Integrating Software Competences and Managerial Skills from Humanistic Background: a case study on University-Industry Higher Education Programs

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Abstract — *The paper points out how approaches to analyze the overall process of Junior Software Technologists Management in ICT Firms could take advantage shifting from a 'knowledge-based approach' to a 'knowing organization approach'. In the latter approach, instead of regarding the knowledge as an object to transfer, it is suggested that knowing is something that people, especially knowledge workers, collectively do and construct.*
The design of University-Industry higher education programs is studied as a 'process of cognitive construction' and as a 'process of political construction', identifying a community of practices involved in multiple mediations between actors, objects, and tools of educational processes. This framework allows to overcome a simplistic view of educational programs as linear processes of knowledge transferring from teachers to students and as series of evaluations carried out by actors with formal hierarchical authority (e.g. teachers during the examination, project leaders during the milestones, managers during the selection interview, etc.).
The paper presents preliminary findings from a case study developed on the pilot project of a Master Program on Software Technology and Management, carried out within a partnership between RCOST University of Sannio and several ICT leader companies. The degree of actual integration between technological skills, business skills, and behavioral repertories is linked to degree of common knowledge developed by the actors (University teachers, Company-tutors, knowledge workers). The degree of ICT companies involvement in higher education programs seems to be linked to a shared view on medium-term knowledge strategies of the University, the firms and knowledge workers. The research described in this paper forms part of a larger research program on Junior Software Technologists Management in ICT Firms, developed following a multi-disciplinary approach between two research areas of the authors: software engineering and managerial engineering.
Future direction of investigation will focus on specific hypothesis aimed to measure the degree of skill integration and the degree of influence detained by each actor, and on a 'knowing-oriented' approach to designing tools that support software education including intranet and e-learning systems.

Index Terms — *Software and Management Higher Education, ICT Firms, Knowledge Workers, Knowing Organization*

BACKGROUND

The criticality of innovation in university education programs for Information and Communication Technologies (ICT) skills is emerging from several perspectives:

i) At the industrial level, the worldwide dimension of competition in recruiting, training and retaining highly skilled people, especially in software industry [1];
ii) At University-Industry (U-I) relationship level, the shifting from 'skill shortage' emergency of last years to more complex 'skill gap', shaping the qualitative distance between university curricula and business job profiles [2, 3];
iii) In the ICT and software engineering practices, the emerging of studies aimed to modelling and categorizing different skills underlying curricula and competencies of technicians and project teams [4, 5].

Recent literature on knowledge management is a common field of action for researchers coming from managerial perspectives (e.g. strategic management, organizational learning, human resource management) and technological ones (e.g. information management, software engineering, experience factory and reuse). From the business perspective of the ICT firms, the powerful theoretical framework on intellectual capital and organizational knowledge opens some key challenges for the management of internal, inter-functional, and inter-organizational processes aimed to knowledge creating and sharing. Notable examples include:

i) the presence of different mechanisms for knowledge integration, such as rules, sequencing, organizational routines, group problem solving and decision making, [15];

ii) the wide availability of practices and tools to gain competitive advantage based on policies for knowledge creation, codification and transfer [7, 8], and for measurement, control and alignment of knowledge flow across organizational levels;
iii) the need for an alignment between training policies and other human resource management policies (e.g. recruiting, assessing, compensation, retention) [10];
iv) the need for a systematic 'networking strategy' aimed to knowledge linking and to improving relational capabilities with external source of embedded knowledge (e.g. Universities, suppliers) [11,16,17,19].

Recent organizational studies identified some limits of traditional 'knowledge-based approaches', proposing a 'knowing organization approach' able to overcome the distinction between knowledge and learning, and the oversimplified view on apparent knowledge-dichotomies, such as tacit vs. explicit, individual vs. collective, situated vs. abstract, verbal vs. encoded [43, 44]. This approach highlights the significance of emotional and social view on relationships between individual knowledge, organizational capabilities and information management [9].

