From Private Finance Initiative to Public Private Partnership: The Financement of Trans-European Networks

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Abstract

The object of this research is finance and projects in changing markets: with the growing complexity of the markets, the analysis of projects needs a different approach. We consider the CoPS (*Complex Products and Systems*) model. CoPS are high-cost, engineering-and-software intensive capital goods and services, such as mobile telecommunications networks, air traffic control systems and high-speed trains. The aim of this paper is to provide, after a critical introduction to the CoPS literature, an original framework trying to understand the problems that can raise from complex projects and the possible applications to the Italian case. The paper is structured in three parts: in the first part it will be presented a general overview about the specific characteristics of CoPS, with a critical analysis about the contribution of this literature on the study of firms' organisational capabilities; in the second part it will be examined the British system of financing complex public projects, with a special attention about the case of Railtrack, using the CoPS framework, namely the project management and the systems integration; finally, we will make some consideration about the Italian context, that will take to conclusion.

Introduction

The creation of a unique market in the European Union (EU) has favoured a competition with no more national barriers, already realized in the market of capital and goods, and now involving also the market of public services, like the transports, under the principle according to which every economic activity must be managed with criteria of efficiency and efficacy, independently of the juridical nature (public or private) of the subject who does it.

The mobility demand between the member states is increasing, favoured by the economic development and by the disposals about liberalization of mobility, harmonisation of norms on economic activity and by the willingness to reduce territorial disequilibria. For this reasons has been defined the Trans-European-Networks (TENs) program, whose mission is the creation of a unique European space in telecommunications, energy and transports.

The European Commission has clearly recognised that private partners will only accept participation in the risks entailed in TENs if they can share at least a controlling responsibility in the construction and management process: in the transport sector in general, and in railways in particular, EU legislation has already prepared the way for open access, and has established the rule of the separation of track ownership and management from the operation of trains.

In most countries, the majority of infrastructure activities are still publicly owned, managed and financed. If the private sector is to take a greater role in the provision of infrastructure services, it can provide capital, management or both. If it provides either, then the existing structure of relationships within the framework of state management and control will have to be changed to a more explicit system of regulation of private sector bodies by public agencies.

Looking at the relative costs of private and public capital, we can see that there are significant differences only if the introduction of capital is associated with a change in the allocation of risks, and such a change is likely to be achieved only if there is also a change in the structure of management responsibility.

Thus, the value of introducing private capital is directly related to its combined effectiveness in transferring risk and responsibility.

The object of this research is finance and projects in changing markets: with the growing complexity of the markets, the analysis of projects needs a different approach. In this paper we consider the CoPS (Complex Products and Systems) model.

CoPS are high-cost, engineering-and-software intensive capital goods and services, such as mobile telecommunications networks, air traffic control systems and high-speed trains.
The idea that a category of industrial products can be defined as CoPS draws on the military systems literature (Walker et al, 1988), and it has been developed with the measurement of complexity of systems (Kline, 1990) and by the scholars of large technical systems (Hughes, 1983). Evolutionary scholars such as Nelson and Rosenberg (1993) mention complex systems, but neither define them nor treat them as a distinct category for research purposes. It is in the second half of '90s that a new line of literature starts to study exclusively these products and services, deepening the reasons of their growing importance, their characteristics and their innovation patterns.

The core capabilities to compete successfully in the supply of CoPS are project management and systems integration (Hobday, 1998): these organizational techniques, in fact, are fundamental to integrate the different types of knowledge, experience and skills of production and management which enable a firm to distinguish itself and determine its ability to adapt, grow and achieve competitive advantage (Leonard, 1995). This brief description allows to define the analysis about CoPS as part of the Systems of Innovation literature: it is used, in fact, the same evolutionary approach and the same comparative methodology. CoPS are so defined as the product of the changes and the evolution of markets and technologies, and the result of the interactions between the various subjects operating in a complex social-economic environment.

The aim of this paper is to provide, after a critical introduction to the CoPS literature, an original framework trying to understand the problems that can raise from complex projects and the possible applications to the Italian case. The paper is structured in three parts: in the first part it will be presented a general overview about the specific characteristics of CoPS, with a critical analysis about the contribution of this literature on the study of firms' organisational capabilities; in the second part it will be examined the British system of financing complex public projects, with a special attention about the case of Railtrack, using the CoPS framework, namely the project management and the systems integration; finally, we will make some consideration about the Italian context, that will take to conclusion.

I THE COMPLEX PRODUCTS AND SYSTEMS

Following the first definition given by Miller et al. (1995), the Complex products and Systems are high-cost and high-engineering products, systems, sub-systems or constructions that present elements of new technologies; they are supplied by a unit of production (a single firm, a group of firms or a temporary project-based organisation) and they are typically purchased by one or more users, under one (or more) formal contracts within a single project. The first element that characterises the category of CoPS is, according to the seminal contribution of Hobday (1998), the inextricable linkage between the artefact and its process of manufacture (the project), so that the definition of one makes most sense in relation to the other. The chief units of analysis to understand the potential and the innovation capability of this category are:

(a) *the project* and

(b) *its output (or product)* and the links between them.

This focus on the supply side differs from the approach used by historians of Large Technical Systems (LTS) such as Hughes (1983) and Summerton ed. (1994) who analyse the historical evolution of networks and systems.

In accordance to this literature, a Large Technical System consists of three main elements. First, a set of components, that can either be physical artefacts, (i.e. tracks, energy supply, depots, etc.) or non-physical artefacts (such as operators, supply and maintenance companies, banks, regulation authorities). Hughes dismisses the notion that organisational, political and social elements are the context, or the environment, in which technology is embedded (Hughes, 1987).

Secondly, components are linked to each other in a certain structure, a horizontal and vertical architecture. Because components are systemically interconnected, changes in

the design or operation of one component often require changes in the design or operation of related components in the system.
Third, in LTS is present a "control component" , exercised by physical artefacts and human operators, that is responsible for system performance and efficiency and for realising overall economic and social goals, such as safety, reliability and universal service (Davies, 1996; Davies-Geyer, 2000).

Davies (1995) considers LTS as made up of individual CoPS (and other inputs) which deeply influence the innovation trajectories.
Drawing upon these two conceptions of a large technical system, and upon the literature about innovation in the project-based supply of CoPS (e.g. Miller et al., 1995; Gann and Salter, 1998; Hobday, 1998), Davies and Geyer (2000) argue convincingly that in large-scale projects the appropriate unit of analysis is neither the project, individual firm, nor the supplier-buyer relationship treated in isolation, but rather the project and operational system that forms a part of a larger system of technical and organisational components. In this way, the project represents a clearly defined CoPS supply task, undertaken within a reliable timescale and given resources, keeping in mind the specific needs of the customers.

I.1 PROJECT AND PRODUCT

The CoPS project is a temporary coalition of organisations which usually cuts across the boundaries of single supplier firms. CoPS projects normally involve a series of phases including pre-production, bidding, detailed design, fabrication, delivery and installation, maintenance and, sometimes, de-commissioning.

Hobday (1998) makes a classification of industrial products based on their technology:
Type A (low-technology) products rely on well established technologies (e.g. roads and simple buildings). These can be large or small in value but no new technology is required at any stage.
Type B (medium-technology) products incorporate some new features but most technology is available, as with new models of existing products.
Type C (high-technology) products consist of mostly recently developed technology. Examples include new super computers and intelligent buildings.

Type D (super high-technology) products, which depend on the development of new artefacts, skills and materials, are fairly rare and depend on emerging technologies. They involve extremely high levels of uncertainty, risk and new investment (e.g. spacecraft and intelligent defence systems).

