

Network analysis and control system in Mega Projects. The case of PICASP Erasmus Project

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Introduction

Network Analysis achieved some significant results in recent years thanks to advances in technology and in the approach to organisational networks. Less exciting were the results obtained with Mega Projects. These projects show high risk with regards to results, to the compliance of the budget and to the realization of the entire project. So far, the response of Mega Projects contracting authorities is to ask those presenting the project proposals to increase the number of controls and connected indexes without obtaining, almost until now, an increase in project performance. This paper examines the proposal to transfer some results of network analysis to the performance monitoring of Mega Projects. Starting from the case of Erasmus PICASP Project for the creation of Pilot courses and new didactics for teachers training in cultural tourism for the development of Caspian Area, the paper proposes an evolutionary model of cycles of simplification and complexification of the networks control systems. The approach of Practice Enterprise which allows the members of the project networks to acquire the practice of teamwork right from the early stages of planning, and, once the project starts case risks or emergencies arise, will be applied within his model.

Network Analysis in organisations achieved some significant results in recent years thanks due to advances in technology and in the approach to organisational networks. Less exciting were the results obtained with Mega Projects with a budget of 1,000,000 euros and more. These projects show high risk with regards to results, to the compliance of the budget and, sometimes, to the realisation of the entire project. So far, the response of Mega Projects contracting authorities is to ask those presenting the project proposals for a higher level of details and to increase the number of controls and connected indexes without obtaining, almost until now, an increase in project performance.

This paper examines the proposal to transfer some results of network analysis to the performance monitoring of Mega Projects. Starting from the case of Erasmus PICASP Project for the creation of Pilot courses and new didactics for teachers training in cultural tourism for the development of Caspian Area² paper proposes a transdisciplinary approach to interpret the differences and the evolution of the types of networks through cycles of simplification and complexification of the control systems and try to connect these results to the control strategy of the projects considering the high risk of failure which appears to affect a significant proportion of these projects.

Particularly, as results are connected to the adequacy of control tools, is relevant to consider managerial concepts like the span of control defined as the number of subordinates of a hierarchical

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² EAC-A02-2019-CBHE, Erasmus+ Capacity Building in higher education, Cooperation for innovation and the exchange of good practices, Joint Projects.

position, and the connected capability of networks to maintain the control in complex procedures, particularly when the system is wide and highly interconnected.

To this purpose, the proposal is to apply, in the project preparation phase, the Practice Enterprise approach which allows project network members to acquire teamwork practice from the early design phases and by doing this practice to work together, immediately available, once the project has been approved, financed and started, in case of risks or emergencies.

Literature Review

This paper involves the Literature concerning three main subjects: the Network Analysis, the Project PICASP, and the innovative didactical approach of learning by doing named Practice Enterprise applied to Tempus Erasmus Projects.

The Network analysis

The research on networks started with the interest on links or ties connecting objects and produced the structuralist approach³. The appliance to social of Network Analysis, codified in the acronym SNA arrived at the study of organizational networks after twenty years⁴ of research concerning various aspects but only in last times researchers use the dynamic analysis of links among organizations to examine the development and change of organizational structures over time⁵.

At the beginning this trend of research consider the organisational evolution from the point of view of the state of organisation development by examining big data from the social media platform⁶. This last contribution recognises that the organizational development is an autonomous field of research using the trans disciplinarity to introduce studies on the complexity of networks facing the need to explain in a coherent process, the evolution of these multidimensional aggregates of ties⁷.

Treur has developed this line of research through the application of network analysis, enhancing its factual aspect and paving the way for an extension of the processes of complexification and simplification to a general and unified model of interpretation⁸.

The PICASP Project

The PICASP Project was considered in publishing within the action institutionally forecasted for the project dissemination with some connections with previous projects⁹.

The appliance of Network Analysis to Project Teams was realised on Research Projects involving more Partners and Researchers¹⁰ and was mainly focused on number of components, diameter, density, and transitivity of the co-author networks with the aim to analyse the contribution of network to the consolidation of a research community.

Anticipatory research on the relevance of link activation in the evolution of networks has posed the problem of the tools to implement in practice a management of uncertainties and emergencies already posed in the study of risks¹¹.

³ FREEMAN 2004, p. 2.

⁴ KNOKE & YANG 2019.

⁵ TOIVONEN, KOVANEN, KIVELÄ, ONNELA, SARAMÄKI & KASKI 2009.

⁶ OGLE, TENKASI & BROCK 2020.

⁷ BIANCHI 2022.

⁸ TREUR 2018.

⁹ ANTONINI, BIANCHI, FAVARETTO, KAKLAUSKAS & PRETELLI 2022.

¹⁰ HICKS, COIL, STAHRMER & EISEN 2019.

¹¹ HURLBERT, HAINES & BEGGS 2000.

The Practice Enterprise

Concerning Practice Enterprise its initial definition was expressed as Practice or Experimental Economy¹² and only in last years was defined as Practice Enterprise¹³. As a learning by doing it was considering an innovative didactical tool but to be distinguished from business games and a simple practical exercise for classrooms of business economics¹⁴.

Practice Enterprise received a strong institutional boost in 1993 as European project funded by the European Social Fund and the German Federal State of North Rhine-Westphalia to connect the different networks around the world in an international non-profit association named EUROOPEN. Since 2021, the international association has become PEN Worldwide.

