonists: Canon and Hewlett-Packard. The mobile phones market is still dominated by Nokia (then Samsung and LG), also if a future development can be a continued growth of Apple and Google for smartphones and Nokia will soon need to face this challenge.

As regards the service providers, important information can be the business model and the number of visitors/users. The highest ranked Online Storage services are skydrive.com and me.com that refer to Google and Apple respectively. Other two important ones are adrive.com and humyo.com

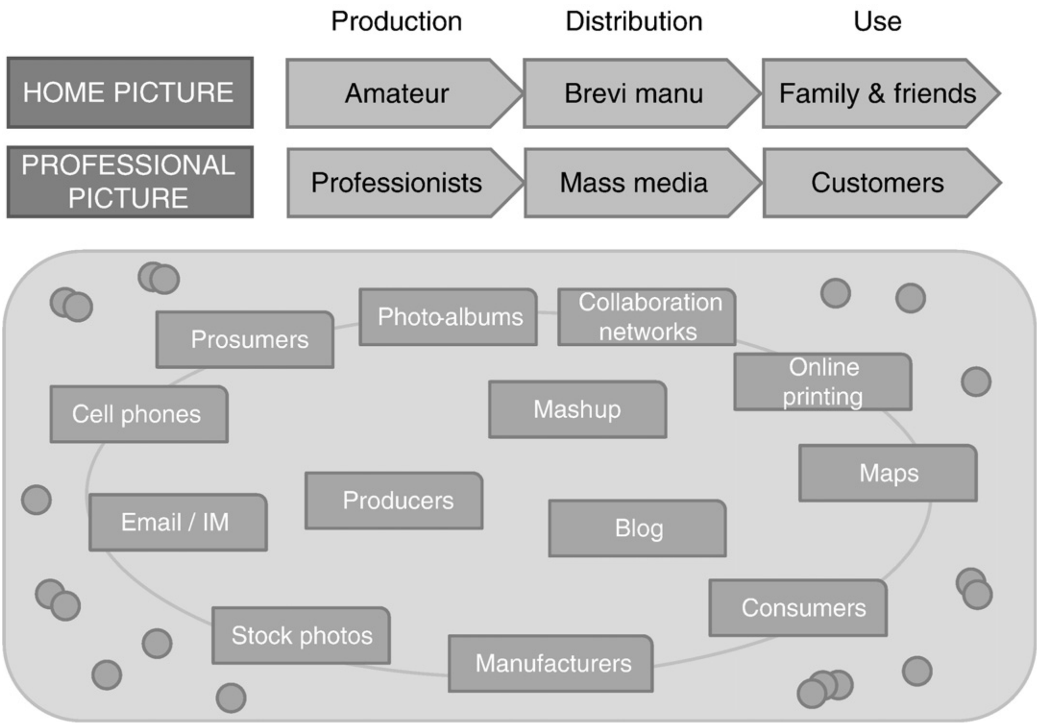

Fig. 2. From value chain to business ecosystem in DIE.

Table 4
Digital imaging ecosystem — manufacturers–number of actors and main ones in the industry.

Manufacturers	Number of actors	Main actors
Camera&camcorders manufacturers	20	11
Storage manufacturers	25	4
Printers manufacturers	5	2
Cameraphone manufacturers	40	8
Total	90	25

Table 5
Digital imaging ecosystem — service providers–number of actors and main ones in the industry.

Service providers	Number of actors	Main actors
On line storage	30	6
Photoalbum	150	4
Social network	20	4
Sw vendor (editing, applet, plug-in, …)	5	2
Online printing	20	2
Web services and sw providers	225	18
Mobile apps providers	142	–
Total	592	–

whose core business is the online storage. The majority of these services are based on an ad-funded business model or on the freemium one, whilst other ones (e.g. Swiss picture bank) that are not-free but offer and guarantee security for data. Similar business models are used by photo album services, where the dominant role is played by Flickr. Social networking services base on advertisement as revenues source, the most known ones are Facebook, Myspace, Google+, Orkut. Online printing services major agents are Kodak and Snapfish that offer the printing via web. The business model is based on paying service, advertisement and partnerships with other companies. Amongst the mobile applications, around the 2% are specific ones for Digital Imaging. The revenues around the applications world are of 4, 6 billion dollars with growth perspectives of 16 billion dollars for 2013. Software vendors' services main players are Adobe and Corel.

6.1.1.3. C. Attractiveness. The attractiveness analysis is based on three main aspects: global profitability, entry barriers and platform structure.

6.1.2. Profitability and entry barriers

The analysis is based on a Delphi study amongst experts. They expressed their opinion as regards the profitability of each industry sector that constitutes the ecosystem and the entry barriers (capital requirements, scale economies, product differentiability, distribution access, and institutional and legal barriers).