According to this classification, CoPS would include components and systems which fall into groups C and D, definitely excluding groups A and B regardless of cost. Taken together, the systemic capacity and the technological novelty are the starting point to describe nature and potential of CoPS.

Hobday (1998) sustained that in this case the measure is not anymore the dimension, but the degree of complexity and hierarchy. Most CoPS, in fact, embody a fair degree of complexity and risk that, compounded, provide an approximation of the relative degree and nature of the complexity of a particular product and suggest the difficulties of the coordination task. In this evaluation it is preferable not to make a distinction between product and project. The two aspects are inextricably entwined, the product shaping the nature and quality of the project and *vice versa*. Equally, the CoPS should be viewed in relation to the market in which they are embedded, as the quality of their attributes can only be understood in the light of the demands of the marketplace, on the contrary of what was sustained by Hughes about LTS (Hobday, 1998; Davies-Geyer, 2000).

Since the 1960s and 1970s, in fact, the innovation environment has changed markedly.

Technological, political and financial changes have forced the pace of innovation in areas such as aircraft and air traffic control systems. Market growth and the internationalisation of firms has called for new forms of regulation.

"New mechanisms of financing and deal structuring involving private capital have made ever larger projects possible. The deregulation of sectors such as telecommunications, aerospace, nuclear power and electricity in several countries has increased the demands for new CoPS in network upgrading, while large new investments in Eastern Europe and East Asia have changed the market prospects facing suppliers" (Hobday, 1998 p.7).

Outside stakeholders' interests and other institutional factors have now to be accounted for both during and after the project formulation stage. New standards of safety and pollution control sometimes need to be built into project planning and execution.

Emerging environmental concerns feed into risk management and coalition forming, through from planning and definition to operation and de-commissioning. Mechanisms for dealing with feedback from users and other stakeholders form an important part of the coordination process, especially for larger CoPS projects.

The quantity and complexity of alternative system architectures can pose significant coordination problems for CoPS suppliers, especially when system integrators, users and regulators have to agree *ex-ante* on the path of innovation (Miller et al, 1995). Certain normal architectures can be stabilised within standard (or dominant) designs, influencing the capabilities and strategies of suppliers. Presumably, the larger the number of tailored components and sub-systems, the more difficult the architectural choices will tend to be.

In order to decide upon system architectures and component design paths, particular forms of inter-firm collaboration are required in CoPS. As many authors show, technological coordination across firms is an essential part of managing innovation, regardless of product type (Vernon 1960; Lundvall 1988; Hamel, Doz and Prahalad 1989). In CoPS, the institutional structures within which suppliers are embedded function to realise markets, create projects and agree innovation paths <u>in the absence of normal market selection mechanisms</u>.

Other related dimensions of product complexity include <u>the variety of distinct knowledge bases</u> which need to be integrated into the final product. In modern aircraft, for example, a wide variety of knowledge bases embracing new materials, software technologies, fluid mechanics and communication systems need to be mastered (Vincenti, 1990). The need for elaborate systems integration can expand the variety of skills and engineering inputs far beyond the competencies of even the largest individual producers and dictate a close work with specialist engineering and software firms to produce the final system.

The attention paid to the changes in the markets and to the technological innovation, typical of the Systems of Innovation approach, in this analysis is transferred at the firm level, identifying a category of suppliers and products with peculiar characteristics, in comparison to the mass-production system.

The comparative analysis between two systems presenting different innovation patterns is, again, a methodology of the Systems of Innovation approach, which is used by the CoPS literature to stress the novelty and the specificity of complex products and systems with respect to other goods of larger use.

I.2 CoPS AND MASS PRODUCTION

A “simple” (and mass producible) product can be defined as one which has: first, relatively few, mostly standardised components; second, production by an individual firm; third, relatively stable, codifiable and predictable properties; and fourth, user involvement mediated through arms-length, market transactions.

Complex products embody at least four closely related characteristics which set them apart from mass produced goods and deeply influence coordination patterns.

First, they are high cost hierarchical goods, made up of many customised, interconnected elements (including control units, sub-systems and components).

Second, they are produced in projects involving more than one firm and frequently many collaborating organisations.

Third, they often exhibit emergent, unexpected properties.

Fourth, there is a high degree of user involvement, through which business needs feed directly into the innovation process (rather than through the market as in the standard model).

A crucial difference is the standardisation of components or subsystems. A car is made up of many parts and components, mostly highly standardised, enabling them to be mass produced in large volumes at low unit cost. By contrast, a flight simulator consists of highly customised components.

Hierarchy is an intrinsic feature of CoPS architecture. For example, military systems can be understood in terms of their hierarchy, extending from materials and components, whose unit costs can be measured in cents or less, to very large systems costing billions of dollars. Within the hierarchy of systems such as Tornado, Trident and the European Fighter Aircraft, the outputs of each stage are the inputs of the next.

As a result of these properties, product life cycles do not follow those predicted in the conventional model. In CoPS, the mass production stage is not reached and the

suppliers' chief task is one of design, development and systems integration (Hobday, 1998). The degree of complexity of a system depends upon the costs and the variety of components, upon the regulation requirements, the difficulties of integration etc.
New product development requires a deep understanding of the limits and possibilities of system architecture, the capabilities of partner suppliers and the needs of highly demanding professional users. Once installed, the CoPS may continue on its path of innovation over many years, with changes being made to control features, sub-systems and performance characteristics.

Throughout the product's life cycle, the users' involvement in R&D, design, production and innovation distinguishes CoPS from simple goods, where direct buyer involvement occurs (if at all) at the early stages.

The depth of user involvement at various stages of the innovation process is one of the critical dimensions of CoPS. In some, user involvement may tail off at the point of production (e.g. in flight simulators) whereas in others it may carry on through to de-commissioning (e.g. nuclear power equipment). The user tends to be a large organisation with a considerable interest in the outcome of each CoPS project. Many CoPS are business-to-business, capital goods, tailored to the needs of specific customers, who depend upon them for their business growth, profitability and survival. Unlike mass market buyers, CoPS user organisations often need to internalise systems design and architectural technology in order to be effective in their own business. Intimate user-producer links allow buyers to feed their needs directly into the specification, design, development and manufacture of CoPS. In telecommunications, for example, large user organisations (e.g. AT&T) influenced the innovation trajectory of exchange systems.

CoPS suppliers can be responsible for maintenance, upgrading and modifications, as well as for information feedbacks useful for future innovations (Rothwell and Gardiner, 1989). Innovation and diffusion are often collapsed together, and it's difficult to distinguish them like in mass-production goods.

Perhaps the chief contrast with mass produced goods is that CoPS tend to be realised through the combination and re-combination of numerous actors within projects.

Coordination crosses the boundaries of firms, with performance relying on the effective synchronisation of all organisations involved in the project.

Because the chief unit of analysis for strategy and competition is normally the single firm, consideration of CoPS adds a new twist to traditional management theories. In CoPS firms create markets in networks and exploit their advantages within multi-firm projects. Therefore, collaboration in bidding for and executing project are core competencies for CoPS producers. Intense and purposive strategies for inter-firm coordination are demanded by the nature of the task. One of the chief functions of the prime contractor is to coordinate the human and physical resources across firms and other organisations to good effect. The effective *ex-ante* coordination across the web of producers, users and regulators is an important feature of successful project-based firms.

For this reason, the disbanding of teams at project completion presents negative implications for production learning and organisational learning in general, because usually firms are able to learn by gathering data on routines and improving group practices (Garvin, 1993; Stata 1989). However, because CoPS projects are temporary and often highly customised, there will be far less scope for routinised learning (Hobday, 1998).

This aspect has been deepened by Davies and Brady (2000), who designed an organisational model allowing firms not to waste their competences and skills at the end of a project.