In recent years, its growing diffusion in universities has represented a significant result compared to the previous, prevalent dissemination in higher institutes¹⁵.

Furthermore, Practice Enterprise could be proposed as a tool to apply the transdisciplinary approach as a bridge between science and action, to highlight the problems and pitfalls associated with its employment¹⁶.

To be mentioned that, in analysing recent trends of megaprojects, the personnel training is not a major research problem¹⁷.

The method

On the one hand, both project management theory and practice had to take note of the high risk that mega-projects fail to achieve their intended goals or cost much more than expected¹⁸.

As far as project clients are concerned, this growing risk over time, also due to the increase in the number of mega-projects to be evaluated and organised, has translated into the request for a more stringent and analytical control strategy in order to prevent catastrophic deviations from objectives and budgets¹⁹.

All this happened by complicating somewhat the project descriptions and the indexes to propose in the submission of projects to the commitment (as happened, for example, for the European projects Tempus, then Erasmus) and by increasing the number of parameters and indexes required in the submission phase.

To analyse the question, the use of indexes for project control should be seen not as a reference to the current moment in which the control of project performance, given the disappointing results, is proposed as an increase in indexing, but as a phase in the development of the network organisation within recurring cycles of simplification/ complexification.

Two questions arise: a) from a theoretical point of view, the question is whether this ongoing evolution has reached its maximum to turn towards simplification in perspective, and b) from a practical point of view, the problem derives from the increasing performance expected from the surge

¹² GREENBLAT 1988.

¹³ PEN WORLDWIDE 2020A.

¹⁴ GORMAN, HANLON & KING 1997.

¹⁵ PEN WORLDWIDE 2020B.

¹⁶ RENN 2021.

¹⁷ CHEN, XIANG, JIA & GUO 2020.

¹⁸ SÖDERLUND, SANKARAN & BIESENTHAL 2018.

¹⁹ VIRTUANI, BARABASCHI & CANTONI 2022.

of controls applied to improve the performance of the project without, with this, burdening the control structure and, consequently, the execution of the project itself²⁰.

We will try to answer the first question by tracing an evolutionary model that explains the evolution of networks through cycles of complexification/simplification using that transdisciplinary approach recently proposed for mega projects²¹.

As it concerns the second topic, we will describe the proposal to apply a different way of carrying out project management using a preparation of the project teams through learning by doing with Practice Enterprise and applying a combination of MOOCs for the preparation of Teachers, with Practice Enterprise for the simulation of Project Management structures²².

One of the target of this approach is to reduce and to prevent the failures or difficulties in the realisation of the project that often led to an increase in costs and to a reduction in results.

The Project networks

The partners of a project, generally grouped in a consortium, correspond to a network of reciprocal relationships that can be analysed through dedicated software such as those applied by Social Networks Analysis (SNA) and namely: NetMiner II, MultiNet, StOCNET, GRADAP, JUNG, KliqFinder, MatMan, Pajek, PermNet, PREPSTAR, SNA, SNAP, SNOWBALL, STRUCTURE²³ with the result of highlighting structures characterized by great complexity, however smaller in size than those typical of social or technological-computer systems which can be characterized by millions of component elements.

To this purpose we can reduce the variety of Networks to four basic typologies (Fig.1).

Structure Typology	Integrated and Autocratic Network	Decentrated Network	Participatory Network	Centralized Network
Macro Structure				
Main Features	Large Dimensions with Integrated Internal Functions	Small, middle and large dimension with specialization induced by the externalization of leader organizations	Small and middle dimensione organized in network without a leader organization	Prevailing leader organization distributing specializations owing its developmental strategies

Figure 1. *The Basic Typologies of Network*

²⁰ BARABASCHI, CANTONI & VIRTUANI 2020.

²¹ CANTONI & FAVARI 2019.

²² BIANCHI 2020.

²³ PARISE 2007.

These typologies include the Integrated and Autocratic Network in which internal functions are realised with an extreme specialisation. This network could evolve into a decentrated one in which some functions are externalised to independent units dedicated to the sub supply. These units, over time, may evolve into independent entities not necessarily linked to the mother company and establishing a Participatory Network. Within this network a unit can assume a leadership acquiring a dominant position and possibly a larger dimension which, over the time, absorb the other units with a structure of Centralised Network, bringing the evolutionary cycle back to the original typology of integrated unit of the various functions. This kind of analysis, applied recently to personal networks, would be extended to networks of organisations without increasing the parameters used in the analysis²⁴.

Considering these typologies, we can hypothesize also an evolutionary process based on cycles of simplification/complification (Fig. 2) in which the core of the model composed by examined typologies evolves continuously according with exigencies to ensure the quality of product/services requested by the market and social development²⁵.

In the core of the model, we have the four typologies which are hypothesised to evolve according to two different self-feeding processes. A complexification process aimed at extending the attention paid to the product/service and to the context in which the network operates Towards the Complexity.

At the other side we have a simplification cycle in which the attention is concentrated on the intrinsic qualities of the product/service and in which the network operates inside the organisation, towards the Simplicity.

²⁴ BIDART, DEGENNE & GROSSETTI.2018.

²⁵ SERRAT 2017.