The data of Manufacturers entry barriers (values more than average) show a low attractiveness and a modest profitability. These data are due to the necessity of high levels of capitals (CAPEX and OPEX) and scale economies for productivity efficiency. The product differentiation is very difficult, and often it is played not on the product but on the brand. The distribution is easily accessible, and after the e-commerce transformation of the market dynamics. As regards the Service Providers instead, attractiveness and profitability are higher (the first investments are lower than for manufacturers) but very different considering the sectors. For example, the Photo album services have a low profitability, because the

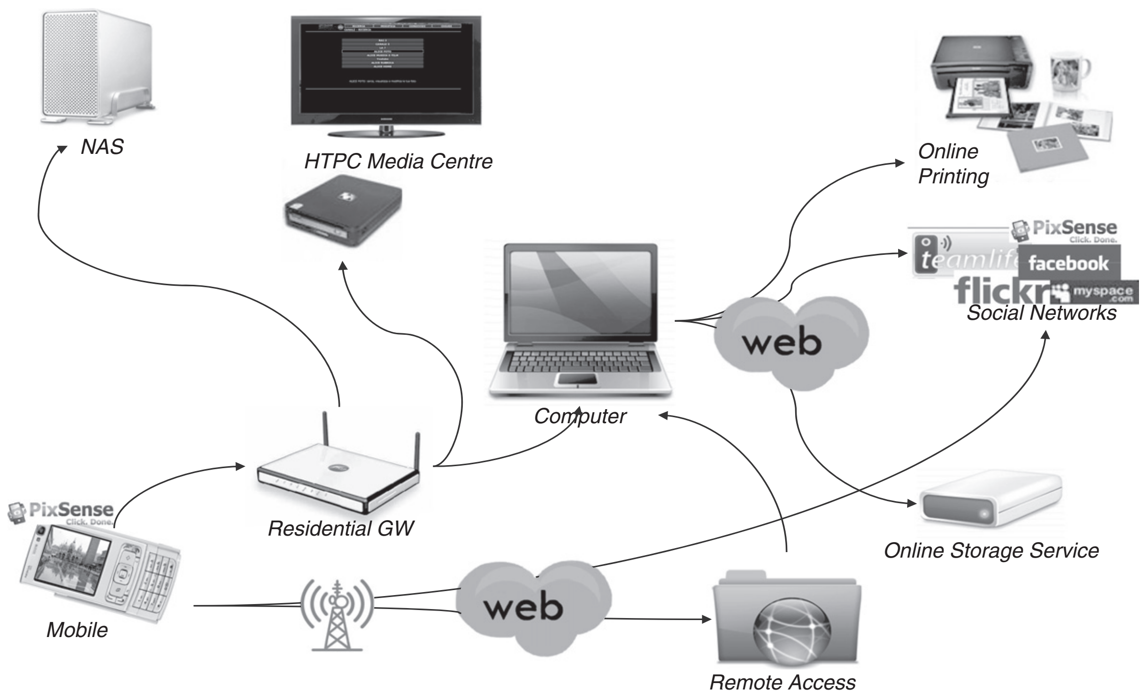

Fig. 3. Schematic representation of the DIE.

consumer can reach the offer for free. Social networks revenues are based on advertising. Also mobile applications offer a high rate of revenues, and they are based on a model of revenues share or are for free and connected to advertising. The Service Providers have the advantage of a fast access to distribution thank to the web.

The data confirm the obvious conclusion of a lower accessibility of manufacturers than service providers, but show also the more attractive sectors inside a class, e.g. application providers are the most attractive ones.

6.1.3. Platforms

The logical schema in Fig. 3 highlights the fluxes of data and information exchanged amongst actors in the ecosystem. The digital imaging ecosystem has two platforms: the personal computer and the Web.

The PC platform is the physical enabler for the entire ecosystem because is the tool that permits the collaboration of the actors and the union of their contributions. It is the enabling technology from a physical point of view.

The extension of the PC platform is the web: they together are the centre of the digital imaging ecosystem. The Web is a programmed and customized platform that is fundamental in the digital imaging ecosystem where all the contents are transported, re-elaborated, stored and shared in the network.

6.1.3.1. D. Relationships

6.1.3.1.1. Tangible relationships. Tangible relationships can be evaluated basing on monetary fluxes, asking "who does pay for that product or service?"

Starting from connections matrix (Table 3) we created an asymmetric adjacency matrix representing the exchange flows of money and product/service amongst actors of digital imaging ecosystem. Fig. 4 shows the graph of tangible relationships amongst the actors of the digital imaging ecosystem: the arrow show the direction of the money, whilst the opposite is the direction of product/service.