The basis and the development of this approach are described in the next section, and it represents an original contribution to the theories about firms' organisational capabilities, specifically oriented on the category of complex products and systems.

I.3 REPEATABLE SOLUTIONS

The view that organisational capabilities, routines, knowledge, skills and experience provide the internal dynamic behind firm growth has produced a large body of literature and range of different concepts, such as resources, capabilities, competencies. The original study of Penrose (1959) laid the foundations of this field of research with the "resource-based" view of the firm (e.g. Richardson, 1972; Wernerfelt, 1984).

The recent literature has developed this theory, arguing that successful firms, in addition to the accumulation of skills during time, they develop the dynamic or core competencies necessary to adapt to or shape the external environment, such as new product, process, technological or market changes (Teece and Pisano, 1994; Foss, 1997; Noteboom, 2000).

Penrose argued that a successful firm creates a ‘strong base’ by specialising in physical resources (tangible assets such as raw materials, plant and equipment) and human resources (intangible assets such as financial, managerial or technical knowledge and skills). A distinction is made between resources and the services a firm provides.

Resources are used by organisations with the specialised knowledge, experience and skills needed to provide a productive service. A firm is able to explore, experiment and innovate in the use of resources to provide new or an expanded set of services. Firms that have grown successfully in new areas of business have done so by establishing and maintaining a central position with respect to the use of certain types of resources and technology and the exploitation of certain types of markets.
Richardson (1972) then argued that successful firms tend to specialise in activities for which their capabilities provide a competitive advantage. In this view, the firm is treated as a dynamic collection of capabilities. A firm must develop the capabilities — i.e. the roles of organisation, knowledge, skills and experience — required to carry out particular functional activities, such as R&D, design, production, marketing, etc. Richardson helps to explain how firms grow along paths set by their prior possession of capabilities and how these capabilities themselves slowly expand and change.

Successful firms tend to specialise in activities that utilise a similar capability (like R&D, design, production or marketing) but that can lead to enter a variety of markets and a variety of product lines.
While a firm must be able to create and utilise a wide body of knowledge and experience to carry out the functional activities necessary to survive in an industry, it is ‘core’ capabilities which enable a firm to distinguish itself and determine its ability to adapt, grow and achieve competitive advantage (Leonard, 1995). A capability which is difficult to replicate or imitate is considered a distinctive capability and a source of competitive advantage but, to keep this position, it must be also value-creating and

must utilise rare resources that cannot simultaneously be implemented by large numbers of firms.

A problem with early research from a resource-based perspective, however, was its failure to examine the influence of the environment on the development of a firm's internal resources. Firms can acquire valuable technology assets and skills without developing the capabilities to gain and maintain their competitive advantage in a changing environment. The relationship between external influences (scientific, technological, market and economic factors) and the internal characteristics of a firm has been specifically addressed by the contingency theory perspective on organisational development (e.g. Burns and Stalker, 1961; Woodward, 1965; Lawrence and Lorsch, 1967; Galbraith, 1973; Davis and Lawrence, 1977; Mintzberg, 1983). This approach challenges the view that there is a single best way to manage and organise a firm, focusing instead on what organisational form is best suited to a particular environment.

The ability of a firm to adapt to changing business requirements depends in part on a capability called "absorptive capacity". Largely a function of a firm's prior knowledge and experience, absorptive capacity refers to the ability to recognise the value of new, external knowledge and information, assimilate it and apply it to meet new commercial objectives (Cohen and Levinthal, 1990) . Because the development of absorptive capacity is path dependent and cumulative, lack of investment early on in a new area of knowledge and expertise may foreclose the future development of capabilities in that area.

Chandler (1990) argues that a firm is a collection of organisational capabilities (the physical facilities and human resources required to supply goods and services) and that these capabilities are critical to the ability of the firm to grow in traditional or new markets. Chandler avoids a top-down, strategic management view of the firm, by including non-strategic capabilities in his analysis. Moreover, Chandler is particularly useful in explaining how a firm's organisational capabilities are linked to attempts to exploit cost-saving economies that are critical to a firm's future growth and competitiveness. It is clear that Chandler's approach is useful to understand economies of volume production, but for the same reasons it cannot fully explain efficiency gains in CoPS, where project-based production is confined to low volumes and products are tailored to the unique requirements of business customers (Davies-Brady, 2000). The two authors then integrated the approach of Chandler with the concept of “project capabilities”, drawing upon the extensive literature on project management (e.g. Middleton, 1967; Morris, 1994; Shenhar and Dvir, 1996;).

Chandler’s framework explains the growth of companies with: economies of scale and scope; the creation of a marketing and distribution network so that the volume of sales matches the volume of production; and a management structure able to co-ordinate functional activities and to strategically plan and allocate resources for future production. Companies that produce new or improved products and use new or improved processes gain ‘first-mover’ competitive advantages.

Chandler’s approach is useful for examining the capabilities of firms seeking to obtain lower unit costs by moving from small batch to large batch and mass production. However, there are three major differences between the nature of production in CoPS compared with high-volume production, which suggested Davies and Brady that a modification in Chandler’s framework was required.

First, while strategic and functional effectiveness is important in CoPS, scale and scope advantages are difficult to realise because production is limited to unit or small, tailored batches. CoPS are designed and integrated by temporary project-based organisations to meet the requirements of individual business customer’s orders. Systems integration and project management, that are useful to win bids and to ensure the completion of projects, are the central capabilities in CoPS, in contrast to the volume production and mass marketing functional capabilities essential in the supply standardised consumer goods (Hobday, 1998). This makes the project-based organisation the most efficient way to produce CoPS, while functional specialisation is better for producing large quantities of products and services (Hobday, 2000).

As mentioned above, this vision has often led to recognise that there is less scope for routinised learning in CoPS because projects are inherently one-off or unique.

The greatest challenge that maintaining capability represents is learning from project to project, because there is a high risk to loose learning to future projects and that in this way the same mistakes will be repeated. Davies and Brady argue that there are opportunities for learning because firms undertake similar categories of projects which involve repeated cycles of activity. Bids and projects are referred to as ‘similar’ when the same sets of capabilities and routines are required for their repeated execution (repeatable solutions).

While bids and projects may be similar and repeatable, and be assembled from increasingly standardised components and subsystems, the individual CoPS provided still has to be tailored to the unique requirements of each customer.

In CoPS production, economies can then result more from the repetition of new types of projects than from scale or scope. It is not so much the size of an organisation or the range of products provided, but rather the increases in the volume of projects executed that permits projects to be delivered at lower costs, on time and to the required specifications.

There are two aspects of the capability building process. First, there are important interactions among the different levels of an organisation — strategic, project and functional — as the firm develops the new capabilities.

Second, the organisational learning process is dynamic and path dependent. Capabilities change over time, as the company builds on its core capabilities and absorptive capacity to identify the new market opportunities, develop the new project and functional capabilities required to satisfy new commercial objectives, and introduce the organisational changes to meet increasing demand for such projects.

So, at the end of ‘90s the CoPS literature identified the central role of projects and the ability to coordinate and internalise different knowledge and skills as the essential elements to understand the potential and the future development of CoPS. This is why the most recent contributions are about the two organisational techniques emerged to face these problems: project management and systems integration.

I.4 PROJECT MANAGEMENT

The management of projects is first emerged as the coherent discipline of project management in the 1960s (Morris, 1994), and its growing importance is linked to the emergence of a new organisational form called the “network enterprise”. The network enterprise involves a vertically disintegrated model of production, in which small- and medium-size suppliers link up with a care firm to firm networks that are able to innovate continuously and adapt to a changing environment (Freeman, 1991). In this network of innovators, the business project becomes the actual operating unit enacted by the network, rather than individual firms or formal groups of companies (Castells, 1996).