The first part of this paper proposes a general framework on 'Junior Software Technologists [JSTs] Management in Knowing Organizations' aimed to analyze the cognitive and political aspects of the cross-border knowledge construction processes between University, large ICT firms and knowledge workers. Moving from this framework, we identify the following key-concepts to face the new challenges for software higher education program design and evaluation:
i) a preliminary distinction between several concepts of information, knowledge, skill, capability, and competence;
ii) the need for a new classification of software skills, based on an University-Industry common process in identifying final technological outputs of software projects, decomposing and hierarchizing single elementary skills requirements, existing business job descriptions and existing university courses and subjects descriptions;
iii) a clear strategy for higher education programs aimed at a strong integration between technological skills (e.g. software development, database, software design), management skills (e.g. marketing, finance, human resource) and behavior repertories oriented to business cultures;
iv) the innovation in education methodologies design, focusing the convergence of education process on business technological project works realized by cooperative team-works of scholars, teachers, university tutors, industry tutors;
v) a strong attention to emotional, cognitive and social processes underlying the interplay between individual and collective learning.

The second part of this paper presents first findings from a case study developed in a pilot project for an innovative Master Program carried out by RCOST University of Sannio, within the recent Italian 'University Reform': the Master Program on Software Technology and Management [12]. This Master was initially stimulated from several ICT actors to give a quick response to 'skill shortage' and 'skill gap' shaping the human resource management in European Software Industry. During the first three editions the program was managed by a community of practice involving technology teachers, business teachers, industrial tutors; this community, in its dynamic composition, cared the different phases of knowledge strategy monitoring, skills integration strategy, recruiting and competence assessment policies, courses and project works delivering, post-courses activities. The deep innovation in the curricula proposed by the Master derives on one hand from the attention to the indication of the IEEE Computer Society/ Association for Computing Machinery Joint Task Force on Computing Curricula [13] and on the other side from the widespread opinion that current approaches to software engineering education must drastically change to consistently provide safe, secure, and reliable systems [14].

THE THEORETICAL FRAMEWORK: FROM THE 'KNOWLEDGE-BASED THEORY' TO 'KNOWING ORGANISATION APPROACH'

Limits in knowledge-based theories

During 1990's decade the economics and business management literature showed an exceptional development of studies carried out within the 'knowledge-based theory' [KBT]. The origin of this movement was strictly linked to the crisis of traditional business models in occidental companies, based on a strong analytic rationality able to design internal policies (e.g. R&D projects, products/markets combinations, recruiting and training of human resources) fitting the external opportunities and threats (e.g. scientific paradigms, technology standards, market trends).

The KBT inspired several perspectives both in management and computer science studies, such as in strategic management [6, 15, 18, 20], in organizational studies [7, 19, 20, 21, 40], in knowledge management [22, 35].

An exemplar KBT implementation in Software Engineering is the Experience Factory (EF) [52] , successfully applied in many projects, including: the Software Engineering Laboratory of the NASA's Goddard Space Flight Center [51] and Daimler Benz [50].

The main purpose of EF is to gather experiences from the life cycle of a product, in order to reuse and improve it. The EF possesses a logical and physical organization and its management is completely independent from the

management of the actual software firm. The reuse of experience is intended in three dimensions: how, what and when. The experience to be packaged is under different forms: process models, resources, quality models, baselines, and defects. The experience can be captured in various ways: equations, models, histograms, algorithms, best practices, and cost models. The EF relies on the Quality Improvement Paradigm for ameliorating the experience's chunks when applying them in real cases. The EF spans on the entire lifecycle of experience: the formalization, the tailoring to the context of usage, the adjustment on the basis of the feedback returned from the application.

In contrast with an 'external-internal' view of business decisions, where technology was assumed as just an ordinary asset to buy and to sell, the KBA linked business success to the processes of building, creating and leveraging knowledge. This fundamental change opened some key perspectives on business management of ICT companies, such as:

i) the metaphor of organizational learning, synthesizing personal insights ,models, systems thinking and shared visions, and pointing out the 'double loop learning' as mechanisms which takes place when actors respond to changes in the environment by detecting errors and correcting errors through modifying strategies, assumptions, or norms [23, 24];
ii) a clear and shared vocabulary distinguishing on the one hand data, information and individual/collective knowledge, on the other knowledge, capability (repeatable organizational routines), skill (special form of capability useful in specialized situation or related to the use of specialized resources), competence (superior capabilities characterized by intention and goal attainment) and competency (emphasizing the links between skills and organizational formal positions) [37, 46, 54];
iii) the definitive identification of technology as primary source of competitiveness, through the concept of core competence, defined as the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies [6];
iv) the emerging of the concept of knowledge strategy, describing the overall approach an organization intends to take to align its knowledge resources and capabilities to the intellectual requirements of its strategy, distinct from the knowledge management strategy guiding specific actions (e.g. building online documents repositories, licensing technologies, recruiting specific skills) [22];
v) the cognitive dimension of technology, coming from the interplay between explicit and tacit dimensions of knowledge [19];
vi) the social dimension of technology coming from the interplay between individual knowledge, emphasizing the embrained and the embodied dimensions of knowledge, and the collective knowledge, emphasizing the encultured and embedded dimensions of knowledge [35];
vii) the emerging of alternative organizational models based on 'knowledge workers', very different in comparison with previous generations of workers, since they combine different skills, own the organization's means of production, and, consequently, are difficult to replace [25, 26, 27, 29].