The measures we used to analyse the BE networks has been the density, i.e. the ratio between the number of edges and the potential number of edges in a graph, and the network centralization, i.e. the degree to which a network is centralized around one or few actors [59]. Centralization captures the distribution of centrality in the network as a whole [60], reflecting the extent to which ties are concentrated in one or more actors. Density has been selected because it shows alternative mechanisms for control and coordination in a business ecosystem. The relative significance of network centralization and density of a network should be evaluated on the basis of the domain (in our case the digital imaging ecosystem), typology of relationships (tangible, intangible and possible) and the network dimensions (number of actors). Generally high levels of network centralization (e.g. over 60%) point out that the network has a star configuration and consists predominantly of central players. On the contrary, if the centralization value is low (e.g. lower than 30%), the relationships are distributed more homogeneously. High levels of density (e.g. higher than 50%) point out a high proportion of relationships of all possible; consequently it can point out the speed at which flows of knowledge and information circulate amongst the actors and the extent to which actors have high levels of business opportunities and constraints.

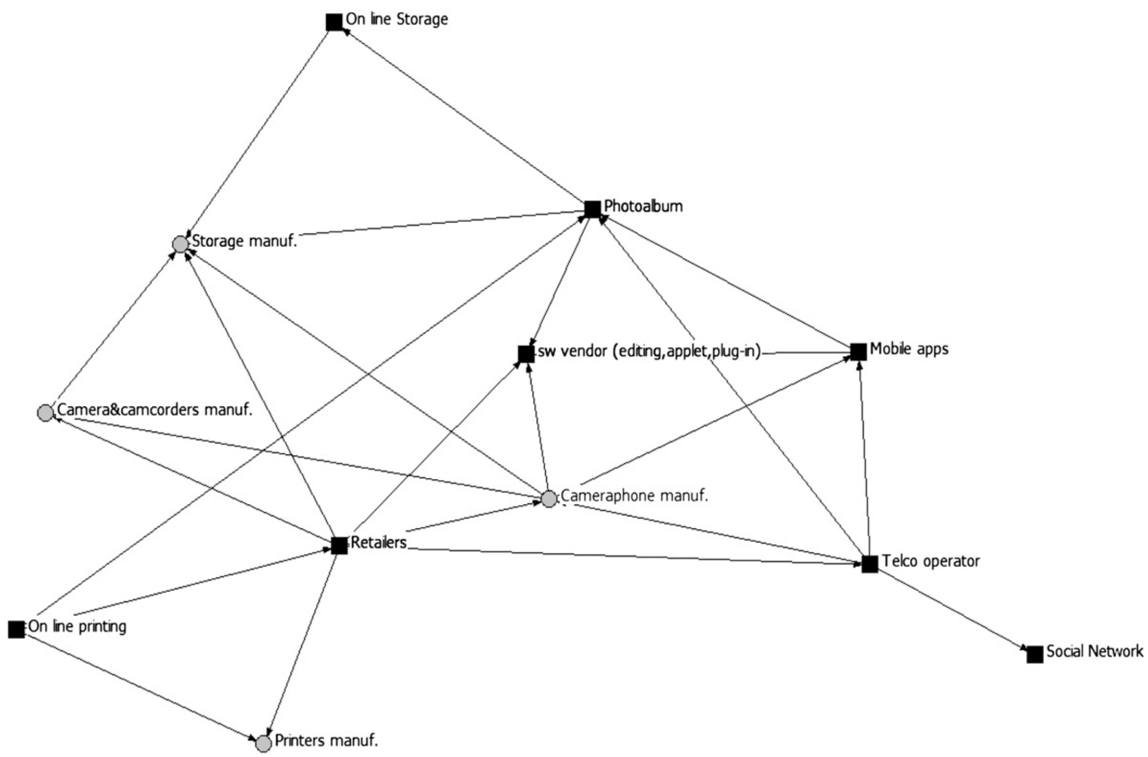

Fig. 4. DIE relationship structure – tangible relationships.

The indexes of network *density* and *network centralization* are respectively of 9.2% (24/260) and 5.79%. The values are both quite low: the network is not close-grained, the revenues are not concentrated in only a point, but are "dispersed" amongst all the actors of the ecosystem. This ecosystem has a high uniformity in the value distribution.

As regards the nodes three important measures can be computed for each node. The *in-degree* is the number of edges coming into a node in a directed graph. The *out-degree* is the number of edges going out of a node in a directed graph. The *betweenness* is the centrality measure based on the frequency with which a node falls between pairs of other points on the shortest or geodesic paths connecting them [61]. The higher is the value of betweenness for an actor, the more this actor is an intermediary in the system analysed.

Considering the dimension of the single nodes, the different values of centrality measures are shown in Table 6. The highest is the in-degree index of an actor the highest is its relative importance in the sense that is the node of destination of many relationships (the actor receives money from many actors). The highest is the out-degree index the highest is its influence, i.e. it is connected to many actors of the network and can influence their behaviour (the actor provides products/services to many actors) [62]. Storage manufacturers, software vendors and photo album services have the higher in-degree values: these are the actors that receive revenues from different actors. Retailers, camera phone manufacturers and telco-operators have the higher out-degree values.

