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► **To cite this version:**

Abdessamed Réda Ghomari, Leila Zemmouchi Ghomari, Dahbia Ait Ali Yahia. Towards an IT-centric internship process in undergraduate studies: the case of ESI, Algiers. *International Journal of Teaching and Case Studies*, 2017, 8 (4), pp.281. <10.1504/IJTCS.2017.088933>. <hal-04565552>

HAL Id: hal-04565552

<https://hal.science/hal-04565552v1>

Submitted on 2 May 2024

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Towards an IT-centric internship process in undergraduate studies: the case of ESI, Algiers

Abdessamed Réda Ghomari,
Leila Zemmouchi-Ghomari* and
Dahbia Ait-Ali-Yahia

LMCS Laboratory,
Ecole nationale Supérieure d'Informatique (ESI) (ex INI),
P.O. Box 16309, Oued Smar, Algiers, Algeria
Email: a_ghomari@esi.dz
Email: l_zemmouchi@esi.dz
Email: d_ait_ali_yahia@esi.dz
*Corresponding author

Abstract: This case illustrates and discusses the issues and challenges faced by ESI, Algiers when it established an IT-centric internship process. Increasing and diversifying internships requires the implementation of a transverse device involving a maximum of internal and external stakeholders, in order to ensure genuine profitability for future engineers who must adapt quickly and efficiently to the professional world. The case study describes an e-management approach that has the particularity of being based on human levers (maximum involvement of internal and external actors) coupled with technological opportunities (use and development of supporting software tools). The case study focuses on early stages (prospecting, validation, and monitoring).

Keywords: internship; IT-centric process; e-management; information system; knowledge; education.

Reference to this paper should be made as follows: Ghomari, A.R., Zemmouchi-Ghomari, L. and Ait-Ali-Yahia, D. (2017) 'Towards an IT-centric internship process in undergraduate studies: the case of ESI, Algiers', *Int. J. Teaching and Case Studies*, Vol. 8, No. 4, pp.281–302.

Biographical notes: Abdessamed Réda Ghomari received his PhD in Computer Science from the ESI, Algiers, in 2008. He is currently a Full Professor at the Ecole Nationale Supérieure d'Informatique (ESI), Algiers, Algeria. From 2001 to 2017, he is an Information System Management Team Head at the LMCS (the Laboratory of Systems Design Methodologies). His research interests focus on knowledge engineering, IT governance, enterprise 2.0, BPM and collective intelligence. He has directed the activities of partnerships with enterprises and continuing training since 2011.

Leila Zemmouchi-Ghomari received her PhD in Computer Science from the ESI, Algiers, in January 2014. Her research interests focus on ontology engineering, knowledge engineering, semantic web and linked data. She is currently a Lecturer at the USTHB: University of Sciences and Technology Houari Boumediene, Algiers, Algeria.

Dahbia Ait Ali Yahia received her Research Master's in Computer Science from the ESI, Algiers. She is currently the Head of Internships Service at the ESI since 2008. Her research interests focus on information systems design and digital document management.

1 Introduction

Universities need to collaborate with their socio-economic environment for their mutual enrichment (Narayanan et al., 2010; Friedman and Roodin, 2013; Dabke, 2015). The relation between the university and its socio-economic environment can be defined as a set of processes and practices that allow technology transfer mechanisms in order to achieve projects that yield benefits for all partners (Cortés-Aldana et al., 2009).

Partnerships can take many forms, including contracted courses, internships, joint projects of research and development, continuing trainings, ad hoc consultations and the creation of new companies for the commercial exploitation of university research results.

This paper focuses on under-graduate internship, particularly: its role in facilitating knowledge acquisition for students, and increasing visibility for schools and universities and how it strengthens the university's ties with the socio-professional environment.

Narayanan et al. (2010), defined an internship as "a term-length placement of an enrolled student in an organisation (paid or unpaid) with a faculty supervisor, a site-company supervisor, and some academic credit earned toward the degree". Internships participate effectively in matching concepts learned in academic learning and the workplace. The National Association of College and Employers (2011, p.2) stated that "internships give students the opportunity to gain valuable applied experience and make connections in professional fields they are considering for career paths; and give employers the opportunity to guide and evaluate talent".

Internships are 'real-world learning experiences', providing educational value (Stanton, 1992). Learning theorists argue that internships contribute to students' intellectual growth by providing a concrete opportunity to apply classroom knowledge in a complex environment (Inkster and Ross, 1995; Simon et al., 2012). A study revealed, that from students' perspective, the internship influence their understanding of real-world issues and the business environment (Schambach and Kephart, 1997).

Several empirical studies on the relationship between internship participation and student employment marketability have been conducted (Clark, 2003; Karns, 2005; Gault et al., 2010). The surveys' results indicate significantly more opportunities for under-graduates with internship experience.

According to Clark (2003) and Ehiyazaryan and Barraclough (2009), perceived value of internship to employers are better job skills, faster learning, more productivity, job satisfaction and willingness of employers to hire interns.

A more recent survey (Simons et al., 2012) indicates that internships enhance personal, civic, and professional development.

Managing internships for under-graduate studies is becoming increasingly important, particularly for engineering schools like ESI Algiers, as attested by:

- Institutional policies encouraging professional training.
- The priority support fund (2009–2012) to assist Algerian high school reform in terms of school-corporate relationships, engineer-entrepreneurship training and practical work.
- The high schools network (RME) since 2014 and the interest in internships as a tool for good quality training.
- The growing interest of the socio-professional sector in schools, as evidenced by massive participation in job fairs, sponsorships, as well as an average of 25–30 companies operating in ESI-business forum (mid-May of each year) and about 20 framework agreements with executives of companies.

Academic institutions struggle to manage successfully this company-based internship process (Hahs-Vaughn et al., 2015).

