A Cluster Reference Framework for analyzing sustainability of SME clusters

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Abstract

In this paper a Cluster Reference Framework is introduced in order to give a complete model for an industrial network useful, to give keywords to a manager for the analysis of the industrial network and the decision making process. During the development of the EU project CODESNET, a big number of data of industrial district have been collected and analyzed. From that data, it has been possible to introduce a classification of the network’s type and to identify the main components of the model of an industrial network. A graphical three dimensional representation of the cluster model has been presented and used in order to give, to a manager that aims to cluster, a tool for a decision making process based on a sufficient view of the cluster main characteristics.

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1. Introduction

The history of European industrial clusters of Small-Mid Enterprises (SME) shows different routes through which groups of small businesses have come to recognize their identity as cluster or network of companies. The recognized different routes can be:

- a process triggered by local training centers, which have helped businesses to form themselves into organic product-service system, so as to better respond to the labor market;
- the aggregation was driven by the need to join forces in the face of adverse market environments;
- the local public administration, or agencies/associations for industrial and commercial development asks SMEs to strengthen cooperation, often during times of crisis.

Sometimes the industry associations themselves have been stimulated by their members, to take charge of setting up a SME network.

The need for stressing cooperation among SMEs and improving networking has been perceived of interest by the European Commission [1] and by individual countries [2] that promote, since some years, new organizational transformations of industrial-service systems into sustainable networks.

“A product service-system is a system of products, services, networks of “players” and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models” [3].

In this notes, sustainability is the characteristic of a networked system of enterprises to survive at changes maintaining its status or by evolving towards new organizational configurations.

The industrial network systems, in Europe, raise from different needs and with different characteristics [4, 5]. The Italian industrial districts and the UK clusters of SMEs have in common the characteristic to be agglomerations of SMEs from the same geographic area. Among the characteristics of this kind of networks, there is the high level of expertise in a specific...
manufactured sector and the availability of raw material in the area or the presence of a big local market are one of the most important key factors for the development of the network [6].

In France, it is common to find “Pole of Competitiveness” as well as the “Scientific Parks” in Greece. This kind of networks rise thanks to national or regional governments incentives to develop a common project. In other countries, like Germany, the SME networks rise around a leading firms that have the characteristics to pull all the SMEs in the market.

Despite the pressure towards cooperation, many SME managers have maintained their individualistic position: this has reflected in many dramatic crises and closures of small businesses, especially in recent years [7, 8].

Consequently the problem discussed in the proposed paper is intended to address the following questions: How does a manager of an SME assess whether an existing cluster could be a "friendly environment" for his small business? What organizational characteristics of the cluster has to be analyzed? Which network structures appear to be preferable such as the types of SME clusters, modeled in terms of standard networks; a classification of the different SME clusters can be standardized.

The paper will motivate in detail the CRF, and show its practical utilization by a SME manager. To this aim, the paper is organized as follows.

Section 2 introduces a model of a SME cluster, by making evidence to the two components above mentioned, namely types of networks connecting the partner SMEs together, and types of cluster management. Depending on these two components, a classification of the different SME clusters can be standardized.

Section 3 will illustrate a three-dimensional framework, namely the mentioned Cluster Reference Framework – CRF, where the types of networks, the types of management organizations and the different ways to create a network of small enterprises will be respectively referred to each dimension. The potential practical utilization of the proposed framework will be discussed by making attention to each pair of dimension: in this way, it will be shown how the presented framework can support a specific analysis of a SME manager. Section 3 will also illustrated a preliminary application of the CRF, by analyzing the three types of dimensions for a number of SME clusters, based on data collected during the European project CODESNET and stored in the CODESNET archive. Some conclusions are discussed in Section 4.

2. Modeling a SME cluster

The modeling of a SME network requires to take account of three main aspect [9, 10]:

- first, the main functionalities to be performed in order to assure an efficient, effective and convenient management of the operations to all SMEs that compose the network;
- second, the type of connecting structure, that means the organization of the links among the SMEs as well as of the types of flows using said links;
- third, the way to create a new SME cluster, that means the different types of pressures to the aggregation of multiple companies in a common network.