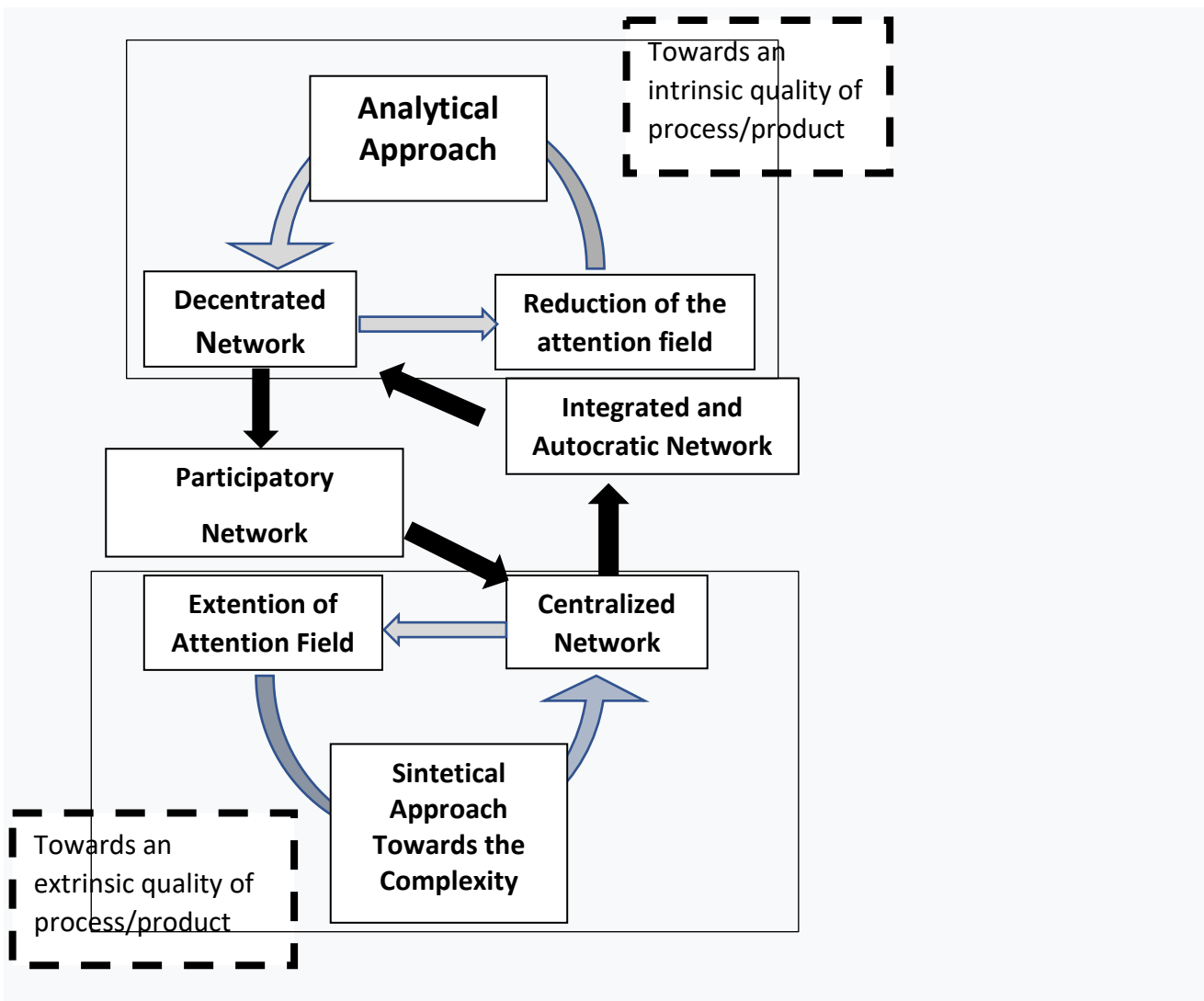


Figure 2. *Cycles of simplification/complexification in the evolution of Networks*

This implies that the Decentralized Network and the Centralised One are stable configurations while the Integrated and Autocratic Network is less stable together with the Participatory One, both considered transition states.

This enforces the hypothesis that simplification and complexification cycles, as also observed in the evolution of supply chains, is only a phase of network management. To this purpose, an implicit assumption of researches on current supply chain integration is that the results obtained from product supply chains can be directly extrapolated to service supply chains and this equivalence makes the transition from internal to external integration compatible with the idea that both configuration are structural but contingent²⁶.

²⁶ YUEN & AND THAI 2017.

Project Acronym	Project Subject	Project Grant Holder	Countries involved	Period	N° of Partners	Distance Learning
BECK	ERASMUS - BECK Integrating Education with Consumer Behavior Relevant to Energy Efficiency and Climate	Vilnius Gedeminas Technical University Vilnius (LT)	Bangladesh, Italy, Lithuania, Russia, Sri Lanka, United Kingdom.	2019-2022	14	Simulimpresa/Practice Enterprise - Moocs
HEIPNET	ERASMUS + Inclusion of Innovative Work-Based-Learning and Business Partnerships in HEI Curricula Development	University of Pavia (IT)	Austria, Germany, Italy, Lithuania	2020-2022	5	Simulimpresa/Practice Enterprise - Moocs
PICASP	Pilot Courses and new didactics for teachers training in cultural tourism for the development of Caspian Area	University of Chieti (IT)	Azerbaijan, Italy, Kazakhstan, Lithuania, Poland, Russia	2021-2023	11	Simulimpresa/Practice Enterprise - Moocs

Figure 3. *The examined Cases of Project Management in Tempus/Erasmus*

Considering the Networks involved into the process of Project Management we can try to apply this evolution to the project processes, examining the trend of complexification individuated in the present of Project Management, and some hypothesis to support the perspective of simplification of controls according to the exigencies of more adequacy of the project management applied to some projects in progress.