While projects are recently being implemented across a growing range of activities (e.g. product lines, organisational tasks or territorial areas), they have always been the dominant organisational form in the design and implementation of CoPS. Major advances in project management organisation and techniques were introduced and refined alongside the new systems engineering approaches used in US defence projects. Project management is responsible for delivering projects within budget, on time, and with the required technical specifications. Since the 1960s, project management techniques have become the standard for the management of commercial engineering projects (Morris, 1994).

A project-based organisation (PBO) is a temporary organisation set up for the duration of a project. For very large and complex projects (e.g. the Channel Tunnel) a PBO can be a consortium of many firms. Smaller CoPS (e.g. flight simulators) may be carried out by PBOs under the control of a single firm.

Two ideal types of project-based organisations can be distinguished from traditional functional organisations. On the one hand there is the total project organisation, where all functions and personnel required to accomplish the project work in a dedicated team and report directly to the project manager rather than the line manager in a functional department. On the other hand, the matrix organisation provides a way of integrating the project and functional resources involved in delivering complex projects. Some primary functions and personnel are transferred from functional departments to the project. The project manager brings together and directs the functions and resources required for successful completion of the project.

Organisational forms can change radically during the lifetime of a project. A matrix organisation is required if opposing forces are equally strong. Matrix organisations first became widespread in the aerospace industry because to compete successfully, airframe manufacturers had to merge both complex technical issues and the unique project requirements of the customer. They need to create a “balance” between project-oriented managers and the managers of the engineering and scientific specialists (Davis and Lawrence, 1997). Dedicated project-based organisations are ideally suited to cope with highly innovative CoPS projects and to respond flexibly to changing customer requirements (Gann and Salter, 1998).

So, the strengths of the PBO are its ability to adapt organisational structures to the demands of each project, coping with emergent properties in production, the integration of knowledge and skills, and responding flexibly to each customer's needs.

The project owner or customer is in fact responsible for project definition and development and for commissioning, start-up and operations. Project management is supported by tools to help the coordination and the simultaneous development of subsystems and to facilitate project planning where there are tight schedule and cost constraints.

Increasingly, buyers of complex products and systems want to deal with a single firm that design and integrates the system and provides services to operate and maintain it. Because system integrators have a detailed knowledge of their costumer’s requirements, they are well positioned to carry out many of the services – from maintenance and renovation, to financing and operating systems – required by their costumers. Their involvement in the provision of services provides opportunities to feed back lessons learnt to improve the future design, reliability and performance of systems.

I.5 SYSTEMS INTEGRATION

Systems integration techniques were first developed in major defence and aerospace projects of the 1950s (Hughes, 1998). Systems integration became a key aspect of systems engineering, a technique for applying interdisciplinary knowledge from engineering and physical sciences, used to integrate technological and human components into a finished system in order to achieve a desired goal.

The systems integrator is responsible for delineating subsystems and components that constitute the system, and for preparing conceptual designs for the performance of each subsystem. Technical specifications for each component and interface in the system are developed at the outset to ensure that interactions among components are mutually

compatible. If specifications change during the project, the systems integrator modifies specifications of all affected subsystem and components. After that, the systems integrator can be responsible for the test and operational environment within which the system is put to work.
Systems integration techniques have spread from aerospace and military projects to telecommunications, electronics, civil engineering, electricity, transportation and other commercial sectors producing CoPS. Suppliers of CoPS have to be capable of integrating a diverse range of technologies and knowledge inputs into the finished product. For example, the major railway equipment suppliers (like Alstom in UK) are responsible for supplying large railways systems involving a combination of different component technologies which require strong systems integration capability.

The CoPS literature reveals four main drivers to this change of methods for production (Davies et al., 2000):

1. the attraction of profitable markets: in particular rich contracts for turnkey projects.
2. demand from costumers and outsourcing trend: outsourcing to suppliers some activities previously handled by their clients (design, project and management).
3. government-led market reforms: privatisations highly increased the market and the variety of costumers in some industries, and the companies in these industries require support.
4. the use of private finance: since 1992 major public projects are funded by private capital.

So the suppliers are not anymore only manufacturers, but also suppliers of services to their costumers. Services become a components of the value-chain: installation, design, delivery, integration, support during the product life-cycle.
The overall system is more important and efficient than the sum of the parts, becoming a new type of business model, offering integrated solutions to customers' business and operational problems.

This could be the starting point for a survey of the British system, with a description of the financing scheme called Private Finance Initiative (PFI), that is now received by the EU as the model to finance TENs projects; then it will be analysed the case of the West

Coast Route Modernisation (WCRM) in the United Kingdom, trying to see which problems make it “a paradigm” about all the uncertainties of the infrastructures projects, that the use of the CoPS method of analysis can help to understand from a different and more complete point of view.

II Private Finance Initiative

A new policy, the Private Finance Initiative (PFI), was introduced in United Kingdom in the autumn of 1992. There are two fundamental requirements for a PFI project. First, value for money must be demonstrated for any expenditure by the public sector. Second, the private sector must assume genuine risk, concept involved in the expression DBFO (Design, Build, Finance, Operate).
PFI has to deliver a better value service, defined in terms of price, quality and risk reduction.

The theory behind the Private Finance Initiative is that risk should be apportioned between the public and private sector according to where it can best be managed.
For this reason it is essential for the civil service to acquire the necessary deal-making skills to take right decisions about whether a PFI solution is acceptable, using two entrepreneurial tests: value for money and risk transfer. Both are difficult measures because there are no set rules and they have to be applied subjectively: any decisions are open to later challenge by controlling bodies.

The underlying assumption of PFI is that efficiency gains generated by private sector construction and management will more than offset the extra cost of capital involved. As risk is transferred to the private sector, value for money rises so long as the private subject is taking on risks with which it is familiar and which it is better able to manage than its public counterparts, until a point where the private sector may be asked to take on risks which it cannot control and which it may be less able to handle than the public sector. Although such levels of risk may be accepted, they will be priced at a level that represents poor value for money for the public sector, because if a Department seeks to transfer a risk which the private sector cannot manage, then the private sector will seek to charge a premium for accepting such risks. The Department should therefore have sought to achieve not the maximum but rather the optimum transfer of risk, which allocated individual risks to those best placed to manage them.

If we divide risks in two categories, non commercial and technology risks, it is possible to notice that major infrastructure projects are inevitably in the public domain and hence vulnerable to public policy risk, such as cancellation by a new government, failure to provide promised access routes or changes in safety and environmental standards. At a national level these non-commercial risks can be negotiated away.

As purchasers under PFI specify a service and not an asset requirement, cost overruns cannot be passed on, where payment levels have been agreed in advance. Greater operating risk can be transferred where the private sector partner is responsible for both the asset and the service.

The most important difference between PFI and traditional capital spending is, in fact, that most of the money goes on service payments for the lifetime of the contract, rather than construction.

The process of privatisation and de-regulation that accompanied PFI made big changes in markets like transports, transforming the manufacturers also in suppliers of services (design, installation, support during the product life-cycle) to the costumers. The competition in the mid 90s changed the traditional relationship between supplier and buyer, stressing the importance of services in the value chain of the products[1].

Former Commissioner of Transports in the European Commission Neil Kinnock backed the concept of "Design-Build-Finance-Operate" (DBFO) supported by substantial equity supplied by the project owners. Owner-equity backed DBFO schemes mean:

- the designers are the future operators, with quality and capacity levels optimised in a long-term perspective;
- the designers are the builders and suppliers, bringing into the planning process precise knowledge of state-of-the-technology and having all interest in keeping costs down and completion times short;

[1](see Davies et al. 2001)

- the builders/suppliers/operators carry out their own financial engineering, and the capital markets will lend not just to a project, but indirectly to the large companies which make up the DBFO consortium;
- the DBFO actor has control over its budget.