2.1. Main functions of a SME cluster

A “functional scheme” of any SME cluster illustrates the main functionalities that compose the SME cluster management organization. It shows the contribution of partners to the cluster management committee (if it exists); the generation of production and financial strategies by the cluster committee; the translation of strategies into action plan to satisfy customers orders by using the cluster structure to produce. In the next Fig.1, the functional scheme is presented: “A” denotes the operations control loop; “B”, the performance evaluation loop; “C”, the finance management loop; “D”, the partners’ interactions management loop.

2.2. Models of the network of SMEs

From the structural point of view, a SME cluster can be represented by the network of SMEs, thus modeled by a graph G=(V,E), where V is the set of vertices and E is the set of edges or arcs. Typically, a vertex can be referred to a component SME, while an edge can represent a SME-to-SME connection between two SMEs.
Since 3.

1. characteristics of the SME network graph:

In practical terms, the adjacency matrix R specifies the existence of all the connections among the graph edges, i.e. the SMEs, whilst the incidence matrix M identifies the links among SMEs for multi-step work sequences; 3.

a SME-to-SME connection could be:

1. a flow of parts from a SME to another, as in case of a supplier-to-client transfer of parts,
2. a transmission of information from a SME to either another or to a common center, as part of a cluster information system,
3. a transfer of orders either between SMEs or between a SME and a common center, as part of a cluster management organization.

For the scope of the present analysis concerning network of manufacturing SMEs, the graph under consideration is referred to the physical part flows.

Among the six different types of matrix representations that could be identified for a graph G, the incidence matrix M [nodes vs edges] and the adjacency matrix R [nodes vs nodes] will be here used for formally modeling the network structure. In practical terms, the adjacency matrix R specifies the existence of all the connections among the graph edges, i.e. the SMEs, whilst the incidence matrix M identifies the links outgoing from each edge, i.e. the SMEs output flows.

Indeed, these two matrices completely describe the network, since they will allow to identify also the following characteristics of the SME network graph:

1. the identification of paths by compiling the path matrix P [paths vs edges], that means in practice the input-output flows of parts from pairs of SMEs operating as suppliers and customers;
2. the identification of circuits by compiling the circuit matrix W [circuits vs edges], i.e. the reciprocal internal connections among SMEs for multi-step work sequences;
3. and the identification of cutsets by compiling the cutset matrix K [cutsets vs edges], i.e., boundaries among internal groups of SMEs, each one with common characters or functionalities.

Incidence and adjacency matrices assume different properties according to the network graph configuration. To understand next matrices it must be underlined that the S and D node are external to the network as fictitious nodes introduced to represent suppliers and final destinations.

Depending on the type of production flows connections of SMEs, a classification of the network layout has been defined, by identifying four network graphs illustrated in the next Fig. 2. The network boundaries are represented by a rectangle, small and medium enterprises by numbered circles and edges between SMEs by arrows. S and D represent, respectively, the Source and the Destination node.

The configuration in Fig. 2a is denoted as Job Shop (JS) network [11, 12]. This network is characterized by a set of SMEs and each one can both provide and receive material/information from the others. This means that it allows the presence of cycles. In this first type of configuration, the geographical proximity and the similarity in producing play an important role for the growth of the network. A second type of SME aggregation has been identified as “supply chain” or, more generally, “multi-stage supply chain” [13]. In this kind of network, the relationships among the enterprises are of client/supplier along the production chain that ends with an important leading enterprise whose brand is known all over the world.

In Fig. 2b, a structure of a Multi-stage supply chain (SC) is represented: arrows represent links typically with an exchange of material or components. Products are differentiated in order to cover different market stratification (shoes for man, women and child): to this aim, the chain is composed by stages with a number of parallel SMEs. Unlike the previous configuration, in this network cycles are not allowed.

Fig. 2c gives a simplified illustration of the Hub-and-Spoke (HS) type, with one leader and five SMEs, all connected either directly or through another partner, to the leading firm. This configuration does not allow cycles and the lead node has a number of entering edges very higher that the other nodes.

