

SUSTAINABLE INNOVATION IN COMPUTER COMMUNICATION AND MANAGEMENT

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ABSTRACT

In this paper will be emphasized common management processes and structures that sustain innovation in Computer Communication and Management. In the beginning, innovation concept and theory will be debated, together with governmental and European structures which support innovation. In the second part of article, some of specific university innovation structures are exposed and compared. Third section of paper presents some innovative products developed in university field. Last part will underline the results in sustainable innovation and future work related to this.

Keywords: innovation, computer, communication, management.

1. INTRODUCTION

First of all, we must start with innovation definition as processes, being seen, as company level, as application of new technologies, concepts or knowledge to products, processes or other company aspects [1].

Another significant source for innovation definition can be found in the Oslo manual of innovation, edited by Organization for Economic Co-operation and Development that propose a set of principles and methods for scientific and technological activities measurement [2]. The Oslo manual define “*Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes*”. In this manual is distinguished the *technological product innovation*, with two subsidiaries: *technologically new products* and *technologically improved products* and *technological product innovation*.

Trott presents in his book [3] a typology of innovation, which covers:

- Organizational innovation;
- Management innovation;
- Production innovation;
- Commercial/marketing innovation;
- Service innovation.

The concept of innovation in various cases is perceived on company level but also on sectorial level [4], where the boundary of economic sector it consist by common knowledge shared by a group of companies which lead to innovation rather in the group then in individual case.

To sustain this affirmation, the collaborative framework, virtual enterprise and other similar concepts show that innovation is accelerated in collaborative environments [5,6],

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environments that are formed from companies, universities, various actors involved in designated area of interest.

Gathering all aspects presented above we should define multiple perspectives of innovation:

- Product level, with two sections: new products and improved products,
- Organizational level, having impact under internal business processes but also at the organizational type paradigm (e.g. Virtual Enterprise, Holonic enterprise, Future Generation of Manufacturing Systems, Lean Manufacturing, Agile Manufacturing [8,9,10],
- Environmental level, where changes implied by innovation affects more companies that work together in order to achieve a common goal.

On the other hand, if it is counted the impact over business of innovation, could be distinguished [11]:

- Sustaining innovation, which improve existing products for already gained customers and markets,
- Disruptive innovation, focused on new market segments, with a fresh set of processes.

Innovation, seen as a multiple impact changes, on different levels, explained above, could not be isolated each time, because implementing a new product involves also new processes or different organizational approach and environmental level. For instance, in case of mobile devices, as new product, force the software companies to promote a different applications selling approach, like Marketplace for Windows devices, AppStore for Apple and the entire environment, because market is divided not from device manufacturer, but from operating system.

Last issue debated regarding innovation is measuring inputs and outputs. The Oslo manual [2] offers a set of procedures and measuring instruments. Measuring innovation impact is not an easy task and is not clearly established, depending on various factors involved.

Mainly, accordingly with innovation definition presented above, the primary goal is to achieve better economical results using new products, processes or market processes. Starting with this assumption it is proposed cost-benefit analyses (CBA). As inputs could be considered the expenditures related with R&D and output number of patents and trademarks [12], as intangible assets and new product announcements [13]. For innovation on organizational level, as input could be considered also the expenditures occurred by modifying or substituting business processes and as output some authors [12, 14] may consider financial performance (profitability, return of investments, and others market performance [15] (share or growth). Comparing R&D activity into a company could also take into account more elaborate indicators like: percentage of added value from total sales, R&D expenditure from total company expenditure, number of R&D employees from total employees etc. Anyway, there is not a determined function, which could be generalized for all industries. The third level of innovation, related with the entire environment where innovation produce effects could be measured with various indicators. The EU used for comparison between EU countries a set of indicators which comprise three categories, with eight dimensions and 25 indicators [16]:

- Enablers, divided in: human resources, research systems results and finance and support,
- Firm activities, with subcategories: firm investments, link ages & entrepreneurship and intellectual assets
- Outputs, regarding innovators and economic effects.