This will be the rule for European projects. But how did it work in the UK?

II.1 PFI at work: West Coast Route Modernisation and the collapse of Railtrack

The privatisation and liberalisation of British railway network (BR) has been established in 1993 with the Railways Act that transformed a monopoly into vertically separated, competitive markets, distinguishing the ownership of infrastructure from the operation of trains.

"Under the act, the break-up of BR created a decentralised structure of more than 100 companies. The railway infrastructure is a monopoly owned by Railtrack. Twenty-five train-operating companies (TOCs) share the passenger transport sector on the basis of franchise agreements with the Office of Passenger Rail Franchising (OPRAF) and track access agreements with Railtrack. Three rolling stock companies (ROSCOs) own and lease the rolling stock to the TOCs. Five firms operate freight services. For maintenance, Railtrack and the train operators contract services from a wide range of suppliers. The market is regulated by an independent Rail Regulator." (Geyer-Davies, 2000).

The Project of modernisation of the West Coast Main Line (WCML) has been discussed since the late 1980s to remedy the capacity constraints caused by an outdated technology on one of the most important and used lines in United Kingdom.

Privatisation and regulation should provide a stimulus to the modernisation of the WCML, but the question is that transport services are unable to sustain an efficient competition because of the existence of irrecoverable technological costs given by the network structure, and so we can define them as natural monopolies. In the economic theory, natural monopoly is a condition in which competition is not desirable or realisable, because the economies of scale or of scope determine an increasing of the costs or useless duplications.

An industry is a natural monopoly if and only if, for every relevant level of output, the cost function is subadditive, namely, given a vector $\boldsymbol{w}$ of price inputs and given two vectors of outputs

$\boldsymbol{q} = (q_1, q_2, ..q_n)$ and $\boldsymbol{q'} = (q_1', q_2', ...q_n')$,

we have that:

$\boldsymbol{C}\ (\boldsymbol{q}, \boldsymbol{w}) + \boldsymbol{C}\ (\boldsymbol{q'}, \boldsymbol{w}) \geq \boldsymbol{C}\ (\boldsymbol{q} + \boldsymbol{q'}, \boldsymbol{w})$,

so it is preferable only one firm than two firms.

In a multiproduct industry, like transports, there is not the traditional link between the concept of subadditivity and the economies of scale: in fact, when the industry produce more than one product, economies of scale are not necessary nor sufficient condition for the subadditivity, so, instead of a large firm, there will be a fragmented market with a big number of subjects operating in natural monopoly.

The main problem is that a firm in natural monopoly will not fix a price equal to marginal cost, and so there will be a not tolerable deadweight (social) loss. The only way to avoid this situation is the regulation, which controls prices at an acceptable social level, giving subsidies to the natural monopolist: the challenge for a regulator will be to find the proportion between prices and subsidies that is the best for the consumers.

The competitive franchising policy of this project made by OPRAF, in fact, has been based on operational performance and on the amount of subsidies required for services. The winner of the competition, Virgin Trains, accepted in the franchise agreement a sharp decline in subsidies over the l5-year franchise period so, when the franchise will terminate in 20l2, Virgin will have to pay a considerable premium to OPRAF. Virgin Trains will only be able to satisfy their financial obligation in the future if their market will grow substantially attracting, with the introduction of high-speed services, new passengers who currently prefer to take the plane for their journeys on that route: so it is indispensable to upgrade the WCML to permit to high-speed trains to operate.

In the early 90s was studied a WCRM project consisting of three distinct stages: the core investment programme (CIP) to upgrade the line for all freight and passenger operators to 175 km/h. Railtrack was appointed responsible for financing this stage.

The passenger upgrade 1 (PUG l) will enable passenger operators to run tilting trains at up to 200 km/h. Railtrack and the operators will jointly finance PUG 1.
For the passenger upgrade 2 (PUG2), Virgin Trains and Railtrack have agreed on a revenue-sharing contract under which Railtrack will receive a share of the additional revenue created by Virgin Trains. This contract was overseen and approved by the Rail Regulator. PUG2 will enable Virgin to operate trains at speeds of up to 225 km/h on the WCML.

But the UK market is really fragmented, and the interests and requirements of the various subjects do not necessarily coincide. In the case of WCRM, in order to run high-speed trains, it is desirable to develop a so-called TBS system (transmission based, in-cab signalling system). Railtrack and Virgin have an interest in adopting this signalling technology but ROSCOs, the banks who own the trains, have no guarantees, if TBS is introduced on the WCML, and an alternative signalling system is used on other lines, that they can lease their trains to other operators on the WCML after franchise of Virgin expires. The ROSCOs are interested in a standard design for new railway infrastructure as well as for new rolling stock. Under such conditions, the decision-making process in projects becomes increasingly difficult.
"Since there is no actor in the UK railway network that is in a position to ensure coherent network design using advanced technology, there is the risk that the, chosen project design reflects the lowest common denominator that all parties can agree on. This situation may pose an organisational problem blocking further network development and retarding innovation." (Geyer-Davies, 2000).

This is the reason why has been established a new subject, the Strategic rail Authority (SRA), thought to provide a solution to these problems, ensuring a balance between the individual demands of the operators and the requirements of integrated network development.
In a fragmented network like this one, effective co-ordination mechanisms, replacing the traditional management hierarchy, are needed to overcome the asymmetry of information between the various subjects and to ensure the overall efficiency permitting also the exploitation of the innovative potential of project-based activities.
The reason why the problem of the asymmetry of information is so crucial will become evident using a simple economic model.

The structure of the preferences and the willingness to pay of the consumers, with respect to a service that presents two typologies (q_1 and q_2) like, for example, passengers or freight transport, are representable with the function of the gross surplus:

$$S = S(q_1, q_2, \theta, s); \quad S_{qk} > 0, S_s > 0, k = 1,2$$

where θ is a generic parameter representing the characteristics of demand (preferences of consumers) that are observable by the firm, but not by other subjects; ***s*** is a quality indicator sometimes observable but not identifiable, namely impossible to include in a contract or to cite in a tribunal to verify a performance.

The technology is embedded in the firm, and it is represented by this subadditive cost function (by which exists the natural monopoly):

$C = C(q_1, q_2, \beta, e) \quad C_{qk} > 0, C_\beta > 0, C_e > 0$

where β is the parameter representing the technology, known by the firm and, depending by the informative contexts, not known by others (adverse selection variable), while *e* represents the effort of reduction of costs, an action generally hidden (variable of moral hazard), so not observable as well, while are observable the costs *C*, obtained ex post by the balance sheet, the produced quantity *q* and so, given the inverse demand functions, the correspondent prices.

In this way, because the regulator knows the cost function *C(.)* it could impose the level of effort necessary for a firm of type **-**β to produce ***q*** at cost ***C***, once is become known the technological parameter or a correspondent message. Formally, we can define the function of the effort necessary to realise the cost ***C***, $\boldsymbol{E(\beta, C, q)}$, obtained solving the equation:

$\boldsymbol{C = C(q, \beta, E(\beta, C, q))}$.

So, to remove the asymmetry of information on β ed ***e***, **should be sufficient to know** β, given the possibility to know the correspondent level of ***e*** with E(.).

The problem is to establish a **revelation mechanism to induce a truth declaration of** β at the moment of the sign of the contract.

This is exactly what happened in the case of WCRM, where the variable technology has been undervalued, and the quality of service delivery has been adversely affected

by the fact that the equipment or other assets used in the service delivery become obsolete and so was needed to make further financial investment in the project in order to introduce equipment based on new technology.
This is an important factor in all long-term procurement projects and is likely to be particularly important in projects involving CoPS model of innovation (Hobday, 1998) and Large Technical Systems (Hughes, 1983).