More recently several authors, assuming a 'constructionist' and 'post positivist' view originated by the sociology of knowledge [30], highlighted some limits in the KBT. Following the 'constructionist' and 'post positivist' view, the knowledge is not the representation of objective realities, but it is an interpretation (therefore a construction) of them; the collective sense-making drives the organizations to connect the truth of knowledge statements to the consensus of a relevant community [28, 48] . Moving from these social and mediated properties several authors criticized some key concept of KBT, especially the distinction between knowledge and learning, and its oversimplified view on apparent knowledge-dichotomies, such as tacit vs. explicit, individual vs. collective, situated vs. abstract, verbal vs. encoded [9, 43]. Indeed the growing adoption of computer technologies supporting production and organization systems (e.g. workflow systems, cooperative systems, etc.) altered the significance both of individual knowledge (e.g. immediate physical responses to situated cues) and of recreating processes of collective learning (e.g. leveraging of previous problem solving successes). Furthermore the distributed and networked structure of companies, shaped both from market globalization and from organization virtualization, created new tensions between different processes in achieving shared understandings of problem identification, problem solving and political mediations. These criticalities suggested a close relationship between encoded knowledge, that is information conveyed by signs and symbols, often enriched by electronically transmission systems, and other knowledge dimensions. As pointed out by [56], knowledge can be studied as multifaceted and complex phenomenon, being both situated and abstract, both tacit and explicit, both individual and collective, both verbal and encoded.

Knowing Organisations as Community of Practices

Moving from an holistic approach to the complexity of knowledge same authors proposed, as unifying theory of organizational knowledge, the evolution from KBT to a 'Knowing Organization Approach' [KOA], where knowledge is not separated from learning and from doing [9, 43, 47, 56]. Indeed rather to study *knowledge* as something that people *have*, as *object* that could be generated, codified and transferred, these authors focus the process of *knowing* regarded as something that people *do*. Some practices of *Extreme Programming* [52] can be viewed as an implementation of such perspective in software development. Extreme Programming is an emerging *agile method*. By this expression, software

engineers refer to a set of methodologies for developing software products, by reducing documentation, costs of maintenance and delivery time. A list of the cited practices follows.
The *planning game* consists of determining the scope of the next release by combining business priorities and technical estimates. This practice lets the development team understand actual business needs from the ongoing projects.
The *collective ownership* allows any component of the team change any code portion in the system any time. Such a mechanism fosters the sharing of tacit knowledge about coding strategies and tactics used in the system, without spending time in writing project documentation.
The *pair programming* prescribes that pairs develop codes, sitting side by side on the same machine. It is demonstrated that such a practice entails a gain on two levels: product and individual. The latter concerns the personal growth of skill and experience from continuous collaboration. The former concerns the improvement of product's and process' quality.
The *on-site customer* prescribes that the customer takes actively part to the development of the product. This helps the project team fully understand the product's vision the customer actually has. Involving the customer in the productive process helps also to diffuse the corrects idea of the product to deliver.
KOA authors collect the process of *knowing* in a framework based on the activity theory [36, 47], that endeavoured to study mind and society overcoming typical dichotomies of Western thought (mind vs. body, thought vs. action, individual vs. society, etc.). In the KOA the main effort is aimed to avoid separating the individual from the collective, or the social from the technical dimensions of knowledge and learning, assuming as unit of analysis the *socially distributed activity system*, where the *organizational knowing cycle* results from tensions and relations between sense making, knowledge creating, and decision making activities carried out by:

i) Individual Agents (subjects of activity);
ii) Their Community (set of colleagues, co-workers, and other relevant groups);
iii) Their Object of Activity (outcome of collective activity).