The PICASP Project and the Tempus/Erasmus Program

Last experiences in Tempus/Erasmus Projects with the use of Practice Enterprise and MOOCs involves many Consortium Networks on different subjects (Fig.3).

In recent Erasmus calls, the integration of MOOCs and PE was practically proposed in three Projects involving the partners from the very beginning of the planning which took place according to the process shown in Fig. 4.

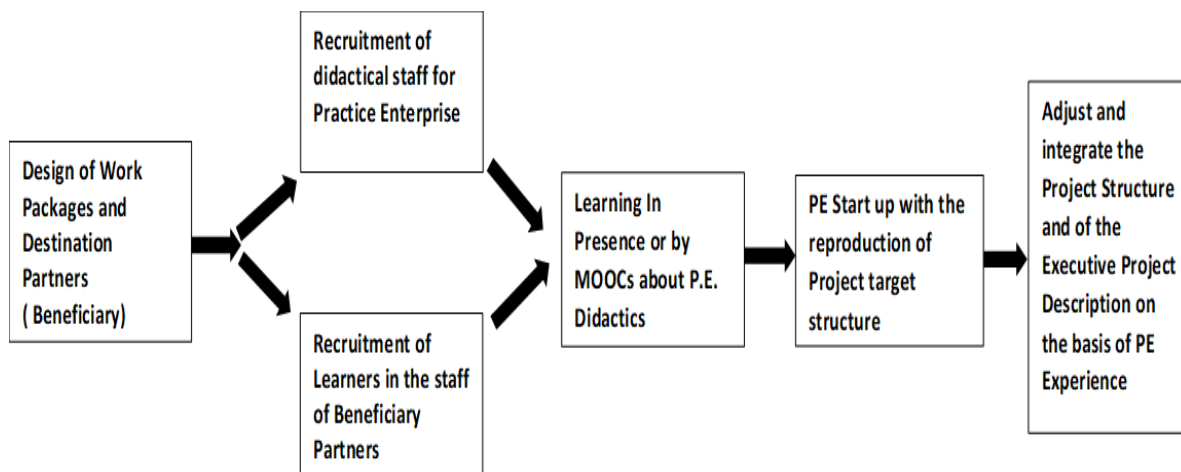


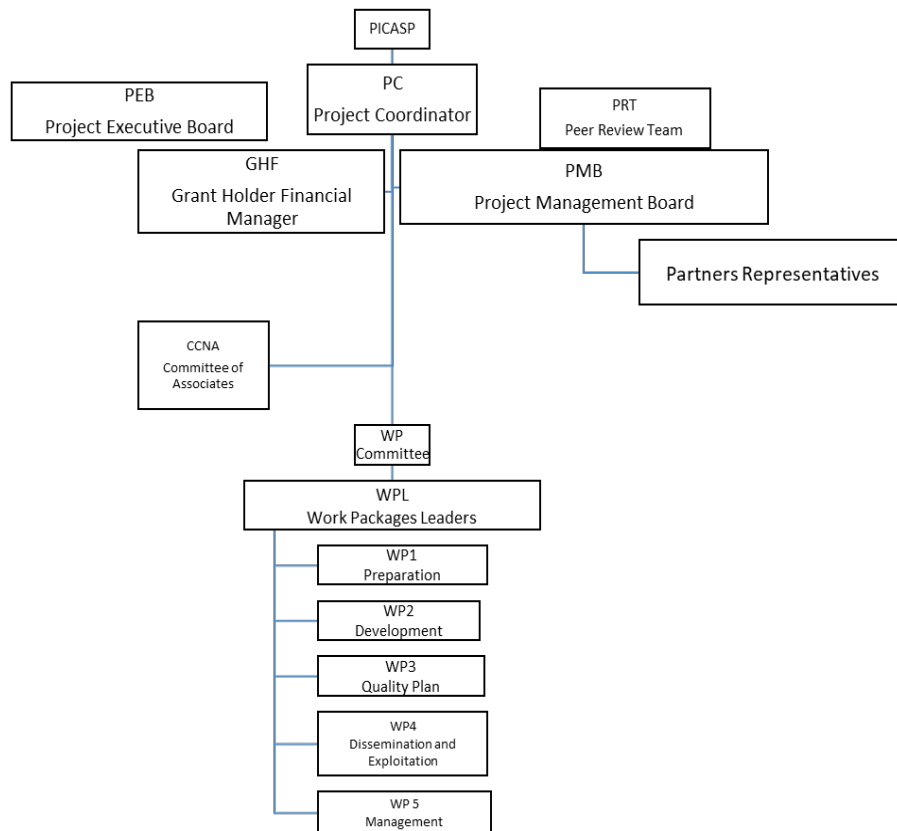
Figure 4. *The process of Project Management with Practice Enterprise*

Particularly in PICASP Project the main objectives were mainly connected to the development of new teaching methodologies as Practice Enterprise applied to the Developing courses in Entrepreneurship and SME Management and to the enhancing of the exchange of best practices with EU partners through mobility of academic and technical staff; Other purposes were the enforcing of stakeholders' involvement in curriculum development and graduates placement together with the establishing of standards and providing quality assurance in didactics with a sustainable maintaining of results after the project end. The main sector chosen was the entrepreneurship relate to the cultural heritage.