In fact, the characteristics of the CoPS model are in contrast with the mass production goods in the way of design, development and production, and on the emphasis on the project-based organisation.
A project-based organisation is set up only for the duration of the project, and while is weak in performing routine tasks and coordinating cross-functional resources, it is very strong when it is necessary to adapt organisational (and financial) structures to the demands of each project, coping with the integration of knowledge and skills and responding flexibly to the needs of costumers. But the effectiveness of this relationship needs more detailed contracts.

However, it is very difficult to stipulate contracts that are really complete, and this is central especially because of the change of the relation supplier-buyer and for the new requirements by the market operators that we mentioned above. It is possible to say, in fact, that PFI, in spite of having a large amount of capital in it, combines the procurement of a service rather than a system, with the additional benefit of shifting the bulk of the risk to the service provider: under PFI contracts the public sector should not retain either the risks or the benefits of ownership of any assets that are developed, on the contrary the service provider should install and continue to own all the equipment, replacing it when appropriate.

Inevitably however, these requirements - particularly the assumption of risk – have meant that until now, only large and well funded companies have been in a position to bid for and win PFI deals, and the specification of those services is central to the success of any project, because accurate results require a accurate specification, achieving a better division of risk between the various contractors, operators and investors.

Could a Labour Government (even if it is named "new") accept this structure? The Public Private Partnership (PPP) has been presented as an evolution and a broader concept than PFI, but the difference is not really clear. What is clear is the emphasis put on the word "public", asserting a partnership between two subjects tat is more similar to a concession rather than discharging an activity to "someone who can manage things better". The government has in fact already been accused by the private sector of attempting to transfer too much risk, in this way retaining more control, in the public sector, but this suggests there would need to be an increase in the size of contribution of government to new projects. However, it is clear from the latest events that there are no extra funds to devote to transports.

The complexity of the new markets and the growing requirements of money for projects are pulling the private sector to find new financing instruments and solutions, because a growing complexity of project should be accompanied by a major complexity of models of financing. This is not really happened until now, and in the next section we will try to examine some possibilities and future developments in this field.

II.2 NEW FORMS OF FINANCING

The private placement markets can provide debt of 25 years or more, a crucial benefit to a long-term infrastructure investment. Banks are nervous about tying up capital for such a long time but simply have to bite the bullet and compete.
Within the wider scope of public-private partnerships, private finance initiatives - projects (we don't have to forget it) that are deemed to be more efficient if financed in the private sector – are thriving in terms of size and diversity. PFIs are also becoming more sophisticated in their methods of financing, using all the latest products from the capital markets. There is a growing requirement on the part of project sponsors for their banks to be able to provide either a bank loan or a new solution, like a bond, or a combination of both. Competition for this business is increasing with new types of founders, such as former building societies, moving in the bond markets.

To understand this problem, the best starting point is the classic Modigliani-Miller theorem, according to which the cost of capital for a project or activity is determined

by the risk characteristics of the underlying stream of returns and is **unaffected** by the mixture of debt and equity involved in its financing, or by other characteristics of its capital structure.
The Modigliani-Miller view emphasizes that the cost of financing a project depends, assuming perfect markets, essentially on its risk profile. Unless alternative methods of financing change that risk profile (by affecting the nature of the risks or the way in which their ultimate burden is assigned between shareholders, taxpayers and other shareholder groups; or by improving the information agents have about the nature of the risks they assume) they will not influence the cost of capital.

If the introduction of private capital does not change either the allocation of risks associated with public projects or the firm or the incentive of their management, it will be likely to increase the costs of these projects. In particular, where that private capital represents pure off-balance-sheet financing - i.e. financing which has no effect on the ultimate distribution of the costs and benefits of public projects - it can only have the effect of substituting state obligations that are not transparent and poorly marketable for debt that is wholly transparent and wholly marketable. This substitution must increase financing costs overall. But there is a contrast between public sector financing, which characteristically has a lower required rate of return but for which the funds available are typically rationed, and private sector financing, which demands a higher hurdle rate but for which capital is likely to be available for any project that meets the rate-of-return criteria. That contrast is the result of institutional factors rather than the nature of the financing systems themselves.

One effect of this use of different discount rates is to bias the choice of technique.
There is in fact a tendency for the public sector to favour long-life, capital-intensive approaches, while the private sector favours shorter-life, lower-capital cost options.
At present commercial banks are the second largest providers in EU countries for infrastructure projects. These banks traditionally prefer short and medium-term lending with maturities of up to 5 -10 years in order to match their lending portfolios with their deposit structures.
The private sector has not been willing to put in the large sums originally expected by government ministers because of the long-term nature of transport projects and the frequently slow pay back.

There is no "credit enhancement" arrangement in place to provide an additional insurance on the risks. A characteristic of many transport projects is the long period that elapses before there is any revenue to meet financing charges.

First, there is the planning and preparation phase where there are high risks of delays and cost overruns, when unpredicted environmental or regulatory problems can occur, which might result in fundamental redesign of the project making it less viable than originally assumed. This phase of the project should require public sector grants and/ or financing by high-risk venture capital.
The second phase of a major transport project is the lengthy construction period, where there is considerable risk of further delay and increasing of costs especially if the project is insufficiently planned and requires major modifications as it develops. The construction phase could largely be financed with bank loans. The risk of cost overruns or delays should be covered by risk capital where possible in order to ensure that the debt service of the projects does not deteriorate if these risks materialise. The balance of the financing needs should ideally be financed in this phase not by debt but with equity or grants.

Even in the mature operating phase, when cash flow is established and gradually strengthening with increased traffic volume and higher charges, risks can remain. Floating rate debt in a period of rising interest rates can be expensive if revenues are fixed. So construction has to be refinanced with long-term and low-cost senior debt. The problem is that most contractors are weakly capitalised and have very limited scope for long-term equity investment. To the extent that they have been obliged to supply risk capital in the absence of alternative investors, it has come at a high cost. This is the reason why the UK PFI market had traditionally been funded by bank loans. Although loans are still widely used, various forms of financing from the bond markets have become more popular over the past two years and are particularly included in the funding of larger projects. The move towards bond funding has occurred as European banks have become more reluctant to lend at low margins.

The European bond market has grown rapidly in the two years since the launch of the euro. Of all the UK PFI projects signed during 1999 and 2000 to date, \$6.7bn was raised through bond issues compared with only \$1.4bn raised through the loan market. (FT data, 2000)

The use of credit enhancement - a guarantee from an insurer that bond holders will be paid back in the event of bankruptcy – ensured the bonds achieved an AAA rating, the highest level of credit worthiness. But issuing a bond at the outset also locks the construction consortium into a repayment schedule. Renegotiating the terms of bond would be more complicated - if not impossible - than renegotiating loan deals with the banks, and the process involves the generation of powerful pressure groups with vested interests in the status quo. Private companies investing under the PFI will want to ensure that their investment is viable. To do so, they will press for a guarantee of a stream of income from the state purchasers. They will then have a vested interest in making sure that the income stream that they have been "guaranteed" will remain. If they succeed in pursuing that interest, the purchasers concerned will be locked into a pattern of provision and a set of providers that may not be appropriate in the long run.

For political reasons, we have seen that the most important question for British Government is now if there are alternative ways of generating private funds for public purposes that do not involve the PFI or full privatisation.