The overall coherency of different actions, moving from signals coming from external environment toward goal directed and adaptive behaviors, results from the multiple mediations that modulates interactions and contradictions between agents, community, and objects. Traditional organizational and cognitive tools became different mediating elements, sustaining these simultaneous relationships; organization and roles structures (e.g. project tasks) mediate between community and object, explicit and implicit rules (e.g. procedures and rituals) mediate between agents and community, tools and concepts (e.g. documents, data bases and libraries) mediate between agents and object. Particularly in the organizational knowing cycle proposed by Choo [9] the effectiveness of multiple mediations is linked to the ability in managing different typologies of resources in information use, such as cognitive resources (e.g. interpretations, explicit knowledge, rules), affective resources (e.g. beliefs, values, preferences), and action-based resources (enactments, tacit knowledge, routines).

The social dimension of knowing, in its twofold expression 'cognitive and political', enhanced the tacitness of collective knowledge instead of individual mastery within the concept of community of practices [45, 49, 55]. Knowledge workers acting as members of such communities, participate in a shared practice informally but legitimately; the community provides a context in which the meaning of objects, problems, events and artefacts gets constructed and negotiated, and in which people live, work, communicate and understand the environment and themselves [41] .

The adoption of a KOA to design University-Industry Higher Education Programs on Software disciplines, allows to overcome some limits of traditional 'knowledge-based' approaches, such as:

i) the assumption of knowledge as object to transfer, with the consequent emphasis on education programs focused on knowledge creation in vertical technological domains;
ii) a strong separation of technological skills from business ones assuming different forms, from a mutual exclusion (e.g. master programs in ICT without business administration courses and vice versa) to a simplistic addition of technology and business courses;
iii) the distinction between context and knowledge, that would be transmitted either as abstract data or as universally applicable approaches to problem solving, with a sharp distinction between theoretical activities (e.g. class, lessons, etc.), practical exercises (e.g. laboratory), and business experience (e.g. project works, apprenticeship, training on the job);
iv) the assumption of learning as passive process, based on a clear boundary between knowledge owners (university teachers and industrial educators) and knowledge receivers (students).

In the next section we present a general framework based on the KOA, aimed to offer specific insights to address empirical research on knowledge workers training and management in ICT companies and in University-ICT companies joint programs.

A KNOWING APPROACH TO SOFTWARE HIGHER EDUCATION PROGRAM DESIGN

In this paper we present a case study carried out from a pilot project on the Master Program on Software Technology and Management. The case study is part of a wider research carried out by the authors within a general framework on 'Junior Software Technologists [JSTs] Management in Knowing Organizations' depicted in Figure 1. The framework is based on two dimensions:

i) The Agents (or Actors) involved as evaluators (on the competences) and decision makers (on the career paths) during the business life of JSTs in ICT companies;
ii) The Human Resource Management [HRM] Practices involving the Agents during the different stages of business life of JSTs.

FIGURE. 1 *ABOUT HERE*

Coherently with the KOA described in the previous section we identify six Actors belonging to three Macro-Categories, as follows:

Macro-Category ICT Firm

Agent 1 – Top Management (CEOs, vice presidents and general managers involved in Human Resource and/or R&D strategies)

Agent 2 – Staff Departments involved in JSTs management (managers and technicians owners/providers of specific routines and rules for HR planning, selection, compensation, training and development)

Agent 3– Line Departments (IT project managers, software development project managers and technicians 'receivers' of JSTs and owners/providers of specific routines and rules for HR staffing and their technical evaluation)

Macro-Category University and Education Centres

Agent 4 – Technology Educators (teachers and tutors of technical courses, such as language programming, software engineering, distributed systems, etc.)

Agent 5 – Management Educators (teachers and tutors of business and organisation courses, such as strategic management, project management, marketing, finance, HRM, etc.)

Macro Category Community of Knowledge Workers

Agent 6- Single Junior Software Technologist (people applying for recruiting or for career development or for project staffing, coming from last years of university courses and/or from other ICT companies).