The betweenness values confirm the values of in-degree and out-degree: Photo album services, Retailers and telco-operators manage more than the others the economic fluxes inside the ecosystem as they are in the middle of these fluxes.

An important role is played by the photo album services providers. They take-in the fluxes from different sources (the sources are: mobile applications, telecommunications operators and on line printing). Then they re-use them in their transactions with storage manufacturers, software vendors and on line storage. They are the basis of the ecosystem that works through creation, modification, interchange and fruition of photographic contents. This analysis is an "internal" one (i.e. it does not take into account external relationships such as the consumers and advertiser). In that case, the role of the social networks will be much more relevant. Anyway, if the analysis considers also the value of the transactions, Social networks show themselves as fundamental, because they are exploited for web advertisement for their diffusion amongst consumers.

As regard the betweenness amongst manufacturers, the economic intermediary role is played by the camera phone manufacturers. They are both supplier and consumers of products and services in the ecosystem, so they manage multidirectional economic fluxes. Mobile applications are the tool that enables the *sharing* of the digital imaging ecosystem.

Table 6
Digital imaging ecosystem — in-degree and out-degree indexes.

	Out-degree	In-degree	Betweenness
Manufacturers			
Camera & camcorders manufacturers	1	2	0
Storage manufacturers	0	5	0
Printers manufacturers	0	2	0
Cameraphone manufacturers	4	2	2,8
Service providers			
On line storage	1	1	0
Photoalbum	3	3	7,8
Social network	0	1	0
Online printing	3	0	0
Sw vendor (editing, applet, plug-in, …)	0	4	0
Web services and sw providers	4	1	5
Mobile apps providers	6	1	2,3
Retailers			6

6.1.4. Intangible relationships

Intangible relationships represent the exchanges. Starting from connections matrix (Table 3) we created an asymmetric adjacency matrix representing the exchange flows of knowledge and information amongst the different actors of the network. Fig. 5 shows the graph of knowledge/information exchange amongst the actors of the digital imaging ecosystem.

The indexes of network *density* and *network centralization* are respectively of 15.9% (21/132) and 13.55%. The values are both low: the network is not close-grained and the information is "dispersed" amongst all the actors of the ecosystem. An agent that acts as "attractor" of all the knowledge and the information resources of the ecosystem is not present. The information flow is focussed inside a sector of the ecosystem and does not link the sectors (i.e. it is intra-sectors and less inter-sectors).

The analysis of the centrality *degree* of the actors highlights that camera &camcorder manufacturers and social network result as an important centre for the information exchanges, whilst retailers and telco-operators are less connected to the other parts of the network with intangible relationships whilst more with tangible ones.

The highest betweenness centrality is represented by social networks. This result can be interpreted considering the offer of integrated services of this service provider: the high level of "intangible" centrality is due to the contribution coming from different actors of the ecosystem who offer their services exploiting the interface of the social networks. They are a key point both for the economic fluxes both for the knowledge and information fluxes. From the other side, the retailers and telco-operators are connected to tangible dynamics. Additionally, this graph and the network values show that the recent "mobile application phenomenon" has a high impact from an economic point of view, but a modest impact as regards knowledge and information. As regards the manufacturers, the catalyst of the information fluxes is the camera&camcorder manufacturers. The reason is that the usefulness of the digital cameras and video cameras is not only connected to the mechanical and quality aspects of the product per se but it is connected also to new functionalities. For these new functionalities, to collaborate with the other actors of the ecosystem is necessary.

6.1.5. Possible future relationships

Possible future relationships are related to a foresight of the links that will interest the ecosystem in a time horizon of 5 years. These relationships are the incremental (tangible or intangible) relationships (Fig. 6).