In addition to these three models that represent very fixed and ruled interactions among SMEs, there is another kind of aggregation, mainly exploited by high-tech production and/or service supply. Since the nature of such aggregation is mainly oriented to R&D, this configuration is named Scientific Park (SP) (or “pole of competitiveness” in France) [14, 15].

In terms of graph representation, the nodes can be considered as inserted in a pre-existing network, and they can activate other connections that are very flexible and more informal than the classical ones. To differentiate these potential connections from the classical ones, we represent them as switches on the graph edges. An example of the Scientific Park network is shown in Fig. 2d. The typical feature of a Scientific Park is that each node is connected directly with the source and the destination nodes (due to the pre-existing network) and all the possible edges between nodes can be activated or interrupted at any time.

The exchanges between such companies does not concern materials or components but is an exchange of information (knowledge, data, models, ideas) and services, thanks to the underlying network of partners specialized in ICT and support to the innovative activities.
2.3. Models of the management organization

As above mentioned and illustrated in Fig. 1, the most general form of a management organization of a SME cluster includes the following main functions: the operations control loop, “A”; the performance evaluation loop, “B”; the finance management loop, “C”; the partners’ interactions management loop, “D”.

In practice, the real application of all these management functions depends on the type of cluster committee.

Consequently it can be stated that the presence of a particular type of committee characterizes a SME network defining the robustness and the possibility of a real future development.

With reference to the cluster analyzed in the project CODESNET, you can recognize the following types of the Management Committee:

- Industrial management committee, i.e. a committee composed by the top managers of the most important enterprises included in the cluster: among the managers, a coordinator is usually nominated. This is the case of small and mid enterprises operating in the manufacturing sector, as automotive, aerospace, electronic ones; in this organization, all the management functions of Fig. 1 are applied.

- Administration management committee, i.e. a committee composed by administrative directors or, more generally, by administrative staff, of some companies in the cluster, with the task of monitoring costs and revenues on behalf of individual companies, and of reporting to external funders (function C in Fig. 1). This can be the case of clusters having a leading enterprise, whose aim is to monitor financial flows without completely removing autonomy to other SMEs of the cluster;

- Marketing-oriented committee, i.e. a committee made up of directors of marketing for some companies, with the task of managing specific marketing initiatives, such as exhibitions, promotional campaigns or advertising (function A in Fig. 1). This is the case of SME clusters of the jewelry sector;

- Political committee, i.e. a committee composed by representatives of the municipalities where the SMEs belonging to the cluster are located; this is the case of some clusters operating in the agro-food sector, as in production of wine. A political committee is a committee that can implement at most promotional functions, but does not have operational duties;

- No committee, i.e. a form of weak interaction, partly marketing – oriented and partly characterized by a political and social nature, with the sole purpose to create a market to the SMEs.

2.4. Models of the SME cluster creation dynamics

Differences in the origin and creation of the enterprise clusters give rise to different types of SME networks, as it has been presented in [15, 16] where an overview of clusters in some European countries has been illustrated. Some countries have seen the emergence of business networks in an autonomous way, or pushed by the companies themselves, or by industry organizations (such as in Italy, UK and Germany), while in other countries national or local governments have promoted investment programs to create networks (such as in France and Greece).

The free aggregation of SMEs can occur either in a territory with no constraints (if there are no specific requirements from logistic needs of the production) or limited in a small area, because of the necessity of a strict collaboration and a strong sharing of resources and information. It can be autonomously induced by the strategic vision of the managers of the SMEs to create a collaborative network in order to plan and manage their production activity. In this type of aggregation, named Autonomous or Marshallian, two particular models of SMEs networks prevail: Supply Chain (SC) and Job-Shops (JS). In the JS network, each SME can both provide and receive products/services from the others, while in the SC network a chain exists, which is composed by two or more stages with a number of parallel SMEs which provide products/services to the SMEs in the following stage.