The second dimension of framework is based on the different HRM Practices involving the Agents during the different stages of business life of JSTs. The HRM literature offers several typologies, more or less detailed, of different specific activities developed by an organization to gain competitive advantage based on expertise and competences of its people, such as HRM tasks [32], HRM practices [31], specialist personnel functions [53], HRM practice areas [42]. Within these wide ranges of functions, from administrative (e.g. compensation) to contractual (e.g. union trade relationships), from psychological (e.g. behavior evaluations) to communication (e.g. advertising), from strategic (e.g. planning) to cognitive (e.g. training), we identify the following five HRM practices typical of JSTs Management in ICT Companies, moving from results of a preliminary panel of ICT Managers: (A) Planning and Staffing; (B) Attracting and Recruiting; (C) Training and Competence Development; (D) Career Path; (E) Retention/Dismissal.

In a traditional 'KBT' perspective the JSTs Management could be viewed both as a 'parallel' evaluation process of several agents, and as a 'sequenced' process where single HRM practices follow the different stages of business life of a JST, from the entrance (e.g. selection and staffing) to the exit (e.g. toward an 'intra-firm' promotion or out of the firm). Usually, as depicted in the background of the Figure 1, organisational structures and practices provide a more or less rigorous attribution of responsibilities, authorities, autonomies and tasks, crossing agents and practices. Clearly also the traditional perspective proposes mechanism of coupling the different evaluations of actors (e.g. horizontal fit procedures, series of selection interviews both with HRM and Line) and detailed feed-back procedures and tools aimed to an unified management of different HRM Practices (e.g. behavioural check lists, rating scales, job performance evaluation methods, co-ordinating mechanisms, etc.) [31, 33, 34, 39].

Assuming a KOA perspective we contend this traditional view from two different perspectives. Firstly we hypothesise that although the overall JSTs Management process is analysable as series of single practices, actually it is closer to a 'process of cognitive construction' of a collective, 'inter-functional' (staff-line departments), and 'inter-organisational' (departments-University-JSTs) knowledge developed by a 'community of practices' consisting of several agents involved. Second we hypothesise that although the overall JSTs Management process is managed by several agents/evaluators with different formal authority and different specialised autonomy, actually it is more assailable to a 'process of political construction' of a collective, 'mediated', 'contested' knowledge of agents involved.

The general framework can be used to analyse the relationships between the degree of real integration between technological and business skills, the degree of openness, and the success degree of knowledge management practices developed by companies or by University-Industry joint programs for:

i) Education Programs for JSTs

ii) Competence Assessment Programs for JSTs
iii) Staffing of R&D or Software Development Projects
iv) Providing for competence growth of individuals and firms.

Particularly in the case of designing and managing Education Programs for JSTs, the framework allows a deep comprehension of the complex relations between knowledge strategy and education choices of Universities and ICT firms, overcoming a simplistic view on the higher education process as choice of disciplines and courses aimed to move from input profile (e.g. university degree, cognitive potential) to output profile (e.g. specific skill required by the firms). Indeed the framework rejects the view of knowledge as object to intermediate between students, companies and teachers, highlighting both the mental patterns of each agent (e.g. links between research and educational interests of teachers, or links between business options and educational choices of the firms) and the situated, mediated and provisional knowing processes between them [9, 56].

THE CASE STUDY

Moving from the framework depicted in the previous section a first case study was developed in last three years, studying the stages of designing, testing and evaluating of an innovative Master Program on Software Technology and Management carried out by an University-Industry joint project between RCOST-University of Sannio and the Italian sites of the following ICT leader companies [ICT partners]: SchlumbergerSema, EDS, Ericsson Lab Italy, Getronics, Lucent Technologies Italia, STMicroelectronics, Telecom Italia Lab, Elasis, FIAT Research Center, Wind, Italdata-Siemens, Gruppo Engineering, Finmatica, Uni.com, Didacom, and Carlo Gavazzi Space.

The general architecture of the Master Programme was linked to the following key-concepts, that define a KOA to Software higher education program design:

i) a preliminary distinction between several concepts of information, knowledge, skill, capability, and competence, allowing a shared vocabulary between actors involved in defining final and intermediate targets;
ii) a preliminary identification of knowledge strategies both of University (e.g. research topics, prototyping targets, long range visions) and of ICT partners (e.g. multinational R&D strategies, role of Italian site, technological and marketing option, HRM strategies and methodologies);
iii) a clear identification, for each ICT Partner, both of specific actors involved in implementing knowledge strategy (e.g. top management, HRM managers, software development managers, etc.) and of overall HRM practices and methodologies (e.g. recruiting, training, competence assessment, long term perspectives, etc.);
iv) the need for a new classification of software skills, based on an University-Industry common process in identifying final technological outputs of software projects, decomposing and hierarchizing single elementary skills requirements, existing business job descriptions and existing university courses and subjects descriptions.