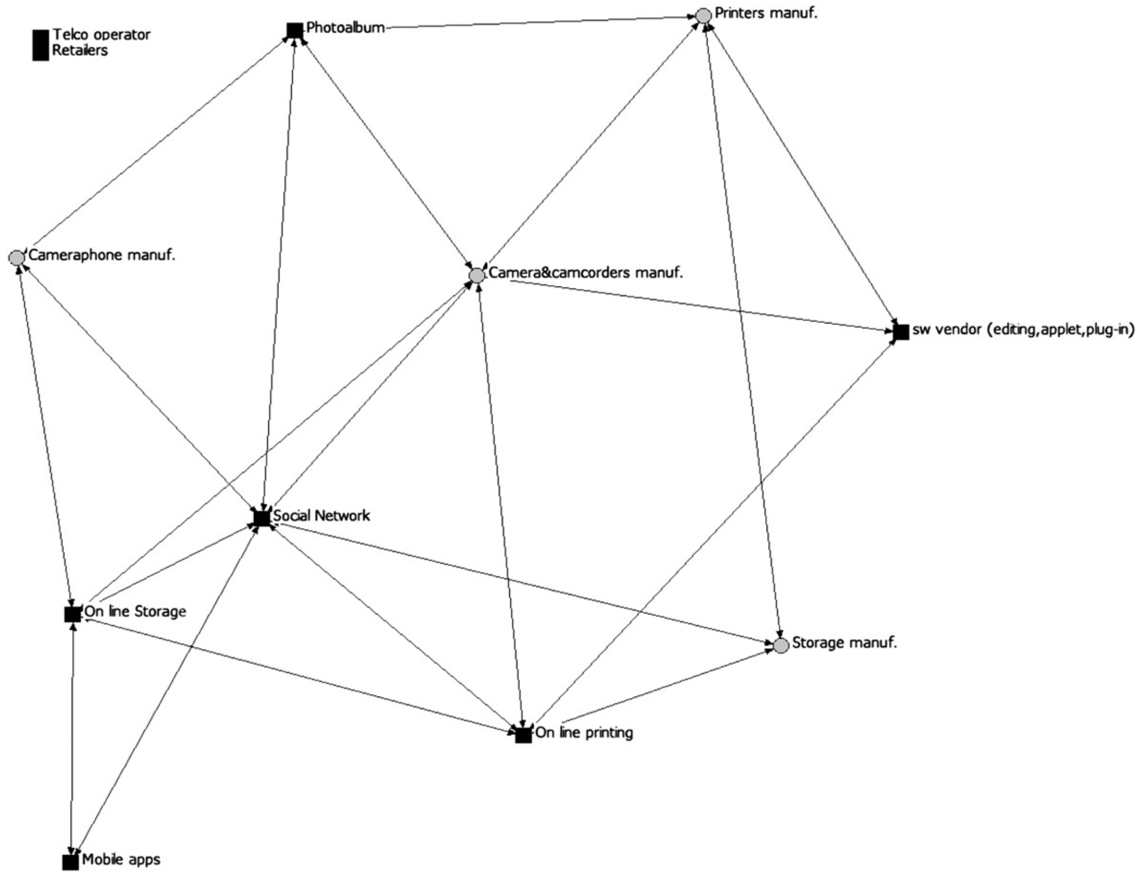

Fig. 5. DIE relationship structure – intangible relationships.

As we analyse the incremental links, the centralization (it refers to the new relationship structure that will develop in the next future) is of 24.30%. The actors that will increase their relationships in the near future will be the telco-operators, with links with online storage and on line printing (service providers side) and with storage, printers and camera&camcorder manufacturers (manufacturers side). Also the online printing services will have a good relationship development in the future; the more interesting link is the one with the mobile applications suppliers that can open interesting scenarios.

A consideration can be made observing that the centralization increases from the analysis of intangible relationships to the analysis of future relationships. This consideration means that whilst the future relationships seem to have a clear role of the emerging actors, at this time the capital and knowledge repartition is still dispersed and the ecosystem is very dynamic. Then, basing on the typology of relationship, different actors play a central role: photo album services have a central role in the tangible relationships, the social networks and camera&camcorder manufacturers are the hubs of the network for the intangible relationships, whilst telco-operators can be the central ones in the future if they integrate their services with the digital imaging ones.

Finally, the betweenness value highlights the level each actor can become the centre of the exchanges of tangible and intangible fluxes: the graph shows the photo album retailers as future important brokers.

6.1.5.1. E. Assets and technologies. The assets and technologies analysis identifies and describes the main technological roadmaps in the ecosystem, discusses the lifecycle of technologies characterizing the ecosystem and uses a quantitative approach to show the trend from a labour intensive to a capital intensive sector.

6.1.6. Technological roadmaps

In the digital imaging ecosystem, the technological roadmaps refer to the digital cameras and to the storage. As regards the compact digital cameras, the trends refer to image and resolution sensors (charge coupled device and CMOS (complementary metal oxide semiconductor)), computational photography (face detection, automatic scene detection, blink detection, high dynamic range, and continuous focus), high speed burst, still-motion and transmitting and information devices (wi-fi, digital living network alliance, and GPS). As regards the storage (hard disk, secure digital, compact flash and the recent solid state drive)), the main trends are first the increase of the memory capacity and the transferring speed (new standard SDXC) and the reduction of the cost for GB and second the development of solid state memories. They are