The network of universities for the implementation of these Pilot Courses had the purpose to verify the possibilities for its dissemination in other partner countries. As it concerns the PICASP Project, still in progress, this will be positive not only in the field of Economic Activities but more generally among the partners how to design higher education, according to UE Standards. Furthermore, it will have a positive impact in the perspectives, for the Caspian Area, triggered by policies to implement Sustainable Development related to the Silky Road. Of note, with the position of Grant Holder represented by the University of Chieti-Pescara, the contribution of Europen-Pen, manager of the international network of practice companies, registered in the project as an Associate Partner with the ICA, Italian Central Institute of Archaeology. The role of the Associate Partner, not having assigned budgets, is to collaborate with their own professional and institutional resources in the implementation of the planned activities, in particular as regards the dissemination and sustainability of the project activities, after its conclusion.

In this way the need to verify the collaboration among partners has two topics, the one is concerning the establishment of the Project Structure with its different positions (Fig. 5)

Figure 5.
*PICASP Project
Organisational
Chart*



The other topic is concerning the realisation, in single beneficiary partners, of a structure having the purpose to start Modules, Courses and Mini Masters with the appliance new didactics represented by MOOCs and Practice Enterprises. Like the ones programmed in PICASP (Fig.6). Particularly Courses having Practice Enterprise as method were undertaken in Kazakhstan by the University of International Business of Almaty and by the Caspian State University of Technology and Engineering in Aktau.

This approach was the subject of a previous applicative research concerning the introduction of an Agency on Volga River, as a structure similar to AIPO, The Agency for Po River in charge to the coordination of interventions on river basin²⁷, next proposed in a project originated from the 7th Framework Project on European Big Rivers of 2013²⁸.

²⁷ BIANCHI 2011.

²⁸ BIANCHI & TAMPIERI 2012.

Country Area	PC	Short Courses	Curricular Courses 1st, 2nd Level	Teachers	Tutors	Mentors	Students
AZ	ATMU	2	1	3	6	3	50
	KHAZAR	2	1	3	6	3	50
RU	ASU	2	1	3	6	3	50
	VSTU	2	1	3	6	3	50
KZ	CSUTE	2	1	3	6	3	100
	UIB	10	5	15	30	15	300

Figure 6.
Courses with Practice Enterprise programmed in PICASP Project²⁹

The Didactics with Practice Enterprise and Moocs

The Practice Enterprise was introduced, with the name of Simulimpresa, in 2001 by the University of Bologna as first experience in Italy of these advanced didactics in university courses.

In October 2001, with the creation of the simulated company Perting srl, the activity of the Laboratory of Practice Enterprise conducted by Daniele Gualdi was launched on an experimental basis, within the Business Organization course (Massimo Bianchi). and with the support of the Cassa dei Risparmi di Forlì Foundation.

Perting srl, operating in the field of organisational and network consultancy and in the sale of ICT products, was the first certified Business Simulation Unit, set up at an Italian University.

Also in 2004, the Forlì Business Simulation Laboratory participates, as a remote support centre for business initiatives, in its first international project of "Training and technical assistance for the development of SMEs in the port district of Durres" financed by the Ministry of Foreign Affairs - General Directorate for Economic Cooperation. During the project, the first Simulation Unit abroad is created: KK Personal Robe by Shkoder.

In the following years this activity continued with refinements of the approach and through the simulated company Perting SrL.

Preparatory to these activities was the education of Teachers, Tutors and Mentors (as showed at Fig. 7), these last ones coming from the entrepreneurial and managerial sector, to the applying of new didactical technologies like Practice Enterprise. Until today, MOOCs were used for the preparation of teaching staff in condition to promote and manage courses oriented to the start-up of SMEs and to the modernisation of the existing ones.

²⁹ ATMU Azerbaijan Tourism Management University; KHAZAR University; CSUTE Caspian State University of Technologies and Engineering; UIB University of International Business. ASU: Astrakan University; VSTU Volgograd State Technical University; Partners excluded in 2022 by EACEA from PICASP Project, owing the Ukrainian War.

Also in this case was essential, for the fulfillment of the project, the preparation of the Teaching Staff (Teachers, Tutors and Mentors) with a particular attention for the coaching activity having the purpose of creating a real team and an adequate network among the staff, an attitude that was replied in the project management applied in PE Courses.