Moving from this approach the pilot project was developed identifying a community of practices acting, with a dynamic composition, during the successive stages of the annual edition as ‘methodologies team work’, ‘content and projects team work’, and ‘staffing team work’ (see Figure 2).

FIGURE. 2 *ABOUT HERE*

Our proposed solution is based on an integration of three key ingredients: i) software engineering, ii) business management; iii) humanistic approach. Indeed the participants to the Master are selected from graduates in several ‘laurea degree’ proposed by Italian Universities (e.g. philosophy, classic and modern literature, law, economics, mathematics, electronic engineering, etc.); at the end of the Master they are employed by Large ICT Firms as technicians (e.g. software programmers, software analysts, software engineers, etc.).

The ‘methodologies team work’ cared, in the six months before the start up of courses, the knowledge strategies monitoring, developing a comparison between R&D and local strategies of each partner that allows to identify both a common R&D platform for the master and some security areas aimed to protect competitive and reserved competence topics required by the firms. The same team work cared the designing and planning of annual edition, developing detailed and shared options about the general program, the integration skills strategy, and the competence assessment methods. The general program was oriented to identify a general objective of the courses aimed to harmonise short term ICT partners skills needs (e.g. web-based software developers,) and their competence development perspectives (e.g. R&D employers, future projects for systems prototyping, etc.).

The integration skills strategy aimed to an actual strong interplay, not a simplistic coupling, between technological skills (e.g. software development, database, software design), management skills (e.g. marketing, finance, human resource) and behaviour repertories oriented to business cultures of ICT industry partners. This integration was pursued through both the macro-designing of horizontal education activities on software projects or business plans, combining parts of the single courses, and the micro-designing of vertical dimension of multi-disciplinary interlacements within single courses. The competence assessment method was developed combining typical academic ‘slot of activities’ (e.g.

examinations, discussions during lessons, class and laboratory exercises, etc.) with business ones (e.g. milestones, presentations, reports, etc.). During these activities the students were stimulated to develop a cognitive ability oriented to a dynamic competence path trough a complex competence assessment system of their individual technical progress (e.g. programming skills, project management skills), their individual behavioural progress (e.g. so called 'big five', such as agreeableness, stability, extraversion, conscientiousness, openness), their contractual and mediation ability (e.g. shared interpretations of requirements, contribution to team cohesion), their collective and team work progress (goal attainment, compliance with content and time requirements, etc.), their sensitivity of business and financial consequences of projects (e.g. costs, revenues, market shares, etc.). The method is reinforced through a continuous process of role exchange aimed both to stimulate the students in tuning their 'self-' and 'hetero-' evaluation ability, and to reinforce their sharing of business evaluation systems of ICT firms.

The 'content and project work team' followed all the operative stages during the 12 months from the recruiting of students to the end of Master Programme, assuring a coherent implementation of methodologies with a choice of single courses, teachers, university tutors, business tutors, able to realise a shared view of interests and perspectives of each actor. In the stage of recruiting a strong effort was aimed to exploit the technical potential of students coming form degrees in humanistic, law and economic disciplines. These students were supported by a specific education method able to sustain a well-disciplined improvement of technical skills (theoretical and problem solving), of cognitive skills (problem setting, categorisation, analysis), of socio-emotional skills (relationship and conflict management, self-evaluation, communication). Since the start up of Program each student was inserted not only in the class, but also in a 'project work team' managed by a university tutor and a business tutor, coming from one of the ICT industrial partner, committed on software and business projects defined as 'live' activities, part of an ongoing project of the industrial partner. The 'content and project work team' cared a continuous alignment between horizontal activities (courses, lessons, exercises, etc.) and vertical ones (project works, reports, dissertation, etc.); in this way they assure also an effective optimisation of time and educational efforts.

The 'staffing team work' cared since the start up a dynamic alignment between HR planning of the ICT partner, the evolution of business and technological trends, the competence development path of each student and the specific needs of Software Project Leaders 'receivers' of the students after the end of the Master Programme.