Actually, the process consists of several activities such as helping students to identify internship sites and complete internship paperwork. Faculty staff has also to define, to communicate the learning objectives, and to determine evaluation methods.

Moreover, they have to meet with students and contact the internship employer at least once particularly to verify student enrolment, evaluate student performance and study the employer evaluation.

The process involves interactions with multiple stakeholders at its different stages (prospecting, validation or maturation, monitoring, assessment, reporting and capitalisation) with time and results constraints, which implies difficulties in terms of process management.

Nevertheless, universities must appropriately train students to adjust quickly and efficiently to a professional world that is increasingly challenging. “All stakeholders agreed that the transition out of university was made seamless through greater engagement with industry through fieldwork and work experience” [Blake and Susilawati, (2009), p.1].

This paper proposes an e-management approach to the internship process that focuses on:

- An organisation by process: that enables knowledge creation and serves the interests of customers represented by the company (expecting the trainee to actively participate in solving their problems) and the trainee (expecting to improve skills, expertise and attitudes) (Bryant and Syan, 2002).
- Human levers: institutional and non-institutional actors and situations of collaboration, such as: students’ end cycle project assessment in the upstream and downstream phases.
- Technological opportunities as a medium and as a basis for the reorganisation (Davenport, 1993; Siurdyban and Nielsen, 2012). Since 1985, when Porter and Millar (1985) published their pioneer article, there has been a paradigm shift in how we understand the role of information technology (IT). Under the new perspective, information and communication technology (ICT) no longer only supports the organisation of the operation, but is also a strategic resource capable of providing the company with a sustainable competitive advantage.

This paper is structured as follows; first, we will provide an overview of partnership issues between engineering schools and enterprises and in particular internships issues. Second, we will describe the proposed internship management approach. Then we will present the case study: ESI internship management system focusing on the process approach, human levers and technological opportunities. The following section highlights results of applying the proposed approach on the case study and analyses the obtained outputs according to the resource based view framework. Finally, we end with a conclusion, limitations and directions for future action.

2 Partnership issues

Partnership is built based on consensus. It is thus based on the recognition of differences governing the mutual interests of the different actors involved.

Collaborating with enterprises is particularly important in the areas of education and research (Ojala, 1994; D'Abate et al., 2009; Friedman and Roodin, 2012). Indeed, university-business partnerships are part of the university's mission, enabling it to be in symbiosis with its socio-economic environment, through a variety of gateways from the university to the company and vice versa.

D'Este and Immarino (2010) stated that the universities that are considered as significant contributors to their innovation activities are more likely to be well ranked universities in science and technology. Moreover, geographical proximity among research partners may facilitate the collaborative research between universities and companies (D'Este et al., 2012).

Regularly, technology partnerships receive substantial support from public institutions (Poyago-Theotoky et al., 2002), actually, some experts on technology had declared that US companies were not commercialising university-based technologies at a satisfactorily rate, that is why US funding initiatives were launched to promote technology partnerships and enhance university-industry collaboration. Most US universities have technology transfer offices to manage relationships with businesses (Paton et al., 2014).

Furthermore, complementarity is critical: the effective creation of new knowledge from collaboration often requires complementary capabilities between universities and industry.

Partnerships with smaller organisations often require more demanding management than those with larger organisations who have experience to support this collaboration. Nonetheless, managing relationships between the university and external partners is often time and effort consuming (De Luca et al., 2014).

In Algeria, the debate on the university-enterprise relationship is an old/new debate. It is often approached simplistically and it often centres on a failure: inertia on both sides, uninterested trainees, underestimation of time consultation, or evaluation. Effective dialogue implies listening to both sides and should lead to actions at different levels.

- From the academic side, universities and schools should raise awareness among companies about the university's local and international research activities, skills, equipment and scientific services, by way of open house events, web portals, brochures, forums, etc. Moreover, they should enhance their scientific and technical potential and guide scientific expertise from universities to national development

needs embodied by the technological capacity of enterprises in addition to making themselves more accessible to small and medium enterprises. Universities should encourage annual internships to introduce students to the socio-professional world and to monitor and evaluate trainees. Universities should also focus on teaching transversal modules, such as communication and project management, to better prepare students for professional integration.

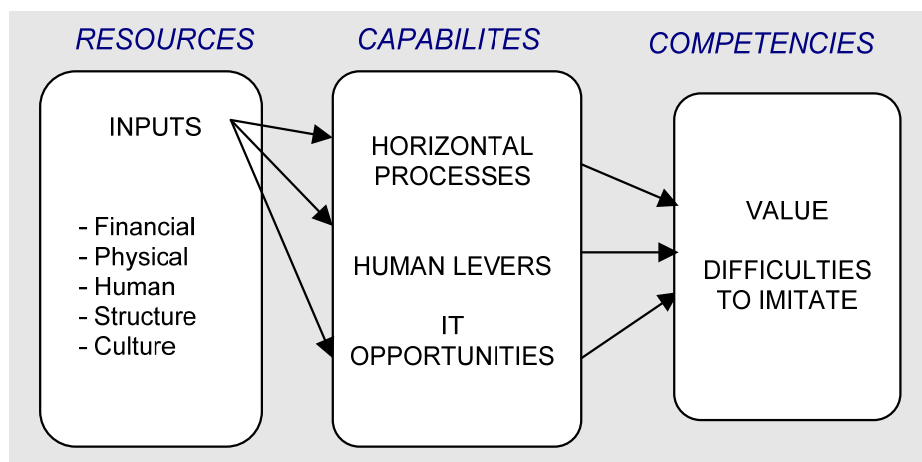
- From the business side, companies should set up an intermediate structure attached to the training and/or public relations department and coordinate management of internship portfolios in the case of multi-site enterprises for better visibility of results and the resources committed. Moreover, they have to establish an incentive mechanism for resource persons mobilised for the supervision and assistance of trainees and disseminate information about the company and its activities via several means, such as the corporate website and brochures.