Because the private sector needs a return on its investment, the contracts must be long, so a change will be very difficult for many years -often over 30 and up to 60 years. "Not only current but future generations (*and Parliamentarians*) will find that they are trapped into forms of delivery and behaviour that others decided for them long ago." (IPPR, 1996)

The wariness about the involvement of private sector in process of decision making is clear: "There is another danger in relying on the PFI, that is when the private sector starts to determine what projects are carried out, so the investment decision becomes privatised. If the private sector is not interested then the project does not happen. If it is, then the project goes ahead. Even where this is not quite so extreme, the exact nature of what is provided and how it is provided may become increasingly determined by what the private sector will consider - and how the PPP can realistically be constructed -and not by what we are really trying to deliver. The structure of PPPs begins to drive the objectives and not the other way round." (IPPR, 1996)

This description represents exactly what happened in the WCRM case. All the subjects thought in short-terms, and the project, because of the delays and the innovation requirements, become too expensive and there was necessity of new long-term investments. In these cases the traditional economic view assumes that all the transactions happen out of the market: debt costs are in fact paid for by operating revenues and there is an "upside" to profitability that is the increasing in passenger traffic and little or no "downside" to making debt payments: the explanation in this view is simply that the government is unwilling to take on the risk.

On the contrary this paper gave some evidence that the choices of governments are absolutely more ideological, and in fact in this moment the government wants to assume control, and the subsequent risk. Furthermore, the PFI scheme assumes that finance is found on contestable markets, so what is central is not a discussion about political economy involving public franchise and the negotiations of responsibilities for outcomes; it is useful instead an analysis about the validity in this case of the Modigliani-Miller theorem. We saw in fact that for the asymmetry of information the markets are not "perfect", and assuming imperfect financial markets implies the rejection of the Modigliani-Miller theorem, and so firms are not indifferent about their financial structure: real and financial decisions are interdependent.

An analysis conducted by the Bank of England (1999) has clearly showed that structure of finance for firms is important in relation to their real activities, so when in the long term there are equity problems like in the case of Railtrack, there are two possibilities: all the participants have to co-fund the project or the privatisation with fresh money from the market.

Until now, the British government preferred to apply the first possibility avoiding privatisation and, on the contrary, substantially re-nationalising the collapsed Railtrack, involving all the subjects in a new project coordinated by the State.

PFI is a project-based organisation and railways are an example of CoPS industrial system. This means that finance as well has to be designed using this model, in this way adding flexibility, new knowledge and different ways and subjects for each period of the project life.

In this case study, probably the destiny of Railtrack was already stated in the report of IPPR in 1996:
"We might well find that the fifth term Blair government may need to do the move between the public and private sectors all over again...in reverse."

III THE ITALIAN SITUATION

There is in Italy a clear disparity between the level reached by private CoPS suppliers and the capabilities of public projects. Looking at the list of products given by Hobday (1998) it is evident that several Italian firms are leaders in this field of production. Examples are high-speed trains, where Fiat Ferroviaria built the so-called "Pendolino" for the British Virgin Trains; Formula 1 cars, where Italy is leader with Ferrari; firms like Alenia spazio or the Italian shipyards, very important suppliers of big cruisers or of sophisticated America's cup sailboats.

The situation is different for public projects for complex infrastructures: looking, across the European countries, at the determinants of market changes that generated the model of systems integration we can see that, while United Kingdom (the most advanced country in this field) Germany and France present a well developed context, Italy shows a total absence of this type of projects.
This situation has several causes: the heavy bureaucracy, the prevalent public finance of projects and the necessity to obtain, to complete the work, the agreement of many different subjects (institutional or not); when finally it has been defined in Italy a model of regulated competition for public services, with private firms competing to win bids for realizing and operating infrastructures projects, it appeared clearly the necessity for the public administrations of the presence of new subjects, with new technical competences, who could be accountable for the regulation of the system and the consequent complex decisions, in this way taking the responsibility off from the public sector.

The lack of those subjects and the concerns of public administrators realized in Italy a total inertia, generating a really critical situation in some areas of the country. The shortage of transports' infrastructures is an emblematic situation: the gravity of the problem is evident considering the strategic importance of transport links in the European context, with the Trans-European-Networks (TENs) program, whose mission is the creation of a unique European space in telecommunications, energy and transports: TENs, in fact, are complex infrastructures that should be designed, financed and built by specialized subjects.

In Italy, the so-called “Legge Obbiettivo” about the strategic infrastructures projects, presented by the Italian Government in 2002, it is clearly influenced by the debate presented in these pages. In fact, for the first time it is encouraged the participation of private finance in the realization of projects, and the project assumes a central relevance, with the introduction in Italy of the project financing.

A particularly interesting provision of this law is about a new figure, the so called “contraente generale” or general contractor, that backs the problem of systems integration: article 2 f) of the law states that this subject is responsible for the “execution by any means of a project perfectly respondent to the needs of the costumer” showing clearly the CoPS nature of these projects. This new figure (really similar to the system integrator presented above) derives from the necessity, in this type of projects, of a unique subject that is responsible for design, build, and finance: these three aspects are regulated by article 2 h), providing total flexibility in the choice of financial instruments and outsourcing.

Nevertheless, this vision of project financing is different by the British scheme of Private Finance Initiative (PFI) called DBFO: former European commissioner on transports Neil Kinnock has backed the concept of 'Design-Build-Finance-Operate' (DBFO) for the regulation of TENs and their operation after the completion of projects: on the contrary, following the art. 2 f) of the Italian law, the general contractor seems to be excluded by the operation of the executed project.
This provision is not really clearly motivated, but it seems inspired by a sort of “prudence”, because the Italian law appears, until now, more oriented to eliminate the bureaucracy that we mentioned above, and so it is mainly directed to prevent misuses of public funds and possible delays during the various phases of the bids. Nevertheless, the private sector is going faster towards the new model, and the most dynamic

subjects, like Recchi or Impregilo, already present themselves as “general contractors” with all the capabilities for an efficient system integration.

In fact, the general contractor should be characterized, according to the law, by “excellent organizational, technical and productive skills”. It is now evident the importance of the CoPS literature and analysis, in the current Italian debate. Then, it is possible to assume that, at the moment of the evaluation of those “organizational, technical and productive skills” mentioned by the law, an important aid could arrive from the literature about CoPS and Systems Integration.

A clear demonstration is the debate that is going on about the requisites to qualify a subject as general contractor. In particular, the discussions are centred about the demonstration of the technical and organisational capabilities: construction companies would prefer a severe technical certification, while the other types of firms (like engineering or installation companies, etc.) are pushing for a demonstration of the capability to complete projects based on a survey of the past activity. This definition is clearly similar to the Davies’ “repeatable solutions”, and the proposal of the number of executed project as a parameter of quality.

CONCLUSIONS

The CoPS literature, as we said in the introduction, is part of the Systems of Innovation approach. In this conclusion, it is possible to understand that the literature about complex systems maintains the great potential and the peculiar approach of Systems of innovation, keeping the ability to understand and to analyse the patterns of innovation with the study of the continuous flows of knowledge and learning inside a single subject (firm) or between different subjects (network).

The CoPS literature maintains also the limits of that approach, like the lack of an analytical model and of important assumption about, for example, the financial structure or the budget constraints, so looking too “managerial”.

The market of CoPS is roughly described as duopolistic and highly institutionalised, involving elaborate price formulas, often negotiated for each single transaction. This leads to a series of problems about regulation and the influence of regulation on innovation trajectories, that are not really deepened and developed.

We can then conclude that the great potential of this literature, as demonstrated by the analysis of the British case, is the description of the evolution and development of a new category of producers and products, related to the evolution and the changes of the external environment, in this way understanding the complexity of problems in projects that make an extensive use of new technologies and analysing the solution adopted by the successful firms during time. These studies can be an helpful guide in a context, like the Italian one, which is changing, because of the lack of advanced techniques to evaluate skills, organization, coordination capabilities and possible innovation paths of firms working in complex projects.