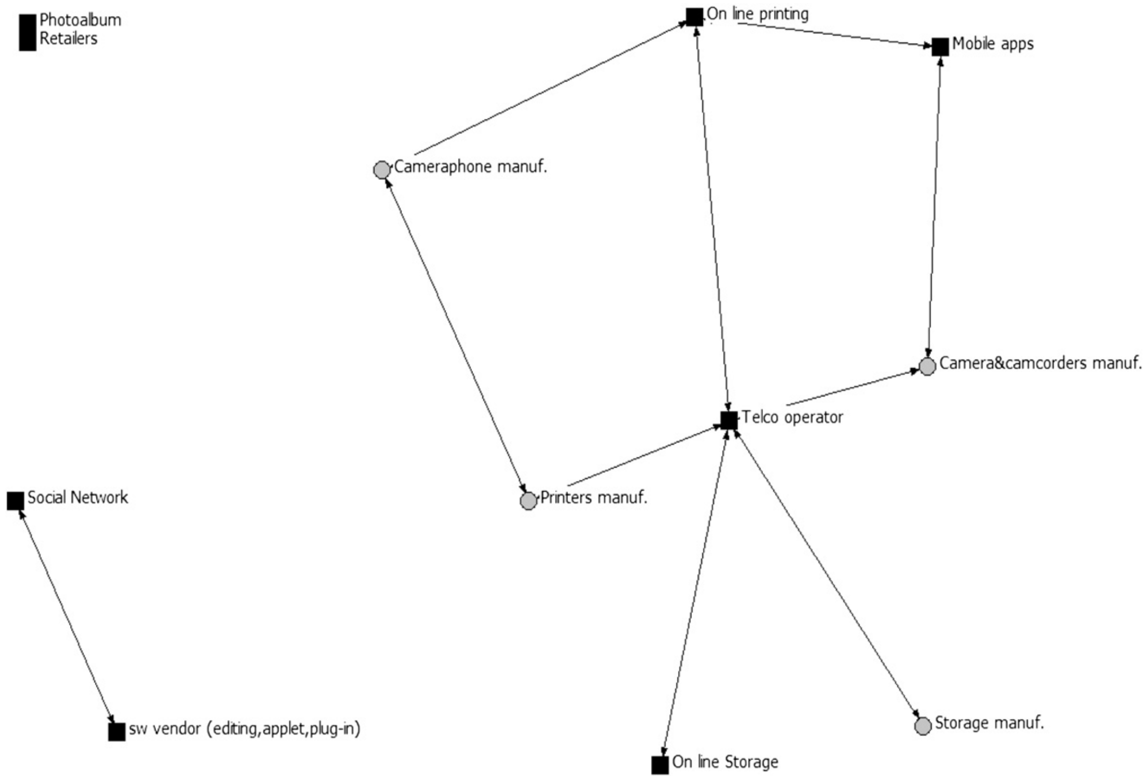

Fig. 6. DIE relationship structure – future relationships.

toward less size, high abilities, high speed and more stable reading/writing operations.

6.1.7. Business ecosystem control point analysis

Identification of the functional elements of the ecosystem, list and description of the control points for every element.

The ecosystem can be subdivided into three functional levels and two connection points. The functional levels are: creation, storage/modification and services. Creation regards all the activities for content (digital photos or videos) generation. In this level, the devices that control the level are the digital cameras and video cameras and the smartphones. Storage/modification regards activities connected to the post-production of the digital content. They can occur directly in the pc or directly in the mobile device for the content creation. Control points are the personal computer and the smartphone

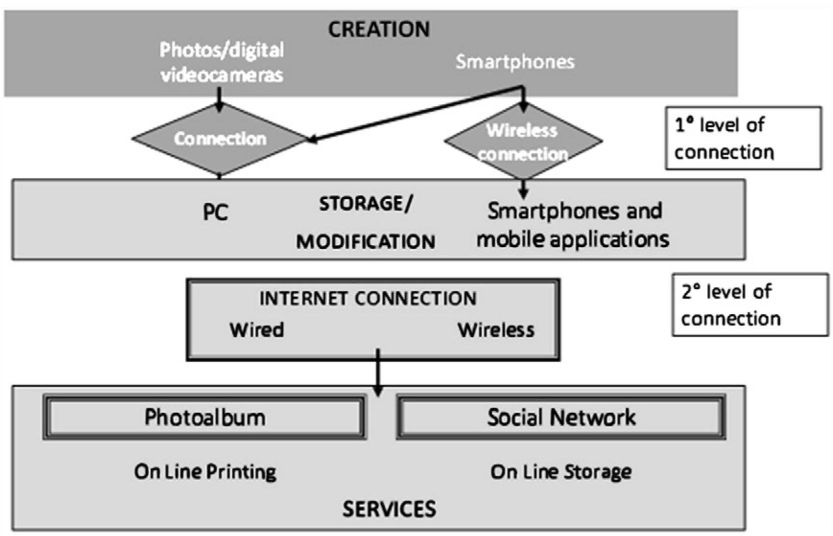

Fig. 7. DIE control point constellation.