3 Materials and methods

Resources in a given educational organisation can be considered as capabilities and eventually defined to be competencies. This progression is a tremendously important continuum to understand in order to define the competitive advantage of any organisation (Figure 1).

Before performing an internal audit using a SWOT analysis to reveal strengths and weaknesses, for example, it is important to be able to distinguish between resources (what we have) from capabilities (what we can do with them or possibilities for competencies) and competencies (distinctive capabilities that put the organisation ahead of its competitors).

Figure 1 Interactions between resources, capabilities and competencies (see online version for colours)



Resources are inputs, whereas capabilities and competencies are derived from these inputs. Processes and people intermix with inputs in order to create activities. These

activities can generate value for customers and they are ideally difficult to imitate, so they represent a competitive advantage.

Resources can be financial (budget), physical (buildings, classrooms, laboratories, servers, machines), human (professors, administrative staff, technical staff), intangible (project knowledge, relational capital), or structural (departments, committees).

Our research question is “how can resources be effectively optimised in an internship management process in order to gain a competitive advantage?”

Capabilities (what we can do) derived from these resources are:

- *Processes*: it is possible to improve the performance of an organisation by using the process approach (Afonso Storch et al., 2013).

A process can be defined as a set of activities organised in a network, in a sequential or parallel mode, combining and implementing multiple resources, capacity and skills to produce a result or output of value for an external customer (Morley et al., 2005). Since the early 90s, the organisation process is defined as a new theory of labour organisation (Hammer and Champy, 1993) for technological innovation (Davenport, 1993). The competitive use of IT (Porter and Millar, 1985), project management, (Duncan, 1996) and maturity models are organisational approaches to well-known processes. However, the organisation by process model (projectised organisation) is different (Gido and Clements, 2008):

- 1 It is a structure of work, as well as a process-oriented view of business processes. The company is focused on the perspective of customer requirements and satisfaction. It is therefore driven by customer requirements and how to provide value.
- 2 It is a horizontal view of the business, crossing borders between organisational units. It is considered the best response to innovation and effectiveness requirements.
- 3 The improvements are visible and noteworthy.
- 4 From a production point of view, it leads to improvements in cost, time, quality, value, consistency, variability, or zero defects.
- 5 From a management point of view, it is characterised by better confrontation with market uncertainty and competition, more rapid adaptation to changes in the environment, and better innovation capabilities.

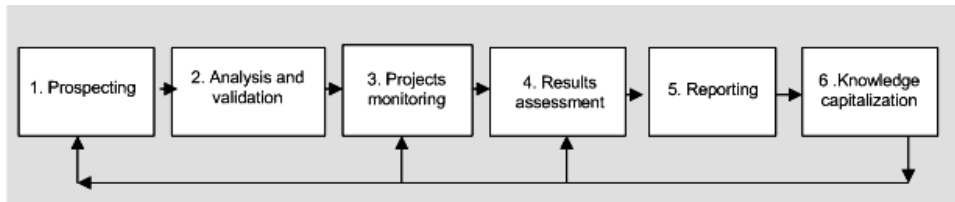
Increasing and diversifying internships requires the implementation of a transverse device involving a maximum of internal and external stakeholders and ensuring genuine profitability for future engineers forced to fit quickly and efficiently in an increasingly demanding professional world (Figure 2).

We recognise that placement sustainability is a challenge for any school; personnel seeking internships is increasingly important each year and the ecosystem (see Figure 3) is difficult to grasp and mobilise. We think that focusing on the upstream phases of this process (prospecting internships, and analysis and validation) is the most effective way to transform quickly and efficiently the organisation of work into a process-based organisation, and converge the administration and the process management. The project monitoring, results assessment phases require the use of project management methods (Duncan, 1996). The reporting phase requires key performance indicators (KPIs)

(Parmenter, 2010) and capitalisation phases appeal to knowledge capitalisation methods (Favennec, 2010).

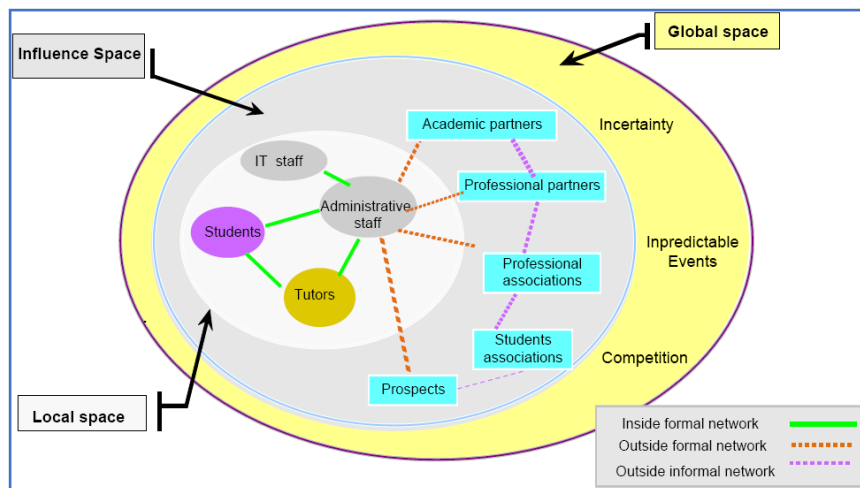
- The human levers, particularly the efforts of a core triplet composed of motivated trainees (students), teacher-tutors and partners (the customer side). The administrative staff plays the role of facilitator. The school is led to develop its activities in a three-dimensional space (Figure 3):
 - 1 A local dimension, corresponding to a structural organisation including: administrative staff, tutors, students and IT staff.
 - 2 An influence dimension, covering the scope of the school's interactions with other organisations, including: academic partners, professional partners, students associations, prospects.
 - 3 A global dimension covering competition, uncertainty.