2. TRIDIMENSIONAL MODEL OF INNOVATION

For a clear view of innovation impact, starting from product level, continuing with the changes involved by this in business process on enterprise level and finishing with all implication on environmental level, we may define the innovation tridimensional model (figure 1).

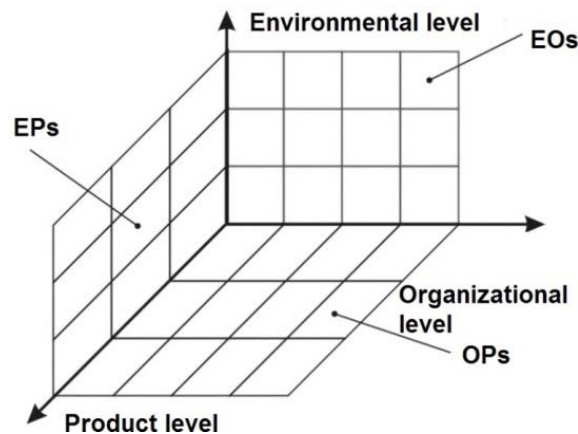


Figure 1 Tridimensional innovation model

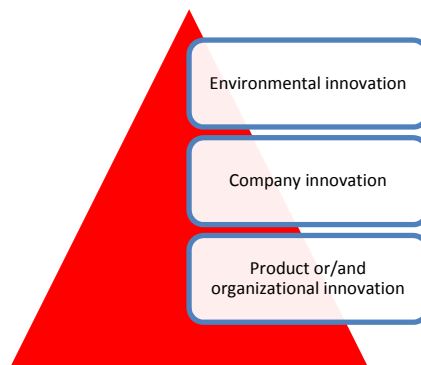


Figure 2 Innovation impact

To develop the model we start by thinking that innovation could start with a new product or improves on old product which involves changes in business approach of companies and finally affects the entire environment.

In this case we start by defining an innovation product matrix, which represent all new product or all improvements for oldest products. Because innovation impact could be measured for each one of them (e.g. by R&D expenditure and sales vales or other indicators) using input and output measures. So generally, we may say that innovation, on product level is a function defined by inputs and outputs (1):

$$ipl(pi_j) = po_k. \quad (1)$$

where ipl innovation function on product level, pi product innovation inputs and po product innovation outputs.

Also, on company level, product innovation may be seen as a matrix of all new products or improved ones:

$$IPL = \begin{bmatrix} ipl_1 \\ ipl_2 \\ \dots \\ ipl_m. \end{bmatrix} \quad (2)$$

and $ipl_{i=\overline{1,m}}$ is innovation function on product level,

Similar, for changes in business processes, could be defined an innovation function for those changes on organizational level (3):

$$iol(ois) = oo_t. \quad (3)$$

The matrix associated with organizational innovations might be:

$$IOL = [iol_1 \quad iol_2 \quad \dots \quad iol_n] \quad (4)$$

$iol_{t=\overline{1,n}}$ being innovation function for business processes changes on organizational level.

Having in mind definitions (2) and (4) we may appreciate innovation impact on company level as (5):

$$IC = IPL \cdot IOC = \begin{bmatrix} ipl_1 \\ ipl_2 \\ \dots \\ ipl_m. \end{bmatrix} \cdot [iol_1 \quad iol_2 \quad \dots \quad iol_n] = \begin{bmatrix} ipl_1 iol_1 & ipl_1 iol_2 & \dots & ipl_1 iol_n \\ ipl_2 iol_1 & ipl_2 iol_2 & \dots & ipl_2 iol_n \\ \dots & \dots & \dots & \dots \\ ipl_m iol_1 & ipl_m iol_2 & \dots & ipl_m iol_n \end{bmatrix} \quad (5)$$

For model consistency, we should consider that $m=n$, $ipl=1$ if innovation based on organizational changes is not involving new products and $iol=1$ if innovation on product level doesn't implies changes on business process.