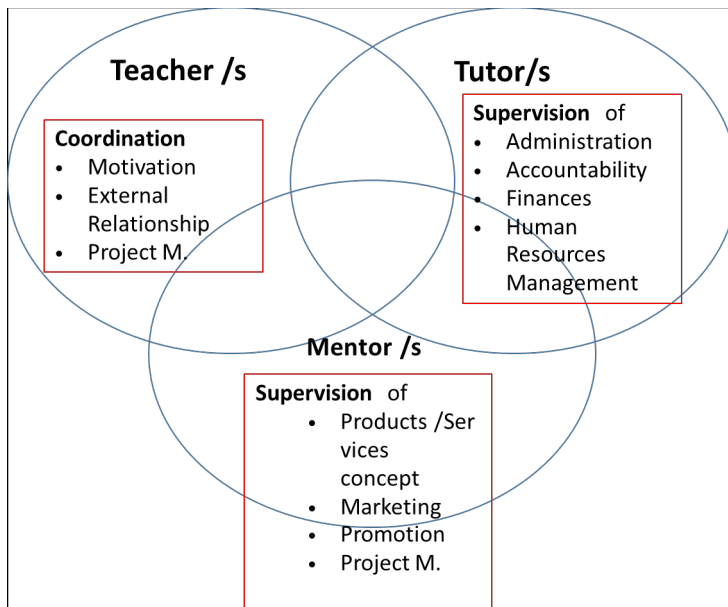


Figure 7. Tasks of the Practice Enterprise Teaching Staff Components

To be mentioned that, among difficulties that the appliance of Practice Enterprise to the Project Management wants to prevent and reduce, is the observation of many project manager with a traditional approach to Mega Projects. In these projects, in most cases, the Chief Project Manager or its organisation, centralises the project management as the sole position having the acquaintance and he is in touch with the most partners. It means that most of the partners, during the preparation of the project and its presentation, are not used to work together. Even more, once the project has been approved, they do not have a common group experience in dealing with unexpected events and emergencies.

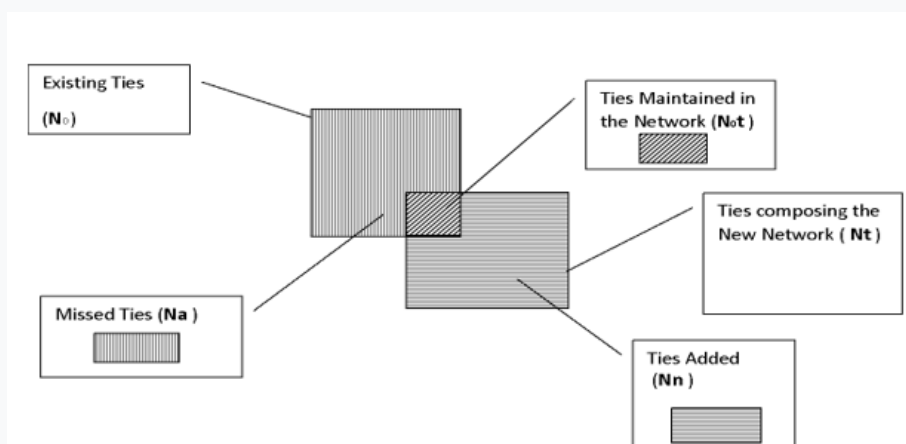


Figure 8. *The model of Ties Renewal*

The appliance of Practice Enterprise contributes to overcome these shortcomings which subsequently translates into significant difficulties when the realization of the project does not go as planned.

The Renewal Process in the evolution of business ties

As it concerns the Renewal Process and the evolution of business ties the model which expresses main parameters involved is represented at Fig.8.

The same model can be represented by the formula of Renewal System:

$$[1] \quad C_{o_n} = C_{t_0} + e - u$$

in which :

C_{t_0} = Initial consistency

C_{t_n} = Final Consistency

e = Input

u = Output

and with the connected basic Indexes:

Time	Turnover	Variation Index
[2] $T = (C_{t_0}) / u$	[3] $V = e / C_{t_0}$ C_{t_0} / C_{t_0}	[4] $E = (C_{t_n} - C_{t_0}) / C_{t_0}$

at their turn connected with the relationship:

$$[5] \quad T = 1 / (V - E)$$

It is clear that this model relating to the dynamic behaviour of networks is connected to the performance that network organisations produce and, having the objective of evaluating the relevance of the indices applied for this purpose from a methodological point of view, it is necessary to think about the formal aspects of the performance with particular regard to the measurement of Objectives, Resources and Results.