Figure 2 Life cycle of internships process



Source: Ghomari (2011)

Figure 3 Human levers of an extended organisation (see online version for colours)



Source: Adapted from Grunstein (2002)

Two networks of information and knowledge overlap: a formal information network (internal and external) between entities, in which information and explicit knowledge circulate, and an informal network of information between actors (for example, Alumni

and students members) favouring exchange of information and sharing of tacit knowledge.

- *IT opportunities*: provide the organisation with a sustainable competitive advantage (Porter and Millar, 1985). The information system is a medium and one of the resources supporting the organisation's strategic intent, which can be connected to the dialectic of effectiveness of the existing business process and the creation of new strategic values. In designing and implementing the information systems, we consider the school as a whole that organises the communication and the treatment of information. This approach belongs to the category of master plans for information systems, i.e., planning strategic changes and implementation tools (Hsu, 2013). It consists of a co-alignment school strategy, organisation and information system taken from (Henderson and Venkatraman, 1993). Some examples of IT support systems:
 - 1 expert localisation tools
 - 2 project management tools
 - 3 web portal
 - 4 web social tools (wikis, document sharing)
 - 5 balanced scorecard (BSC)
 - 6 project memory.

Competencies (distinctive capabilities)

According to Trichet (2003, p.1) « a competency is the effect of combining and implementing resources in a specific context (including physical, social, organisational, cultural and/or economic aspects) for reaching an objective (or fulfilling a mission) ».

We previously presented the combination of resources required to attain organisation objectives. In this section, we are going to focus on analysing the output of this combination that can create a competitive advantage, namely: value and inability to imitate. Moreover, if it is inimitable, it is rare. These features are known indicators of the widely used and well-known resource based view framework.

The resource-based view, RBV (Barney, 1991) is one of the most cited theories in the history of management (Kraaijenbrink et al., 2010). It explains the internal sources of a firm's sustained competitive advantage.

Firm resources are defined broadly in the RBV and include physical resources, human resources, information resources, organisational processes and even organisational capital resources (internal and external relations) that can be leveraged by a firm for competitive advantage.

The VRIN attributes describing a firm's resources are relevant to how they may result in a sustainable competitive advantage.

- *(V) Valuable*: meaning they have power to create or leverage opportunities or minimise threats inherent in the firm's operating environment.
- *(R) Rare*: the more ubiquitous a given resource is throughout an industry, the less likely that resource is to provide any one firm with a competitive advantage.
- *(I) Imperfectly imitable*: rare and valuable resources that are hard to imitate may enable a competitive advantage to not only be achieved, but also to be sustained over longer periods of time.

- (N) *Non-substitutable*: as with the other resource attributes the availability of viable substitutes, for a given resource diminishes the likelihood that it will be able to generate a competitive advantage for the firm. In brief, a sustainable competitive advantage can be achieved when the valuable and rare resources can be protected from imitation and substitution.

The output of the internship management approach could be evaluated using the RBV framework. Given the difficulty of applying the framework on a theoretical basis, we will apply it to the case study in the results and discussion section.

4 Case study

E-management implements a new type of organisation, which takes advantage of new information and communication technologies (Siurdyban and Nielsen, 2012).

The new organisation can be designed using benchmarking methods. There is opposition between two types of approaches, which disagree on the issue of corporate change and the emergence of the strategy top down or bottom up.

Top down strategy is guided by the purposes of management and critical success factors for the enterprise (Davenport, 1993). In this case, the strategy is only conducted with and by managers. Their strong commitment is considered necessary, and what requires effort is changing their methods (creating a vision process) and their behaviour. The approach is based on the goals to be achieved by the process, and understanding of existing processes serves only much later, to define the most effective methods of change.

Bottom up strategy is mainly inspired by auditing the functioning of the company, its strong points and its weak points. The strategy is built from internal ideas going up the hierarchy (Hammer, 2004). It is based on the identification of shift levers and constraints. Nonaka (1994) argues that the search for strategic opportunities and changes falls under the organisation of knowledge management.

In the case of ESI internship process, we have applied the second approach (bottom up). Thus, we began by auditing existing internship process that enables us to achieve the new information system.

ESI (the Higher National School of Computer Science) (Algiers), was established by Executive Decree No. 08-220 of 14 July 2008 with reference to the transformation of INI (the National Institute of Computer Science Training) into a higher education non-university school in Algeria.

The number of students at ESI is around 950, including 250 students who join the integrated preparatory course at the beginning of every academic year. They are supervised by 124 permanent teachers.

ESI school graduates an average of 180 annually in three specialties: computer systems, software engineering and information systems. A Master's degree is awarded to some of the engineers since October 2011 (fifth year students who want to obtain a Master's degree).

Two research laboratories are active and host ten research teams working on various topics, such as: embedded systems, big data, knowledge engineering, and information systems, networks, e-learning, image processing, and optimisation.

ESI as a leader and a predecessor in Algeria has the responsibility to guide and orient the newly established engineering schools in the process of optimising resources effectively to manage internships as a key mission of these schools.

The 'internship management process' at ESI, launched in 2009, is a high priority project. Students are encouraged to complete two summer internships: one internship at the end of the first year of the integrated preparatory course, and one internship at the end of its third year, or the first year of the advanced cycle. These internships are followed by an end-cycle project (9–12 months).

At the end of their practical training, students write an internship report and give an oral presentation, generally in the presence of a jury composed of teachers assisted by professionals

The practicum has several aspects: for the student, it is an immersion in a professional environment. The student will implement the knowledge acquired, where the student will collect knowledge and become acquainted with the premises of his future activities.

For the school, the practicum allows it to communicate directly with the workplace. Dialogue with professionals supports under-graduate programs' evolution.

For companies that host student interns, the practicum is an excellent opportunity to develop, experiment, and test the potential of trainees for future recruitment.