Another requirement is both innovation functions should have identical selected inputs and outputs, in order to be a consistent mathematical model. By choosing different inputs or outputs, or just a part of them, we can see the impact of those indicators on innovation functions and if a predictable correlation might exist between them. Must be underline that, in case of using functions, we may consider multiple inputs but a single output. Other authors proposed a combined innovation index instead using functions [17].

So, relation (5) is *innovation bi-dimensional definition* on company level. Further to advance to tridimensional perspective, we should add the impact of innovation on environmental level. Therefore, iel represents innovation function on environmental level:

$$iel(ei_u) = eo_v. \quad (3)$$

$$IE = \begin{bmatrix} IC_1 \\ IC_2 \\ \dots \\ IC_z \end{bmatrix}$$

and matrix where IC_z , supposing that environment is given by all companies which are part of it.

We underline that is an empirical model, used just to underline innovation impact and if is selected for testing should be completed with other statistical models and not always the assumption that all inputs and outputs could be exactly measured or appreciated is true.

As last part for theoretical section, as presented above, innovation suppose specific expenditures, meaning new equipment, personnel costs etc. [18]. Those expenditures could be supported by internal or external funding. Entire R&D activity might be externalized. In this case we may discuss about for types of companies:

- Companies which develop innovation and applies in their business,
- Companies which develop innovation and is transferred to another company, by bilateral agreements or auctions for a specific product or technology (e.g. R&D Centers, universities, innovation centers,
- Companies which not develop innovation by their own and prefer to import or to externalize this function from companies presented above,
- Companies which not develop innovation and not import or transfer from other company.

The innovation is appreciated as well on country level [16], presenting data on global or European level. In this case, all indicators and methods are presented inside of study.

European Union support, by direct financial meanings, companies which develop or transfer innovation. As activity, depending on subject and project type, could be funded:

- R&D activities, having as results a new product or service,
- Technological transfer activities, for spreading new technologies,
- Business incubators, for facilitate development for new companies,
- Support activities.

3. UNIVERSITY INNOVATION STRUCTURES

Starting on these assessments about companies types related to innovation perspective, presented above, we present some of innovation support structures, usually set in-side of university, but not always.

In the beginning we will discuss about Research Centers (RC). They are meanly focused on delivering new products or services on market. Those products will be delivered to market by themselves or by a third party. The initiation of developing new product could be as request with specific details from other companies or government or to participate to research auction in order obtain external funds. In general, RC is focused on eternal fund to sustain R&D activity.

The lifecycle of innovation for RC is described in figure 3. The chain is triggered by an original idea or by a research request. After this phase is completed the preliminary design. The RC board evaluates the feasibility of the project, meaning time and costs and decides if the idea is viable, from technical and economical point of view. After the decision is made, a careful planning follow, containing all R&D stages: theoretical and applicative research, comparing technical possibilities, establish technologies used, designing of application development process, development & testing and implementation.



Figure 3. Innovation lifecycle for RC

From human resource perspective we should underline that employed researchers are highly trained for a specific domain.

As case study for R&D centers we use RAU INFORTIS RC, set inside of Romanian-American University. Mainly, research centers are centered to a specific scientific field or to multiple domains with interdisciplinary research. In INFORTIS case [20], the field covered is IT&C and specific domains are:

- Formation of an organization as a Virtual Enterprise in the context of globalization,
- Modeling activities, processes and material flows, information and knowledge / innovation,
- Management and engineering enterprise virtual,
- Information systems and decision support systems based on IT technologies and type Internet / Extranet / Intranet,

- Application-specific architecture of modern enterprises operating in a digital economy, on the basis of relations B2B, B2C and IB (Business - to - Business, Business - to - Customer and Intra - Business) and e-commerce,
- Developing specifications and sizing infrastructure to support Virtual Enterprises,
- Project management for information systems and engineering software used in Virtual Enterprises,
- Training, specialization and improvement of human resources in industry, using technologies and methods of e-learning, distance-learning and multimedia,
- Insurance under the outsourcing, certain services in the areas referred to using the facilities of the center.