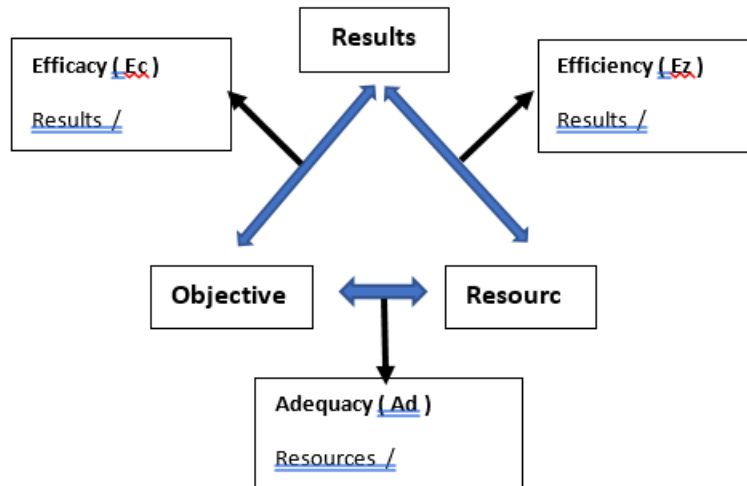


Figure 9. Main typologies of basic performance indexes

The performance of networks

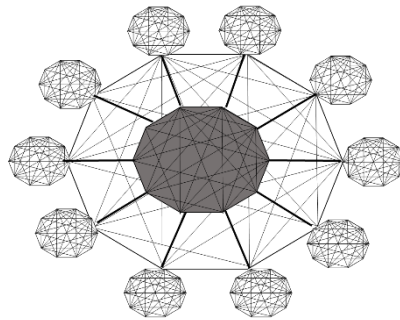
As it concerns the performance of the process that transforms Objectives and Resources in Results, we can distinguish three typologies of basic indexes (Fig. 9).

The representation of Fig. 9 can be also considered as the one of a system of indexes each of them with its own characteristics but, at the same time, related with reciprocal interdependencies that produce the following:

$$[6] \text{Adequacy} = \frac{\text{Resources}}{\text{Objectives}} = [7] \frac{\text{Efficacy}}{\text{Efficiency}} = \frac{\cancel{\text{Results}}}{\text{Objectives}} \cdot \frac{\text{Results}}{\cancel{\text{Resources}}}$$

If we unify the formulas [5] and [7] in a single transform, by setting $E_c = 1$, i.e. on the condition that the Results coincide with the Objectives, we can obtain:

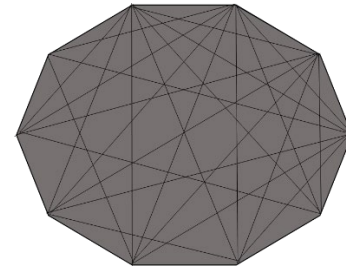
$$[8] \text{ Adequacy} = \text{Efficacy} / \text{Efficiency} = 1/(V-E) = T$$



Traditional Project Management
Structure

Structure

Simulation



Project Management

Fully Interrelated

by Practice Enterprise

Figure 10. *Project Management Structures*

In this considering that, when the Efficacy is hypotised as 1, the Efficiency corresponds to the difference $(V - E)$ between Turnover and Variation Index, and the Adequacy is exclusively related to the Time of fulfilment of Results.

This can be a very restricted condition but, examining problems connected to most of projects, Time is the most diffused critical condition. This transform connects the calculation of Network Performance with its dynamics represented by the numerical evolution of links.

Particularly, if we consider the traditional structure of the project management in a consortium of participants, focused normally, as the practice told us, on the project manager or on the partner in charge to the project management, and compare it with a network deriving from the appliance of Practice Enterprise as demonstrated in empirical studies³⁰ the dynamics of the links differ greatly.

³⁰ TAMPIERI 2013.

N° of Partners	N° of Links with centralized Project Management	N° of Links with the fully Project Management
5	4	120
6	5	720
7	6	5040
8	7	40320
9	8	362880
10	9	3628800
11	10	39916800
12	11	479001600
13	12	6227020800
14	13	87178291200
15	14	1,30767E+12

Table 1. *Comparing the potential evolution of Project Management Networks*

Moving from centralised Project Management to the fully exchange of the planning through Practice Enterprise applied to project partners (Fig.10), the results of the performance indicators change significantly. Starting from a minimum of five partners we can simulate the evolution of Network Links in the two different structures as compared at Table 1.

Both typologies of Network allow us to highlight the intrinsic limits regarding coordination. The traditional ones have the limit concerning the classic Span of Control defined by Graiciunas³¹. According to the Span of Control principle, a manager couldn't coordinate more than 7-8 partners, although this limit can be raised to 15-20, if the coordination position is represented by an organisation with several project managers³².

The fully networked project management within 5-7 number of components assumes soon, after a few steps, a number of possible connections out of control, entering in the domain of hyperlinks.

Obviously not all links will be activated, during the planning of a project, but the design carried on by a project network in which different subjects are involved from a managerial, administrative and technical point of view requires an interfunctional and interpersonal dynamics that cannot be taught without practical application like the one experienced by Practice Enterprise as fully project management team.

³¹ GRAICIUNAS 1937.

³² BIANCHI 2020.