ESI's 'corporate internships management' process has focused on increasing the number of internships that students complete as part of the engineering curriculum. Students spend almost a full year working for companies, out of the five years they attend ESI. The school increased the number of student interns per year, from an average of 180 before 2008, to between 500 and 600 after the launch of the internship management project. Besides, the process managers has emphasised on the need to diversify the types of sectors and the geographic regions of students placements. ESI is a national school: students come from over 70% of the country's provinces, while services and industry are concentrated in large cities (Algiers, Setif, Oran and Annaba).

However, the school's administration faces two major problems, on one hand, the lack of internships: The school is currently limited in its search for available internships, partly by the fact that it is in contact with a relatively small number of companies. This causes a lack of placements in relation to the number of students, on the other hand, the handling of feedback from various sources of information (students, partners, and administration).

To illustrate opportunities for internships at ESI, we choose to use The SWOT tool (Pickton and Wright, 1998) that allows integrating subjectivity and pragmatism: what is strength at one time can become a weakness at another time, and threats can be transformed into opportunities (see Table 1).

The study reveals that the school benefits from many resources which are its main strengths: a managerial willingness manifested in the energetic support offered to the organisational structure dedicated to this operation since 2008, a mature research activity (ten research teams), well-established IT tools (web portal, personal websites), and the familiarity of staff with new technologies. Undeniably, all these factors facilitate dialogue between the school and the external environment (partner universities, companies, professionals, and alumni of the school).

One of the weaknesses we must tackle is the fact that teachers and researchers (potential tutors) are not very motivated to collaborate with companies, because of the level of effort such collaborations require. Indeed, teachers usually choose to work with a

company if the activity is covered by an agreement (contract or other form of partnership), it is in their field of interest, and it contributes to the advancement of knowledge and the training of students. Therefore, it is important to consider teacher and researcher motivation as part of this new mission (better manage the internship program).

Table 1 Opportunities for internships at ESI: SWOT Analysis

<i>Internal</i>	<i>External</i>
<p>Strengths</p> <p>Managerial will: sponsorship is vital dedicated organisational structure (service for enterprise relations) two research laboratories hosting a dozen research teams high schools network since 2014 to enhance resources sharing clubs and student associations that animate the local life the web portal (http://www.esi.dz) and social web page, as a collaboration tools familiarity with new technologies</p>	<p>Opportunities</p> <p>Institutional policies and financial support (national research fund) encouraging professional training successful experiences likely to improve the image capital and the visibility of the school diversity in internship offers from national and international companies</p>
<p>Weaknesses</p> <p>Struggle to motivate supervisors (such as through coaching) lack of support staff qualifications difficulty of convincing sponsors lack regarding the sharing and dissemination of knowledge (students, supervisors, administration, economic partners) a network of school alumni that has to be exploited</p>	<p>Threats</p> <p>The market is increasingly attentive to school products private sector competition in the coming years</p>

In addition, we must pay special attention to the vital roles of administrative and support staff in the new management system, which must be trained appropriately.

The proposed internship process implies modifications in school organisation internally (local space) and with its ecosystem, namely influence space and global space as illustrated by Figure 4.

The school develops its activities in a three-dimensional space:

- A local dimension, corresponding to the following structural organisation:
 - 1 A service of enterprise relations, which depends on the directorate of external relations, in charge of prospecting, validation; monitoring conventions, invitations to conferences, and capitalisation.
 - 2 A directorate of under-graduate studies, represented by the service of internships, in charge of monitoring internships and programming thesis defenses.
 - 3 A web service, in charge of communication and dissemination via the intranet and/or the web portal of the ESI.
 - 4 A permanent secretariat, in charge of information dissemination and schedule management.
 - 5 An IT department, dealing with the implementation of applications and maintenance.

- An influence dimension, covering the scope of the school’s interactions with other organisations, including: units of formal monitoring of trainees at the enterprise level (offering facilitation, coaching, and assessment), academic partners, professional partners, alumni, associations of students, offering information, entertainment, and intermediation.
- A global dimension covering competition, uncertainty.

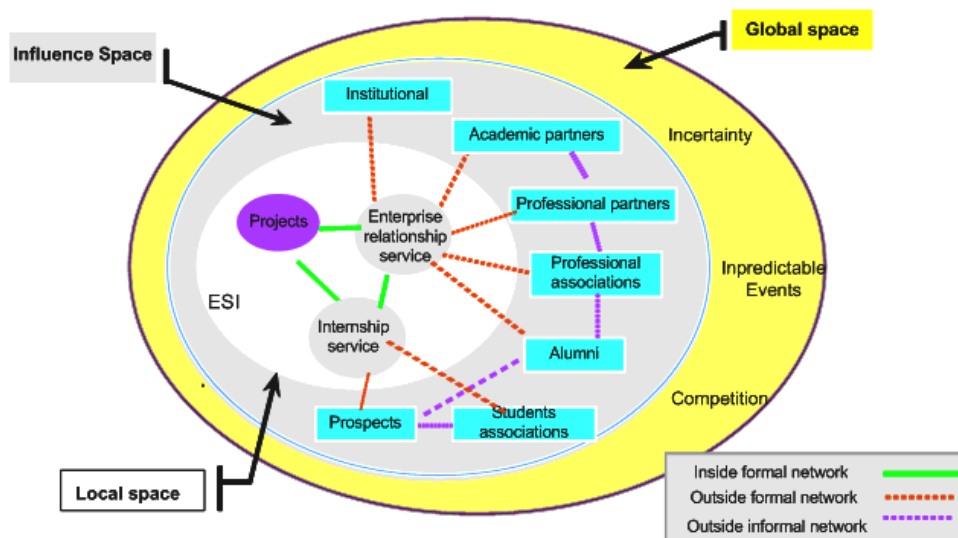
Two networks of information and knowledge overlap: a formal information network (internal and external) between entities, in which information and explicit knowledge circulate, and an informal network of information between actors (for example, alumni and students members) favouring exchange of information and sharing of tacit knowledge.