Bibliography

Abbot J., *European railways slowly open up* in Modern Railways October 2001.

Baumol W.J., Panzar J.C., Willig R.D. (1982), *Contestable markets and the theory of industrial structure*, Harcourt Brace Jovanovich, New York.

Bream R., *Growing range of options available* in Financial Times survey on PPP. Monday December 3 2001.

Brigden A., Mizen P., *Money, credit and investment in the UK corporate sector* Working Paper n.100, Bank of England 1999.

Castells, M., 1996. *The Rise of the Network Society*. Blackwell, Oxford.

Chandler, A.D., 1990. *Scale and Scope: The Dynamics of Industrial Capitalism*. Belknap Press of Harvard Univ. Press, Cambridge, MA.

Cohen, W.M., Levinthal, D.A., 1990. *Absorptive capacity: a new perspective on learning and innovation*. Administrative Science Quarterly 35, 128–152.

Corry D., Le Grand J., Radcliffe R., *PPP: A marriage of convenience or a permanent commitment?* IPPR-Institute for Public Policy Research, London 1997.

Cowie H., *Private Partnership and public networks in Europe* Federal trust for education and research, London, 1996.

Davies, A., Brady, T., 2000. *Organisational capabilities and learning in complex product systems: towards repeatable solutions* in Research policy, 29, pp. 931-953

Davies, A., 1995. *Innovation in Large Technical Systems: the Case of Telecommunications*, Draft Working Paper, CENTRIM-SPRU-OU Complex Product Systems Project, EPSRC Technology Management Initiative.

Davies A. with; Tang, P.; Brady, T.; Hobday, M.; Rush, H.; Gann, D. *Integrated solutions: the new economy between manufacturing and services*. Brighton: SPRU, 2001

Economic Commission for Europe – BOT expert group, *Public – Private Partnerships: a new concept for infrastructure development* United Nation publication 1998.

Foss, N.R., 1997. Resources firms and strategies. A reader in the resource-based perspective. *Oxford University Press, Oxford.*

Freeman, C., 1991. *Networks of innovators: a synthesis of research issues*. Research Policy 20, 499–514.

Freeman, C., 1995. *History, co-evolution and economic growth*. Working Paper, MERIT, University of Limburg and SPRU, University of Sussex.

Galbraith, J., 1973. Designing Complex Organizations. *Addison-Wesley, Reading, MA.*

Gann, D., Salter, A., 1998. *Learning and innovation management in project-based, service-enhanced firms*. International Journal of Innovation Management 2 4 , 431–454.

Garvin, D. A.,1993. *Building a Learning Organization*, Harvard Business Review, July-August, pp78-92.

Geyer A., Davies A., *Managing project-system interfaces: case study of railways projects in restructured UK and German markets* in Research Policy 29 (2000) pp. 991-1013

Hamel, G., Doz, Y. and Prahalad, C., 1989. *Collaborate with your Competitors and Win*, Harvard Business Review, Vol.1, Jan-Feb., pp133-139.

Hobday, M., 1998. *Product complexity, innovation and industrial organisation*. CoPS working paper, SPRU, Brighton June 1998.

Hobday, M., 2000. *The project-based organisation: an ideal form for management of complex products and systems*? Complex Products, Systems and Services special issue . Research Policy

Hughes, T.P., 1987. *The evolution of large technological systems*. In: Bijker, W.E., Hughes, T.P., Pinch, T. Eds. , *The Social Construction of Technological Systems*. MIT Press, Cambridge, pp. 51–82.

Hughes, T.P., 1992. *The dynamics of technological change: salients, critical problems, industry*. Research Policy 25, 1261–1276.

Hughes, T.P., 1998. *Rescuing Prometheus*. Pantheon Books, New York.

IPPR, *Building better partnerships – the final report of the Commission on Public Private Partnership*. IPPR publication, London 2001.

Kay J., *Efficiency and Private capital in the provision of infrastructure* OECD Infrastructure policies for the 1990s (1993) pp. 55-74

Kline, S. J., 1990. *A Numerical Measure for the Complexity of Systems: The Concept and some Implications*, Report INN-5, Thermosciences Division, Department of Mechanical Engineering, Stanford University, California.

Laffont J.J., Tirole J. (1986), *Using cost observation to regulate firms*, Journal of political economy 94, pagg. 614-641.

Lapper R., *Risks grow as market expands* in Financial Times survey on International Project Finance. Tuesday December 3 1996.

Leonard, D., 1995. *Wellsprings of Knowledge. Building and Sustaining the Sources of Innovation*. Harvard Business School Press, Boston.

Middleton, C.J., 1967. *How to set up a project organization*. Harvard Business Review, 73–82, March–April. 509–533.

Miller, R. , Hobday, M., Leroux-Demers and Olleros, X., 1995. *Innovation in Complex Systems Industries: the Case of Flight Simulation*, Industrial and Corporate Change, Vol. 4, No. 2, pp363-400.

Modern Railways special report, *West coast route modernisation* June 2000

Modern Railways special report, *West coast route modernisation* August 2001

National Audit Office, *Examining the value for money of deals under Private Finance Initiative* Report by the Comptroller and the Auditor General, London, Session 1998-1999: 13 August 1999.

National Audit Office, *Innovation in PFI Financing: The Treasury Building Project* Report by the Comptroller and the Auditor General, London, Session 2001-2002: 9 November 2001.

Morris, P. W. G., 1994. *The Management of Projects*, Thomas Telford, London.

Nelson, R.R., Rosenberg, N., 1993. *Technical Innovations and National Systems*, in R.R. Nelson (ed.) *National Innovation Systems: A Comparative Analysis*, Oxford University Press, New York.

Nooteboom, B., 2000. Learning and innovation in organizations and economics*, Oxford University Press, Oxford.*

Penrose, E.T., 1959. *The Theory of the Growth of the Firm*, Wiley, New York.

Rosenberg, N., 1982. *Inside the Black Box: Technology and Economics*. Cambridge Univ. Press, Cambridge.

Rothwell, R. and Gardiner, P., 1989. *The Strategic Management of Re-innovation*, R&D Management, Vol. 19, No. 2, pp. 147-160.

Schmalensee R., Willig R.D. (1989) *Handbook of industrial organization*, Vol.II, Elsevier Service Publishers B.V.

Shenhar, A.J., Dvir, D., 1996. *Toward a typological theory of project management*. Research Policy 25, 607–632.

Summerton, J. ed., 1995. *Changing Large Technical Systems*, Westview Press, Oxford.

Suzman M., *Concept starts to take root* in Financial Times survey on PFI. Friday October 18 1996.

Teece, D., Pisano, G., 1994. *The dynamic capabilities of firms: an introduction*. Industrial and Corporate Change 3 3 , 537–556.

Vernon, R., 1960. *Metropolis 1985: an Interpretation of the Findings of the New York Metropolitan Region Study*, Harvard University Press, Cambridge, Massachussetts.

Walker, W., Graham, M. and Harbor, B., 1988. *From Components to Integrated Systems: Technological Diversity and Integration between the Military and Civilian Sectors*, in P. Gummett and J. Reppy (eds.), *The Relations Between Defence and Civil Technologies*, Kluwer Academic Publishers, London.

Wernerfelt, B., 1984. *A resource-based view of the firm*. Strategic Management Journal 5, 171–180.

Williamson, O.E., 1985. *The Economic Institutions of Capitalism*. Firms, Markets, Relation Contracting. The Free Press, New York.

Woodward, J., 1965. Industry Organization: Theory and Practice. *Oxford Univ. Press.*