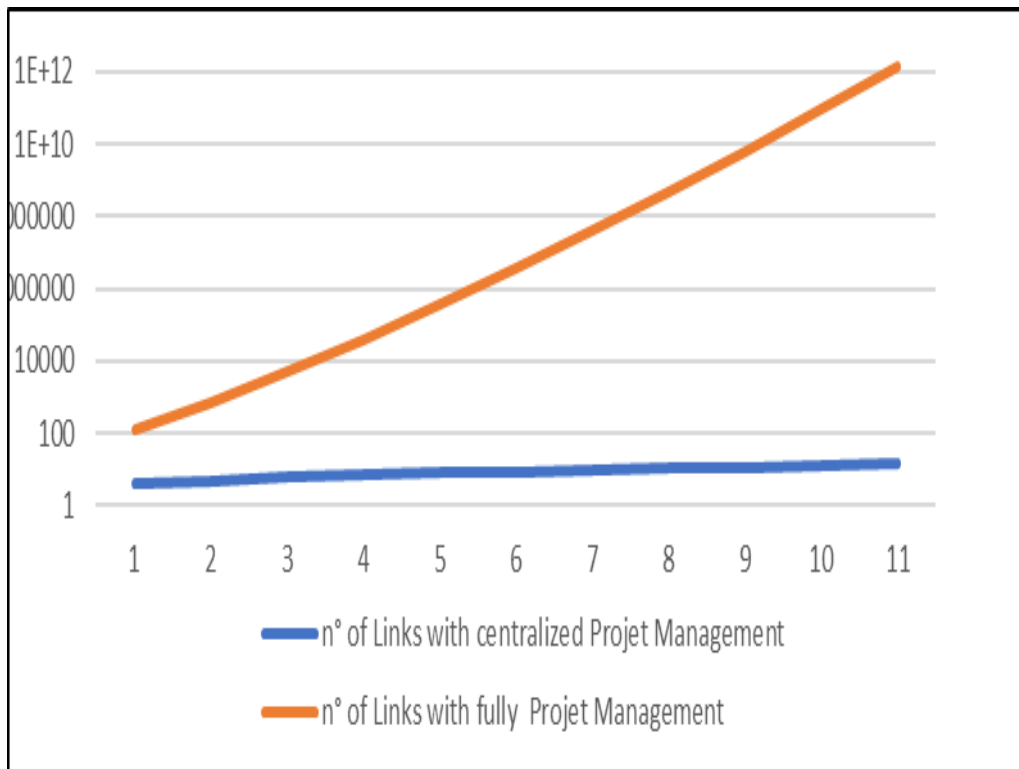


Figure 8. *Evolution of Project Management Network in logarithmic scale*

According to this condition for a convenient Adequacy of the project performance, the recommended maximum number of learners or participants to each initiative of Practice Enterprise is around 10th-15th and to this purpose the basic organisational structure normally applied is the one at Fig. 9. This structure represents the Organisational Map of Perting, the Practice Enterprise created in 2002 by the University of Bologna, Campus of Forlì.

Conclusions

Studies on project performances with the application of Practice Enterprise are at the beginning^{33 34}.

³³ BIANCHI, FERNANDEZ-LARA & GUALDI 2015.

³⁴ BAE, QIAN, MIAO & FIET 2014.

The problem is to transform the organisations business model by making choices that yielded three rigid consequences: entrepreneurship participants' high sense of ownership, feelings of accomplishment, and trust. The choices implicit in the teaching model have to eliminate the hierarchy, decentralising decision making, focusing on teams to get work done, and having participants own the assets.

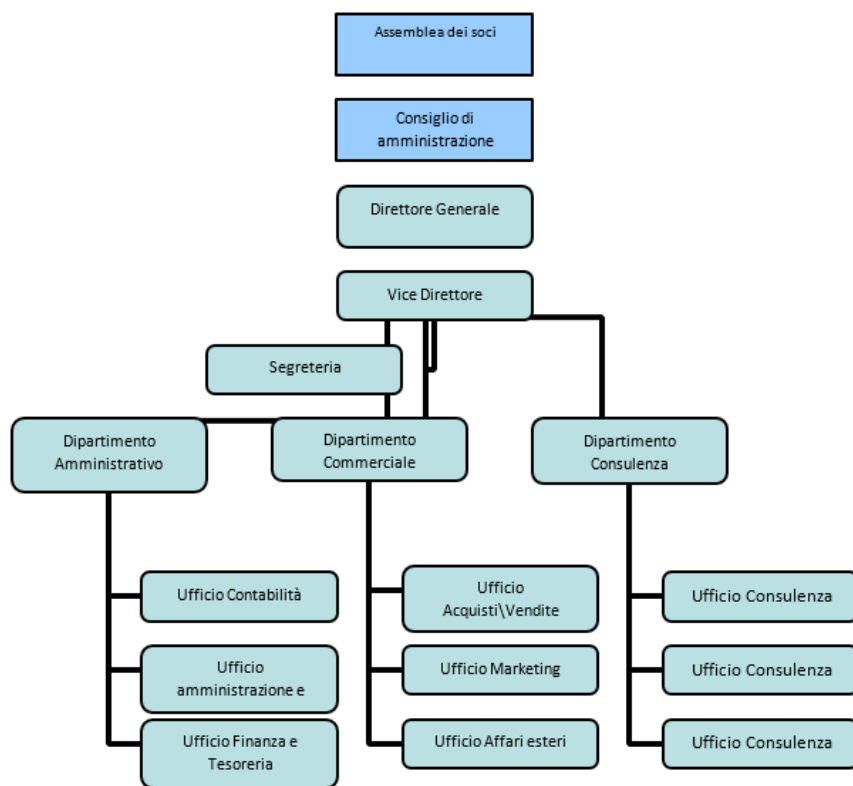


Figure 9. *The macrostructure of PERTING Practice Enterprise*

Also, in project management the mission is to break down barriers among network partners introducing initiative like Practice Enterprise to prepare people to work together before the project starts, from the first steps of the project design. This allows to face adequately eventual distances of results and costs from the ones programmed and enforce the collaboration to

maintain the project organisational structure of governance once the project starts.

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