The mission of RAU INFORTIS RC is:

- Developing scientific theoretical and applicative research,
- Offer consultancy for economic processes,
- Disseminating research results, as is provides in contract, by organizing and participating on scientific conferences or others similar channels;
- Establishing a more close cooperation with the national and international scientific research excellence.

In order to perform the best of contractual obligations RAU INFORTIS RC and has set the main lines of action:

- Formation of collective research, which interact to achieve the objectives of contracts;
- Orientation of research to cover some areas in accordance with the documents prepared by authorized institutions (CNCSIS, the European Commission - the FP7, etc.).
- Design and development of a database required in providing advice on various economic processes;
- Streamline business research to create a good reputation in the case of entities like the existing national / international;
- Increased relevance of scientific work, the visibility of the act of research at the international, and as a first step of this process, the Center aims to enhance / enhancing the transfer of managerial know-how in the U.S. and the developed countries of the European Union in Romania.

The research activity, in case of RCs is evaluated under specific indicators according with GO 274/2002 art. 74. In case of funded research each financing organization may establish their own set of indicators. To complete the case study, for instance, in case of R&D project, financed by National Plan of Research in Romania, the results of R&D are measured by:

- Final result of project (subcategories: new products, machines, installation, new technologies, new technical documentation, plans, new software, standard, software service, new systems, structures and processes, new methods and techniques and new studies),
- Final results stage (Conceptual model, Experimental model, Functional model, Prototype, Pilot Installation),
- Results novelty area (national, European or international),

- Young researchers involved in project,
- Equipment acquisition (equipment and R&D installation having selling price over 100 000 EUR, specialized communication networks, infrastructure for documentation and communication),
- Results dissemination (Scientific articles, books, conferences).

So, we may extract a set of indicators for innovation in case of R&D projects:

- Expenditures value for realizing a new product, software, service or reorganizing process,
- Type of innovation (new product, modernized product or organizational innovation),
- Stage of innovation (Conceptual model, Prototype, Pilot or deliverable)
- Innovation infrastructure (equipment, software, hardware infrastructure),
- Innovation dissemination coverage (books, articles, conferences, press releases, markets).

As preliminary conclusion, RCs are sustaining innovation by delivering new products or services to market and transfer new technologies to external companies. Usually RCs are not covering the innovation brokerage, the innovation results having from beginning an owner, all related results from its activity being part of R&D contract.

The second part of this debate is reserved to Innovation Centers, generally sustained by software companies, developed with local subsidiaries and partners help. The case study for this kind of innovation structure is Microsoft Innovation Center Network. This Network counts over 100 MICs on five continents, with various fields of activity and business model. The MICs have a common goal to generate and promote innovation through business environments into a sustainable fashion (figure 4).



Figure 4. Sustainable innovation key elements

Through this initiative, MIC set inside of Faculty of Computer Science for Business Management, which has undergraduate and graduate in Economics Informatics offer support for:

- New connection between academic learning and professional skills from labor market, helping to develop those computer abilities to have success on employment market,
- Actual technological platform and curricula, with modern on-line large learning facilities on Microsoft site. It is proposed to design and develop and to implement of an e-Campus platform,
- Organize training sessions, courses, workshops, labs and seminars, accordingly with international standards of academic education,
- Direct involvement of employers in students' internships.

Microsoft Innovation Centers offer programs, essential for software industry development, grouped by:

- Skills and intellectual capital development (software development courses, business skills, professional certifying programs and training for juniors' employment). Universities use MIC to achieve continuous teachers learning programs, to develop new curricula adapted to market changes,
- Industry partnerships (implying software companies into training curricula, software quality certification, research programs for students). MICs consolidate the connection between academic environments, software industry and Microsoft. Microsoft partner companies and local representative prepare training curricula, pilot programs, workshops, opening new horizons regarding initiative and opportunities for professional carrier for future graduate,
- MIC accelerates the innovation through pilot programs (e.g. RAU – MIC is oriented to Windows Phone and Windows 8 apps developing).