CONCLUSIONS AND FUTURE WORKS

A first evaluation of education methodologies tested in a pilot project of Master Program on Technologies and Management Software could be guided from some basic indicators on its economic, relational and educational aspects, synthesized in Table I.

TABLE I *ABOUT HERE*

Financial indicators and the growing partnership of ICT Firms seem to confirm the growing adoption of a KOA approach within the education and recruiting policies in the ICT industry. This data is reinforced observing the dynamics of the master's third edition, whose industrial partnerships were formalised in 2002. This was a critical period for the IT and TLC industries both at world-wide level et in Italian trends, as confirmed from the fact that for the first time from 1996 the ICT market has fallen of 1,2%. Although the firms involvement in the first edition could be explained with 'tactical' needs aimed to face the skill shortage of period 1999-2000, the growing trend, also in a period with low HR needs and large availability of ICT curricula, seems to suggest a shift of ICT firms toward a 'strategic' approach in education investments, linking those activities to a wider medium-term competence development strategy. Indicators about students response, especially about students so motivated to leave existing job positions similar to the immediate post-master perspectives, seems to confirm a similar strategic approach, aimed to develop a long-term competence with a high potential of renew, following the dynamics of technologies and labour market.

From a theoretical point of view some interesting cues emerge assuming as framework the 'JSTs Management in Knowing Organisations' depicted in the section § 3. Firstly, assuming a perspective on higher education for JSTs as 'process of cognitive construction' we observed that the educational process only to all appearances can be viewed as a linear process of knowledge generating and transferring from teachers to students. Indeed all the actors (teachers, business tutors, students) are involved in a collective action that is embedded in educational tasks, relationships, and procedures. In this way each student develops a shared interpretation with the other components of community about technology and business issues underlying requirements requested by teachers and business project leaders. This shared interpretation, consisting of mental schemata, common language, organisational metaphors, and decisional rules, sustains a dynamic ability in goal-orienting its processes of learning and its decisions about knowledge conversion (tacit/explicit), knowledge strategy (building/leveraging), and knowledge linking (teachers/work group). Secondly, assuming a perspective on higher education for JSTs as 'process of political construction' we observed that the educational and recruiting process only to all appearances can be viewed as a series of evaluations carried out by actors with formal hierarchical authority (e.g. teacher at the examination, project leader at the milestones, HR manager at the selection interview), with an unidirectional flow of decisional power and a clear distinction between evaluators and evaluated.

Indeed all the actors are involved in a collective and distributed activity aimed to balance tensions, to reduce ambiguity, to establish cognitive consensus for technical and business problem setting, problem solving, task organisation, deliverable acceptance. In this way each student develops a political sensitivity coming from a real experience in participating to multiple mediations shaping the turbulent processes of project management in ICT firms, often stressed by contradictions and paradoxes deriving from simultaneous pressures of markets, competitors, alliances, governments and R&D organisations.

Findings of the pilot project lighted also some limits in the proposed framework, especially to setting up specific methodologies for wider empirical researches on the overall JSTs management process. Moving from a stronger inter-disciplinary approach between two research areas of the authors (software engineering and managerial engineering) future steps will be dedicated to:

i) the design for almost three empirical researches (1. on the JSTs Management process in ICT Large Firms; 2. in the Small and Medium ICT Firms; 3. on the Educational Approaches of ICT Universities);
ii) a clear identification of specific research units for each of the previous empirical researches (e.g. for each firm the definition of managers and departments to analyze);
iii) the formulation of specific hypotheses, coming from the framework depicted in this paper and measurable with specific metrics, about the behaviors of research units in JSTs Management (e.g. influence degree of each agent in the political construction processes, integration skills degree in each firm, etc.);
iv) the formulation of specific taxonomies of ICT skills facilitating the setting up of methods or empirical research, such as questionnaires, interview grids, direct observation, data analysis;
v) the identification, within the mechanisms for software and business knowledge integration, of specific hypotheses to design routines as varied repertories of responses in which individuals' moves are patterned as 'grammar of action' [66].

From a managerial point of view this research could be useful to design and test specific methods and tools for knowledge management systems and E-Learning systems supporting JSTs management in ICT companies and ICT research organisations.