The customer-supplier type of aggregation may be originated when firms of different size and different strength in the final product market agree to activate together connections of several suppliers depending on one (or few) leading SME. This is the case of Hub-and-Spoke networks, where one or two leading firms push to create a network of suppliers in order to increase their performance and their position on the local and external market: now the hub enterprises drag the production.

The public body driven aggregation is organized through a collaborative project founded by national, international or private bodies. This is the case of the Scientific Parks, characterized by high skill, high technologies and high innovation, requiring an high sharing of knowledge, resources, information and skills, the aggregation approach cannot be based on autonomy of SMEs; large investment are required as well as an accurate selection of both SMEs and the personnel of high qualification to be employed.
3. The Cluster Reference Framework - CRF

The three main aspects of a SME cluster model, namely SME network type, management organization, and cluster creation, defines three dimensions of a frame as in Fig. 3.

This frame can be seen as a three-dimensional matrix, each internal box being associated to a triplet:

<network type; type of Management body; network’s agreement>.

Said tripled specifies a SME cluster type.

In each box, the names of some SME clusters (among the ones stored in the CODESNET archive) can be located: then, each box offers to a SME manager a set of preliminary information for evaluating if joining the considered network type could be of some interest for his/her SME.

The real utilization of the schematic model of Fig. 3 can be realized by considering some Italian industrial districts, as the one reported in the following Table 1 from the CODESNET archive.

![Fig. 3. Schematic model of CFR.](image)

An example of specific analysis has be done by referring to the manufacturing sector, with attention to districts producing shoes.

The manager of a SME of this same sector, aiming to join a district, has at disposal the “archive” illustrated in Fig. 3. He will use the archive boxes tagged with the word “product = shoes”, thus obtaining the following Table 1.

<table>
<thead>
<tr>
<th>District Name</th>
<th>Network Type</th>
<th>Management body</th>
<th>Network creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fermo</td>
<td>HS</td>
<td>None – existence of leading firms</td>
<td>Free aggregation</td>
</tr>
<tr>
<td>Vigevano</td>
<td>SC</td>
<td>None – No leading firms</td>
<td>Free aggregation</td>
</tr>
<tr>
<td>Lucca</td>
<td>SC</td>
<td>None – No leading firms</td>
<td>Free aggregation</td>
</tr>
<tr>
<td>Verona</td>
<td>SC</td>
<td>Marketing-oriented committee</td>
<td>Free aggregation</td>
</tr>
<tr>
<td>San Mauro Pascoli</td>
<td>SC</td>
<td>Marketing-oriented committee</td>
<td>Free aggregation</td>
</tr>
</tbody>
</table>

The selected boxes, however, are referred to different triplets, then the manager receive the following information:

a) Fermo’s District:
   - Network type = Hub and Spoke;
   - Management body = none (existence of leading firms);
   - Network creation = free aggregation.

b) Vigevano’s District and Lucca’s District:
   - Network type = Supply Chain;
   - Management body = none (no leading firms in the chain stages);
   - Network creation = free aggregation.

c) Verona’s District and San Mauro Pascoli’s District:
   - Network type = Supply Chain;
   - Management body = Marketing-oriented committee;
   - Network creation = free aggregation.

In summary, manager asking for joining suggestions can get:

- A common information: all districts aim to accept new partners, being born from “free aggregation”.
- Specific information: make a choice between a cluster where a leader will plan the future and a cluster where, at most, common marketing strategies could be plan together.

Depending on the manager’s desire to maintain large autonomy and to be supported, the “archive” of Fig. 3 can provide immediate, even if preliminary, suggestions.

4. Conclusion

The analysis of a number of industrial districts, collected during the development of the EU CODESNET project and his evolution in national research programs, gave rise to a complete model of an industrial SME cluster, with three main complementary aspects (and model components): SME network cluster, management committee, cluster creation dynamics. A graphical three dimensional representation of the cluster model has been presented. This same representation has to be interpreted as an “archive” of cluster data/information. This archive is useful tool for a manager who aims to join a cluster, but wants to take its decision based on a sufficient view of the cluster main characteristics.
References


[17] CODESNET: COllaborative DEmand and Supply NETwork, European Coordination Action, EU-funded project EU FP7.