To emphasize the particularity of innovation lifecycle (figure 5), in case of MIC-RAU, it is addressed to students. First phase covers a training program, outside of university curricula, focused on various technologies. The training focuses on general concepts understanding and also on developing practical skills for attendees. A curriculum is conceived under pyramid shape, accessing several training being conditioned by previous training pass. After training, MIC organize certification exam to prove that student skills are sufficient developed. MIC – RAU offers MTA free vouchers. Students can attend at certification exams inside of MIC, being Certiport Testing Center.

After students gain certification, they may attend to DevCamp, a developing session having as final result a software application, which after is published on Microsoft Marketplace.



Figure 5. Innovation lifecycle for MIC

The activity scorecard for MICs, covers a variety of managed programs and is composed by [21]:

- **Training Reach.** Total number of people (students + entrepreneurs + faculty + ICT professionals) reached by MIC training activities. A training activity is defined as a hands-on training lasting more than 4 hours. This metric is automatically updated with data coming from the activity management system (summing all reported students and ICT professionals reported on technical training and business training activities).
- **Student Reach.** Total number of students reached out by MIC activities, including training sessions, MIC lectures/events, projects, incubation weeks, internship, imagine cup camps, etc. A student is someone who is currently enrolled in an academic institution and do not work in the ICT sector. This metric is automatically updated by the activity management system, by summing all students reported from activities flagged as concluded. This metric is associated with the KPI Students.
- **ICT Professionals Reach.** Total number of ICT professionals reached by MIC activities. An ICT professional is someone that works for in an ICT company (developer, ITPro, IT Admin, IT Manager, designer, tester, DBA, etc.) as their main source of income and is not enrolled in a High School or University (for undergrad courses). An ICT company is a startup, ISV, System Integrator or VAR which main business is based on information technology or communications. This metric is automatically updated by the activity management system, by summing all ICT Professionals reported from activities flagged as concluded. This metric is associated with the KPI Students.
- **Startups.** A Startup is a private held, incorporated company in business for less than 3 years, who generates an annual revenue under USD 1 million. This metric totals the number of companies reached by MIC activities. The metric is automatically feed by the activity management system, summing all startups reported from activities flagged as concluded. This metric is associated with the Startups KPI.
- **ISVs.** Total number of non-startup stage, ICT companies (Independent Software Vendor, System Integrators or Value Added Resellers) reached by MIC activities.
- **Jobs.** Total number of job positions or intern positions filled by activities driven by the MIC. The number here must not include trained people, but only those who were hired by local partners or attended internship program at the MICs based on programs like Student to Business, Job Enablement Programs, and Technical Trainee programs. This metric is reported manually, since there is no way to automatically count jobs from the activity management system. This metric is associated with the Jobs KPI.
- **Business Cases.** Total number of cases (press articles, marketing documents) talking about a project develop at the MIC in collaboration with the local ecosystem.
- **ISV/SI Product Win.** Total numbers of prototype or solutions jointly develop by the MIC with a local ICT company.
- **End Customer Solution.** Total number of prototypes or solutions created with non-ICT companies at the MIC.
- **Certifications.** Total number of Microsoft technical certifications obtained through MIC activities (count only approved test results), using vouchers distributed by the MIC. This metric is reported manually, since there is no way to automatically count approvals from the activity management system.

- Training Sessions. Total number of training sessions with more than 4 hours of duration.
- Satisfaction. Average satisfaction with MIC activities by considering 5 = VSAT and 0 = DSAT.
- Windows 8 Apps Published. Total number of Windows 8 Apps published to the Marketplace
- Windows Phone 8 Apps Published. Total number of Windows Phone 8 Apps published to the Marketplace
- WP8 Apps on Azure published. Total number of published Windows Phone 8 Apps using any Azure Service, e.g. mobile services, websites, database, etc.