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FIGURES AND TABLES

FIGURE. 1
A KNOWING APPROACH TO JUNIOR SOFTWARE TECHNOLOGISTS MANAGEMENT IN ICT FIRMS

		HRM Practices for JSTs Management				
Agents involved in JSTs Management		**Practice A.** Planning & Staffing	**Practice B.** Attracting and Recruiting	**Practice C.** Training and Competence Development	**Practice D.** Compensation and Career Path	**Practice E.** Retention/ Dismissal
Macro-Category	Agents					
ICT Firm	**Agent 1** - Top Management					
	Agent 2 – Staff Management					
	Agent 3 – Line Management					
University and Education Centers	**Agent 4 –** Technology Educators					
	Agent 5 – Management Educators					
Community of JSTs	**Agent 6 –** Single JST					

FIGURE. 2
A FRAMEWORK FOR MASTER PROGRAM MANAGEMENT

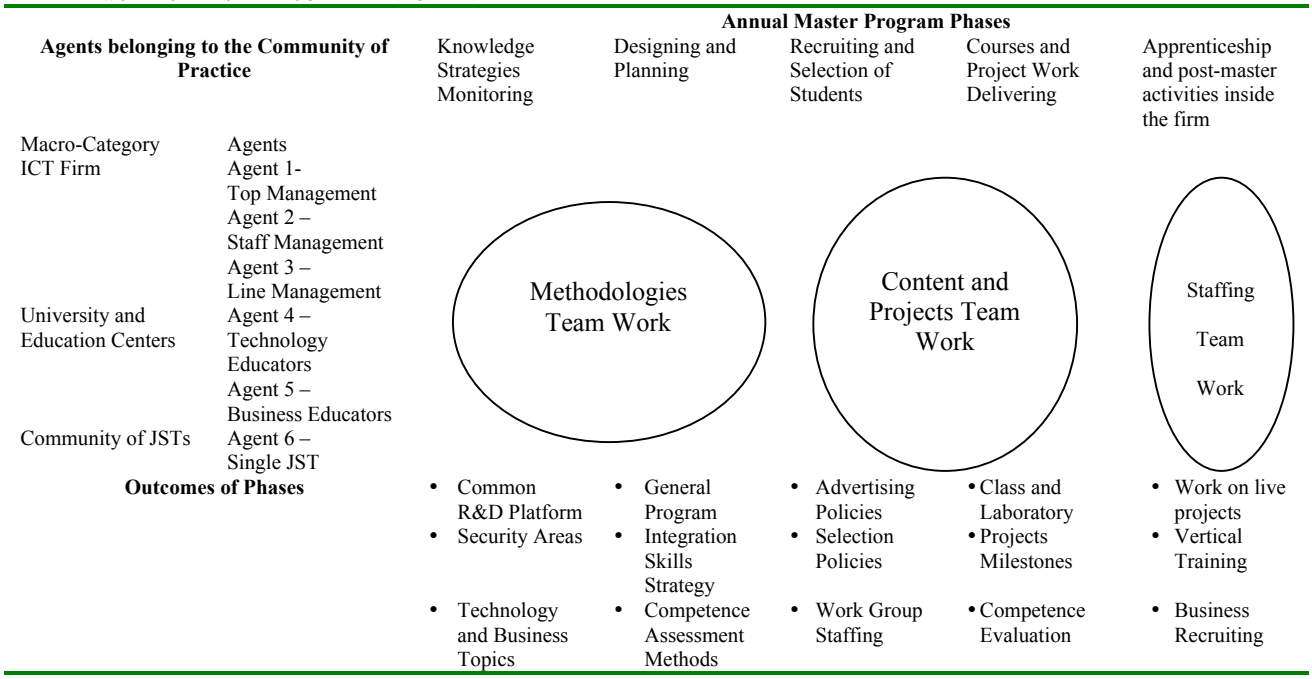

TABLE I
BASIC INDICATORS ON PILOT PROJECT

Indicators	**1° Edition**	**2° Edition**	**3° Edition**
Percentage Public Funds	57%	0	0
Percentage Private ICT Firms Funds	43%	100%	100%
Number of ICT Industrial Partner	5	9	14
Number of Candidates applying for the selection	637	368	450
Number of enrolled Students	58	55	55
Number of graduate students	57	52	50
Percentage students from extra-surrounding areas	60%	74%	75%
Percent. students receiving job proposal within 1 month from Master conclusion	87%	60%	60%
Percent. students receiving job proposal within 6 months from Master conclusion	91%	74%	75%
Percentage of students renouncing previous jobs to participate to Master	29%	23%	20%