Next, we analysed how ESI staff was utilising the current school information system, using questionnaires and interviews. It emerged that the system is characterised by:

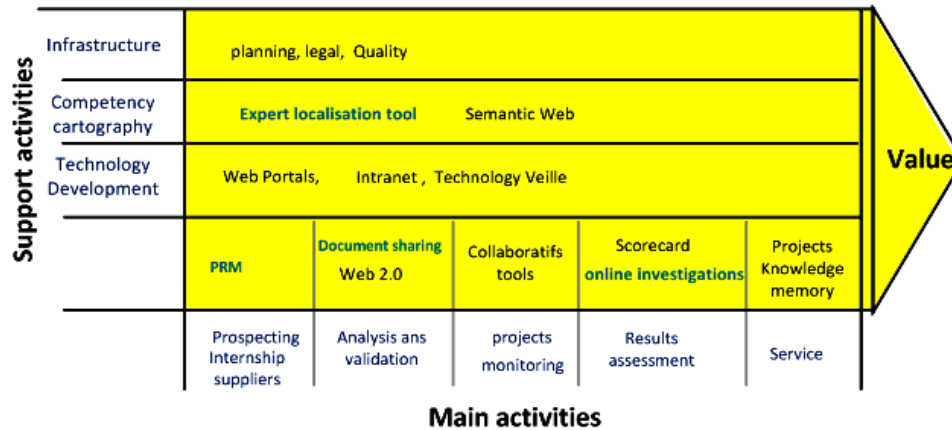
- A functional partitioning that slows any decision. Existing applications are isolated in functional areas and there is no interoperability between them, although the internet is operational.
- The availability of some relevant information, updated through the web portal and school e-mail. However, staffs are still unable to learn about all relevant activities.

We designed the information system process ‘management of under-graduates’ internships’ in a modular way. We have then identified and developed ICTs (Figure 5) to ensure the performance of this process.

Figure 4 Human levers of ESI school (see online version for colours)



Source: Adapted from Grunstein (2002)

Figure 5 Channel of special value internships and ICTS (see online version for colours)

Source: Adapted from Porter and Millar (1985)

The main activities of the internship management process are prospecting internship providers, analysis and validation (maturation), project monitoring, reporting and capitalisation.

a Prospecting internship suppliers

A prospect resource management (PRM) process is the ideal approach to organise a better prospecting activity (Carton, 2004) and is inspired by customer relationship management (CRM) (Schawel and Billing, 2012). Therefore, we designed and implemented a PRM tool (see Figure 6) at ESI to improve the prospecting of internships at enterprises. The PRM process was carried out as part of an end-cycle project (September 2011). It works by ‘pushing’ information to potential suppliers of internships. The main steps are:

- Identification of information sources and the definition of a collection strategy. For this construction, a scalable ecosystem is necessary. The challenge is to identify organisations throughout the national territory (public relations departments serving companies, labs and students) to be potential internship suppliers. All participants can contribute to the enrichment of the ecosystem and to ensure that the school has a sufficient placements portfolio in terms of quantity and diversity (type of internship, duration of internship, training location).
- The search, editing, updating, and visualisation of various statistics.
- The holding of a database on organisations and future prospecting.

While the ESI-PRM tool is also used for managing user accounts and access rights, its main features are:

- The capture of contacts: the tool serves to enrich collaboratively the database of prospects with new contacts (company, contact person) by exploiting data sources such as conferences and bids obtained by the students. This allows the ESI-enterprise assistant to find contacts and view information associated with them (Figure 6).

Figure 6 Prospects introduction interface (see online version for colours)

The screenshot shows a web interface for adding a new company. The main form is titled 'Ajouter une nouvelle entreprise: ou [Ajouter une personne](#)'. It contains several input fields: 'Nom de l'entreprise' (filled with 'Sonatrach'), 'Téléphone' (two fields with '02145670' and '02145678'), 'Email' (two fields with 'contact@sonatrach-dz.com' and 'direction@sonatrach-dz.com'), 'Websites' (filled with 'http://www.sonatrach-dz.com'), and 'Adresse' (filled with 'Djenane El Malik Hydra, Algiers 16035'). Below these is a 'Description' field containing a paragraph about Sonatrach. At the bottom of the form are links for 'Ajouter cette entreprise' and 'Annuler'. The interface also has a sidebar on the left with navigation options like 'Profil', 'Mes Espaces', and 'RÉCÉMMENT CONSULTÉ', and a top navigation bar with 'Ajouter un contact' and a search bar.