For FY 2012, entire MIC Network reports overwhelming results, counted in [22]:

- 24 407 ICT professionals helped by MIC Network,
- MIC Network contributed to creation of 4 515 new companies,
- Create 3 300 jobs on entire world,
- 506 Wins, cases and prototypes,
- 5 812 ISV's,
- 93 630 people trained,
- 65 158 students reached,
- 2 884 certifications offered,
- Over 3 000 WindowsPhone apps published on Marketplace,
- 272 Azzure apps published,
- 18 W8 apps (in September 2012).

The last innovation structure presented is the Business Incubator (BI). As case study were taken Romanian-American University Business Incubator who started its activity in 2006 and ceased in 2009, because of lack of external funds. Usually a building space is offered for SME activity, encouraging by low rent prices and annexed services the SME incubation. The incubator offer technical support for SME's, from industrial domains such as: automation, IT and applied informatics. Another target share is services for those above mentioned domains, including long life learning. The Incubator facilities and services are:

- Entrepreneurs and employees training,
- Manufacturing facilities, including industrial equipment,
- Administrative and secretariat services,
- Support for SME registration and preparing the business plan,
- Equipment acquisition and technological transfer,
- Technical/economical evaluation of products and services produced by incubated SME,
- Industrial lobby or other promotion service to develop new products or services,
- Management strategy and administrative planning to achieve objectives in different domains: manufacturing, technological transfer, sells / acquisition, marketing, finance,
- Funding and financial guarantees for SME, international cooperation a "joint venture".

The main role of incubators, in sustaining innovation, is to offer support to young companies in their early days of life, to help them to grow, some of very successful software

today companies starting from an idea (e.g. Google, Facebook). In this case the innovation lifecycle starts from an idea (could be software or a service), follows with framing idea as business, company initiation, company incubation and finally is getting to a mature company, able to generate other new software, products or services.

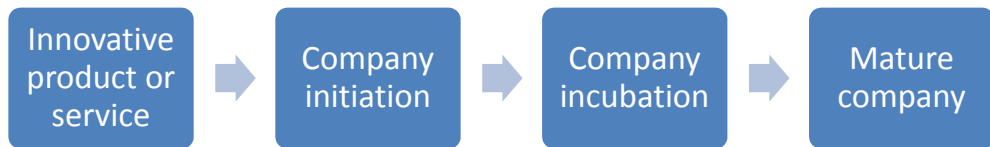


Figure 5. Innovation lifecycle for IB

Accordingly with the evaluation procedure of Romanian National Council of Scientific Research, the activity of such business incubator is measured by:

- Improving operation and communication infrastructure,
- Improved workspaces,
- Trained staff, training sessions,
- Support for innovative SMEs and ideas incubated,
- Number of new products,
- Number of \ new technologies,
- Number of upgraded products,
- Number of upgraded technologies,
- Services performed for SMEs,
- Physical incubated SMEs,
- Number of SMEs virtual incubated,
- License agreements,
- Direct contracts with third parties,
- Contracts with local / central authorities,
- International agreements,
- Participation on national and international fairs and exhibitions,
- Awards / medals,
- Printed materials (brochures / guides / CD).

4. COMPARISON AND CONCLUSIONS

Moreover, having in mind a clear idea of what's happen in those sustaining innovation structures, we can identify some type of services that intervene in their activity. So, accordingly with figure 6, are identified seven services for sustaining innovation:

- Technical training,
- Business training,
- Generating ideas,
- Technological transfer,
- Launching new products or services,
- Startup programs.