SERVICE UBIQUITY	High	**REAL TIME SHARING**	**IMAGE RECOGNITION**
	Low	**ON LINE BACKUP & SHARING**	**MOBILE AUGMENTED REALITY**
		Low	High
		MOBILE AS INFORMATION SOURCES	

Fig. 8. DIE scenarios.

and mobile applications. Services regards the different offers of services represent the different control points: photo album services, social network services, online storage services, and online printing services.

As regards the two connection points, the first level of connection is between creation and storage/modification: all the activities that permit the transferring of the digital content to the personal computer and the access to the mobile applications that are needed for the post-production activities. Here the activities represent the control points that are the connection to the pc for the data transfer and the wireless connection for the applications download. The second level of connection is between storage/modification and services (online printing and online storage): it is the modality to access to web services of the digital imaging ecosystem. The internet connection can be wired or wireless and these two typologies represent the control points.

6.1.8. Control points organization and definition of the control point constellation

The control point constellation has the aim to highlight the relationships and the logical sequence of the different control points and the functional elements of the ecosystem. The result is the dynamic representation of the functioning of the ecosystem, in order to understand which control points have a strategic role (Fig. 7).

6.1.9. Analysis of the control point constellation and identification of the fundamental control points

The control point analysis identified the PC and the Smartphone and mobile applications as control points of the digital imaging ecosystem. They connect and control the ecosystem at two levels of connection.

6.2. Ecosystem evolution

For the digital imaging ecosystem we built a scenario analysis and a roadmap for future evolution.

6.3. Trends and uncertainties

6.3.1. Trends

The trends that can be highlighted are: (1) mobile internet is more and more a commodity because of the diminishing of the prices and new service offers; (2) the storage device evolution is moving toward two sides: technological one (capacity increase and increase of speed of transferring/reading/writing) and economic one (diminishing of the price for GB); (3) the technological evolution simplifies more and more the consumer approach to the digital photography and new devices and functionalities are helping humans abilities; and (4) the sociological trend of the consumer toward the digitalization of their lives is increasing.

6.3.2. Uncertainties

The uncertainties that can be highlighted in the digital imaging ecosystem are: service ubiquity (it permits to utilize in every place and moment a wide set of services, using also remote applications) and mobile devices as information sources (services from mobile devices are dedicated to choose and supply relevant information for the user).

6.4. Scenario graph

The two uncertainties identify four scenarios, as in Fig. 8.

7. Conclusions

As businesses become more and more modularized, characterizing relationships and understanding how business decisions or actions taken by one entity impact all of the interrelated entities become a key challenge. Ignoring these interactions can lead to unexpected and potentially undesirable outcomes. BEs represent the new frontier for the comprehension of companies' relationships. Tools that help to systematically characterize the BE and analyse the potential impact of different business decisions on each entity in the network are essential for improving business design.

Many authors discuss the increasing complexity of markets and the changes of the paradigms of companies' relationships, but structured methodologies are still few. This work would like to be a first step in this direction, in order to comprehend the complexity of these new relational structures. The methodology of business ecosystem network analysis (MOBENA) is a tool that can facilitate the knowledge about the BEs, with a first improvement toward the standardization of the procedure for different contexts and the reusability of data and information.

The present work is the first proposal of a systematic methodology to study the static and dynamic structure of a

BE. This means that it draws not only the shape of the ecosystem identifying the constituent elements and the relationship amongst them in a certain moment of time, but it helps in imagining how it can evolve during time through network analysis and foresight. The MOBENA provides an overview of the possible evolution of the BE (e.g. highlighting the relationships and the logical sequence of the different control points and the functional elements of the ecosystem and providing a scenario analysis and a roadmap for future evolution). Nevertheless, as we affirmed in the Introduction, the time variable is fundamental because the relationships amongst the constituent elements may change the ecosystem structure. In this sense the results of the MOBENA can be used for a further dynamic analysis.

A deeper comprehension of the relationships between organizations' strategies and their operational process on one hand and the embeddedness of organizations in business ecosystem structures on the other hand can be obtained by empirically studying the dynamics of company outcomes and business ecosystem network structure, and how these mutually affect each other. Social science literature proposes various methodologies for the analysis of network data over time. Evolutionary-network models often use multi-agent simulation in different context (e.g. Dynamic Network Analysis [63–65]. Other authors [66,67] use these simulation models as models for data for statistical inference in order (1) to test hypothesized effects of variables on network dynamics and (2) to represent network evolution by developing for probability models implemented as simulation models in a continuous-time model using observations at discrete time points.

Strategies and characteristics of BE agents (as regarded by MOBENA) could be studied as a process evolving over time, where strategies and their operational processes and BE network ties mutually influence each other. So a first research direction could concern the development of an advanced simulation model for the dynamic analysis of the business ecosystem based on MOBENA.