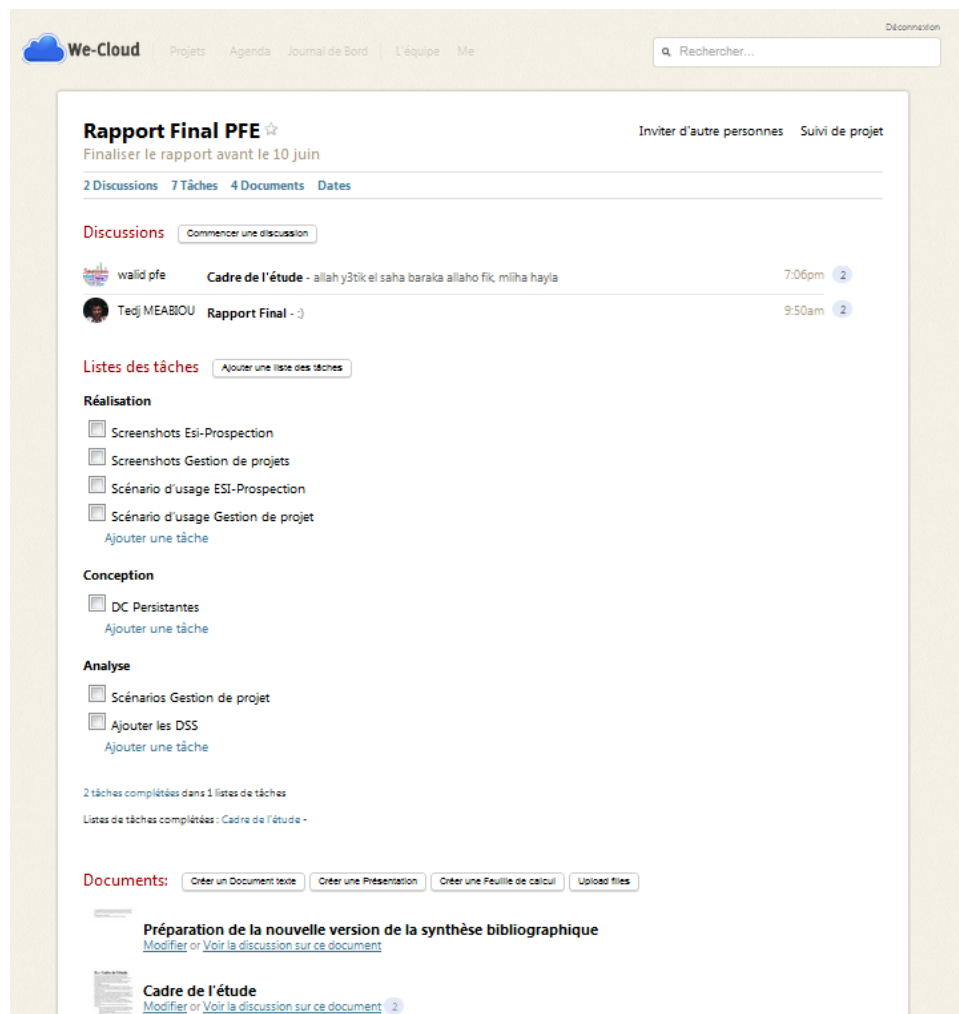
- Grouping of contacts, which exploits classification criteria such as legal form and nature of activities to segment and target contacts in the same group during the prospecting action.
 - Event planning: the tool works on a 'push' system, where information such as schedules and automatic reminders are sent to potential internship suppliers by e-mail.
 - Monitoring of prospecting actions (communicating with and reviving prospects): Used to alert the user of prospecting actions previously delayed or scheduled, using all channels and prospecting tools, such fax, e-mail, and phone calls, within constraints on availability and costs.
 - Ranking of internship offers: this function accumulates and classifies internship offers according to the level, specialty, and length of the internship.
 - Treatment of internship offers: users can accept or decline internship offers. After an offer is revised, an answer will be sent to the bidder, accompanied by a justification in case of refusal, allowing users to reverse decisions at a different time.
 - Viewing statistics on the results obtained by the system, such as the prospect statistics (number of leads/sector, number/province, prospects/customers conversion rate), statistics on internship bids, and post-placement outcomes.
 - History of actions, which allows the user to track all prospecting actions made with a prospect during a specific time-period.
- b Analysis and validation (maturation)

This activity engages intra-school expertise through collaboration around the collaborative web 2.0 tool (document sharing between teachers and researchers) in order to better treat internship offers, assign internships to students, annotate internship sheets, and manage and share the topics repository for future trainees.

c Project monitoring

This activity ensures effective teamwork. The software tool allows users to create and track projects, with features such as end cycle project discussions, to do tasks, and project resources. It allows all team members to know at any time the progress and results of the project (Argyris and Schön, 1978), using a logbook that stores the project timeline (Figure 7).

Figure 7 Space project tracking (see online version for colours)



d Reporting

We use key performance indicators or KPIs (Parmenter, 2010) to represent measures focusing on different stages of the internship management process that are the most critical for the current and future success of the school, including:

- Intern placement rate (per type of internship).
- Number and types (SME, large companies) of host organisations annually.
- Rate of internships proposed by school partners or by alumni.
- Rate of teachers participating in tutoring activities annually (per type of internship).
- Internship evaluation sheets filled by host organisations.
- Results of anonymous interns surveys.

e Service (capitalisation)

This action concern project shared by the different actors, addressing good managerial practices and monitoring of trainees, and products made with a view to exploiting the results.

The support activities of the internship management process are competency cartography and technologies development.

a Competency cartography (mapping)

The work of the academic staff is expanding and covers more and more new tasks described by Losego (2004) as invisible work. Staff skills are diversifying, while availability becomes simultaneously scarce in the absence of skills inside the system (Le Boterf, 2000). Namely, questions such as ‘who knows what’ and ‘who does what’ in every part of the organisation are answered in part using tools which localise expertise and are actively involved in the transfer of knowledge within any organisation.

For ESI, it consists in developing intra-cognitive skills (school teacher potential) and inter-organisational relationships (professional and alumni networks), and making them available on the school intranet and usable for an administration that has to be reactive or proactive in facing market requirements.

A web 2.0 tool (Bower, 2015) called ESI clever network 1.0 (Figure 8) promotes the supply of the knowledge base on the principle of ‘attended declarative’.

It has the following advantages: conviviality and ease of use, open competencies knowledge base, assisted tool collection, research, and system of labelling or tagging, and chart of tool usage.

b Technologies development

An engineering school is like any organisation that needs to store, handle, and distribute all kinds of information and knowledge (about students and staff, educational and scientific, and its relations with the environment). This action monitors the existing technology to improve the available tools (intranet, web portal, extranet), increasingly solicited by internal and external actors.