For each innovation structure a number of services are set in legend of figure 6. Anyway, after experiencing those three innovation structure, depending on scope we can underline that:

- RCs' are highly specialized in their activity field, needing specialized HR an equipment, developing projects, most of the time, for external companies or other financing bodies. In case of university RC's HR is almost assured by teaching body or scientific researchers, the research activity being linked to national or international funding opportunities,

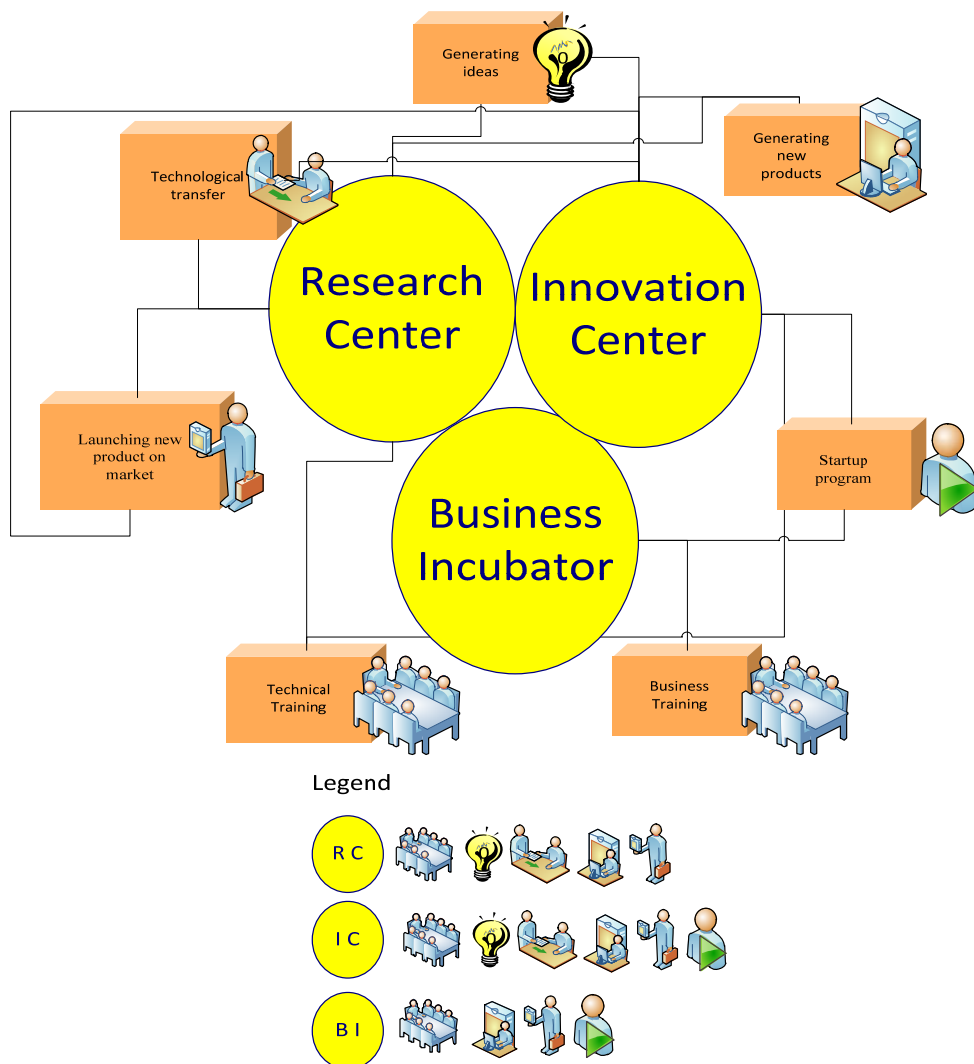


Figure 6. Innovation services

- IC is sustained and integrated into Microsoft activity calendar, addressed mainly to students, but also to teachers, into design and improving academic curricula. As results, because of Microsoft help and resources, we can clearly say that IC is a place where new technology is proofing its value. From all over one hundred ICs, each one has its specific business model, from profit company to university bodies,
- BI are oriented to sustain new companies and business, dependent from external funding to succeed offering lower costs for incubated companies.

Overall, we can say that sustaining innovation is not an easy and very programmatic task, more organizations being oriented to avoid or to reduce the risk involved by developing new products or services or reorganizing their business. Also, without entrepreneurship spirit, the innovation is not revealed at its true value. Moreover, sustaining innovation in universities is highly important in order to prepare students for being a good employee but also a good entrepreneur.

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