This is important in terms of business ecosystems. They can be seen as complex adaptive systems (CAS): a system of multiple loops and chains, loops within loops, mutual cross-feed relationships connecting them, inhibitory connections, preferential reactions given different substrate concentrations. Complex systems are composed by simple components and complexity arises from local interactions. One of the core questions for engineering and exploiting the extraordinary properties of complex systems is how to define and use simple local rules to generate higher levels of organizations.

Complex dynamical systems can have tipping points at which a sudden shift to a contrasting dynamical regime may occur. Although predicting such critical points before they are reached is extremely difficult, Scheffer et al. [68] suggested the existence of generic early-warning signals that may indicate if a critical threshold is approaching. They highlighted leading indicators that may occur in non-equilibrium dynamics before critical transitions, illustrated how such indicators can perform in model generated time-series and discussed this for natural ecosystems. We think that qualitative indicators can be found also for business ecosystems: the different pictures of evolution over time of the ecosystem through network analysis can help in this way in giving suggestions to business.

The MOBENA methodology has the aim to identify new business opportunities taking into account the evolution of the ecosystems themselves. It can be used as a "diagnosis tool" to give a rapid outline of the state of the ecosystem. From a dynamic perspective, then, the methodology can be used as a tool for verifying the health status of the ecosystem over time. Moreover, the methodology could be used as a tool for comparing the indexes amongst ecosystems (comparing your ecosystem with competing ones) if there is a wider panel of data.

The input MOBENA requires involves expert judgment and identification of the relevant connections and fluxes, but the collection of different opinions and the analysis permit to plot significant graphics and identify the areas of improvement. For example, MOBENA can be used also to analyse the health status of individual possible partners in the ecosystem or parts of the ecosystem itself (e.g. typologies of partners, partners with different size, etc.).

From a historical perspective, the analysis can be repeated and the changes of indexes can signal anomalies and can help in understanding mid and long-term developments of the ecosystem; these anomalies must then be evaluated and appropriately addressed by managers.

Finally, MOBENA can help in deciding as regards different possible partners: plotting the network with a new partner can be a helpful instrument for deciding on selection and maintenance of partners.

In the specific case of Telecom Italia Future Centre, telecommunications are more and more pervasive. From a side, it is important to study how telecommunications conduct a change in ecosystems and from the other which new business models are applicable in those ecosystems. The MOBENA methodology has been helpful in studying the changes of the Digital Imaging ecosystem. The project began with the aim to define and realize service concepts to apply functionalities and characteristics of the digital imaging to telecommunications network and services functionalities, particularly referring to web and mobile.

The photographs are pictures of our memories, and their value is in their uniqueness, authorship and non-reproducibility. The rapid spread of digital photography and video contributed to the creation of a huge iconographic heritage that is stored on computers, exchanged via email and instant messenger and published in dozens of sites, blogs, social networks. Digital images and videos produced, exchanged and shared over the Internet generate about 60% of traffic on the IP network. Most of the applications and services that enable the exchange and dissemination of digital images is characterized by ad-funded business models. They are subsidized by the presence of advertisements, online advertising agencies, advertisers, but not by operators (providing the service and ensuring connectivity). This is the main reason for the development of new business models, accompanying the service concept in order to supplement traditional revenue models (advertising) with innovative models based on access to and use of capabilities of the telecommunications network.

The MOBENA methodology permitted to study the business models for new products and services, hypothesizing different business models and identifying pro and cons for each one. For example, the first result was the realization of a prototype of a guide video system for smart phones, enabled by two-dimensional bar code scanning.

The project then encouraged and fostered the establishment of relationships with innovative companies in digital imaging, such as Amazon, HP, Snapfish and Pixsense in order to collaborate in the design of service concept and their business assets. In particular, in collaboration with these companies, new generation service concepts have been realized, ranging from the hypothesis of a photo printing service multi-channel (web, mobile, IPTV, kiosk) with geo-location functionalities to design of a multi-channel service for sharing digital images and videos, particularly centred on access mobile.

Finally, the final phase developed the concept of augmented reality application for smart phones. Photographs taken by the smart phone is enriched with information that the Operator aggregates from various service and content providers. The MOBENA permitted studying different business models and deciding with the information.

Building the methodology presented two main difficulties and limits: the standardization (the methodology is structured in order to collect the common aspects for all typologies of ecosystems but also to have a certain grade of flexibility to analyse their specific characteristics) and the data and information availability and retrieval. So, future research directions would like to test also the methodology in other industry sectors and to improve the knowledge about the concept of business ecosystem, with further empirical research.

The knowledge of a phenomenon is the basis of its evolution. The definition of ecosystem as a complex system focusses the attention on the comprehension of its present and future relationships. The aspect that supplies much information in a complex system is the relational one: the challenge of the comprehension of the BE is a network challenge. Finally, comprehending the dynamic interactions means to integrate foresight methodologies in the BE analysis. That is why the MOBENA proposal is focussed on these two important points: relational and network structure and dynamic foresight analysis.

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