Figure 8 Interface of ESI clever network 1.0 (see online version for colours)

5 Results and discussions

Given the requirements of accreditation bodies such as Commission des Titres d'Ingénieurs (CTI) or Accreditation Board for Engineering and Technology (ABET), engineering schools as technical teaching institutions are undeniably the most concerned and involved in university-business collaboration and this is made particularly apparent through the use of internships. The internship is certainly a building block in the education process and can be a highlight of student life.

Successful management of the corporate internships process is a challenge for academic institutions, but it is necessary if students are to develop the skills needed to integrate quickly and efficiently in an increasingly demanding professional world.

With regard to the case of ESI Algiers, the proposed internship process generated several benefits. Table 2 is based on each activity constituting the internship management process; it shows the changes after implementation of the process as well as the supporting tools and corresponding benefits.

With regard to the RBV framework, we can assert that our newly implemented internship management system is:

- 1 *Valuable*: Table 2 summarises benefits generated from the implementation of the internship process, such as saving time and seeing a significant improvement of internship prospecting, validation, and monitoring.
- 2 *Imperfectly imitable*: a new computer science school based on the ESI model, ESI SBA, was created a few years ago. Even if there are some similarities, it is quite different from what was previously available. This difference is due to a richer and denser ecosystem than ESI Algiers has. This environment naturally offers more

opportunities in terms of prospecting. With regard to the difficulty to imitate the ESI Algiers management internship process, we hypothesise that it is due to so-called ‘causal ambiguity’. According to Reed and De Fillippi (1990, p.1), “tacitness, complexity and specificity in an organisation’s skills and resources that can generate causal ambiguity in competency based advantage and thus raises barriers to imitation”. A process may be difficult to imitate because its link to competitive advantage is misunderstood by the organisation itself.

- 3 *Rare*: if it is imperfectly imitable, it is rare. These two indicators are closely related.
- 4 *Non-substitutable*: in computer science faculties affiliated with universities, the number of students is significantly larger compared to their number in engineering schools. In addition, there is often no prospecting for internships. As a result, students must seek internships on their own. Hence, there are two consequences: the first is that the demand is greater than the supply and therefore fewer internships in companies are carried out. The second consequence concerns the quality of the internships: it is compromised given the reduced number of possibilities, which reduces the possibility to make a rigorous selection (validation) as is possible in engineering schools.

Table 2 Summary of changes after implementation of the internship management process

<i>Activity</i>	<i>Changes after the implementation of the internship management process</i>	<i>Added value</i>
Prospecting	<ul style="list-style-type: none"> • Use of the ESI-PRM (prospect resource management) tool to identify new businesses and share information available from contacts and other alumni • Annual job fair (mid-May) comprised of an average of 50 professional organisations • Information monitoring of professional organisations and human resources • Three types of internships: worker stage, short-term and long-term internship 	<ul style="list-style-type: none"> • Supply of internships exceeds student demand (ratio: 1.5 internship offerings per student for long-term internships) • Offerings of internships coming from an increasing number of activity sectors (+150%)
Analysis and validation	<ul style="list-style-type: none"> • Collaborate to annotate the topics of the internships coming from the partner companies and carry out an evaluation in asynchronous mode (sharing of documents) • Use of ‘ESI-clever’, a web 2.0 tool to help local staff localise intra-organisational skills 	<ul style="list-style-type: none"> • Time-saving (an average gain of three weeks): internships started on time • Improved quality of the proposed internships topics because of rigor of selection criteria
Projects monitoring	<ul style="list-style-type: none"> • Use of ‘ESI-clever’ to help local staff set up the traineeship commissions in order to assess intermediate and final deliverables • Virtual meetings between students and supervisors according to the appointments defined in the project plan 	<ul style="list-style-type: none"> • Less internship abandonment or disagreements within internship providers (2.5% instead of 12.5%)

Table 2 Summary of changes after implementation of the internship management process (continued)

<i>Activity</i>	<i>Changes after the implementation of the internship management process</i>	<i>Added value</i>
Results assessment	<ul style="list-style-type: none"> • Use of 'ESI-clever' to assign competencies according to internships topics • Scheduling of the defense according to the availability of the involved actors • Evaluation of dissertations and software prototypes 	<ul style="list-style-type: none"> • Improved quality of assessment
Reporting	<ul style="list-style-type: none"> • Anonymous survey of satisfaction of trainees 	<ul style="list-style-type: none"> • Quality indicators for improving training
Knowledge capitalisation	<ul style="list-style-type: none"> • Feedback on the projects carried out 	<ul style="list-style-type: none"> • Co-construction of innovative knowledge around this process

6 Conclusions

We presented in this paper an e-management approach to designing a crucial process for any engineering school in pursuit of excellence. This approach is a subtype of master plan approaches for information systems, i.e., planning strategic modifications and implementation tools.

We have optimised the resources by adopting a process-based organisation that goes beyond the traditional mission of internship management by attaching upstream activities (prospecting) and downstream activities (reporting and knowledge capitalisation). We developed two types of software that support some process activities, namely:

- *Transactional process systems*: PRM tool to maximise quality offerings.
- *Decision support systems*: competency localisation system (ESI-clever) to optimise the use of skills in the validation and monitoring of trainees.

However, the current work presents some limitations, such as a lack of support of all internship process activities (results assessment, reporting, and knowledge capitalisation).

In addition, the developed tools supporting the activities of the internship management process are not integrated. It is preferable to switch to an enterprise resource planning software solution to have a complete and coherent device.

The return on experience or knowledge capitalisation should be implemented using communities of practice and a memory of projects. This will enable the user to mutualise knowledge around the practice of trainee coaching and to share with all stakeholders the knowledge around the projects carried out.

Other projects that deserve special attention in the coming years include integrating developed applications to optimise process quality (value); assisting innovative projects co-built with partners; and reconsidering partnerships between academic institutions, which are not accustomed to pooling resources, to achieve commitments with third parties. To this end, partners should mutualise information systems by default.

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