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ICT BASED INFORMATION FACILITIES TO BOOST AND SUSTAIN INNOVATIVENESS

Abstract. Databases, repositories and other information and knowledge resources and knowledge-based services are at the core of innovation that has become a vital growth factor for companies, communities and nations. This paper identifies the types of ICT information facilities and services that can boost and sustain innovativeness and map them onto particular stages of the innovation process.

Keywords: information facilities, innovation, innovativeness, ICT

ZINFORMATYZOWANE SYSTEMY INFORMACYJNE WSPIERAJĄCE INNOWACJE

Streszczenie. Bazy danych, repozytoria i inne systemy informacyjne oraz usługi oparte na wiedzy, stanowią kluczowy element innowacyjności, która stała się ważnym czynnikiem wzrostu firm, społeczności i narodów. Artykuł podaje typy systemów informacyjnych i usług wykorzystujących platformy informatyczne do wspierania innowacyjności oraz łączy te systemy z poszczególnymi fazami procesu innowacyjnego.

Słowa kluczowe: systemy informacyjne, innowacje, innowacyjność, ICT

1. Introduction

Information and Communications Technology (ICT) is a horizontal impact technology that goes across almost all branches of economy and society. ICT facilities, be they PCs, tablets, smartphones, or wi-fi routers/modems, are abundant and ubiquitous and have become a permanent part of corporate, institutional, and even private landscapes. Putting it bluntly

one might metaphorically say that ICT is already a chunk of the civilizational DNA that determines what and how people do, behave, and think. It is interesting to observe how quickly and aggressively ICT influences things and processes on a micro and macro levels, how it pushes communications, globalization, scientific research, defense, manufacturing, education, health, environmental matters, and last but not least overall lifestyle. ICT has been transforming industrial society into knowledge society that can operate in both the 'real' world and the virtual universe based on the internet. One of the main leverages of this emerging society is innovation and the winning attitude for it is innovativeness. With a little risk of exaggeration we claim that companies as well as whole nations that want to successfully face present and incoming challenges have to adopt the following adage: innovate or perish.

Innovation is relative to many factors of diverse nature and dynamics. It has technological, social, and cultural dimensions. It is definitely not one thing that can be easily grasped and mastered. On the contrary, it is a complex multifaceted process laden with uncertainty and various expenditures. Countless books, articles, dissertations, collections of best practices, and guides have been published, and a number of brain storming sessions, seminars, workshops, ateliers, conferences, and consultancies took place with the aim to discover and reveal the essence of innovation and innovativeness. Unfortunately, the results of these efforts are not up to the expectations. We still are not able to generalize a multitude of innovation case studies in order to develop a satisfactory theory of innovation acceptable for both practitioners and researchers. Perhaps in order to grasp the very notion of innovation an innovative approach is needed.

In this paper we distinguish from each other the notions of discovery, invention and innovation. Discovery is an outcome of a fundamental scientific research even if it emerges as a result of serendipity (ex. gravitation law, penicillin). Invention is about creating an artifact that has not existed so far (ex. light-bulb, transistor). Innovation however is a result of purposeful and painstaking endeavor driven by a pre-defined objective, often undertaken in an organizational framework (ex. iPhone by Apple Inc.). Discoveries and inventions are hardly subject to management; they are like looking for a needle in a haystack. Innovativeness however can be planned and managed. Obviously the boundaries between these three notions are not clear-cut; nevertheless, they have a common denominator which is creativity, perseverance, and information and knowledge. The latter, namely information and knowledge, are our topics of interest in the context of innovation. More specifically, in what follows we shall attempt to identify ICT based information facilities such as various types of repositories, databases, warehouses and knowledge-based services that can boost and sustain innovation and innovativeness. Then we shall map these facilities onto particular stages of the innovation process. A note on an open innovation ecosystem will conclude the paper.

2. Innovation and Its Myths

Etymologically the term *innovation* has its roots in the Latin noun *innovatus* derived from the verb *innovare* whose meaning is: to reform, to change, to renew. Thus innovation leads to a new product, service or process that, however, can include already existing components, or it is an old product, service or process that is significantly renewed, revamped or improved. A classic definition of economic innovation coined already in the year of 1912 by J. Schumpeter reads: “(i) *The introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of a good;* (ii) *The introduction of a improved or better method of production, which need by no means be founded up-on a discovery scientifically new, and can also exist in a better way of handling a commodity commercially;* (iii) *The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.* (iv) *The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created;* (v) *The carrying out of the better organization of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.*” [16]. The time goes by but this definition still captures the essence of what innovation is and preserves its appeal. It is beyond the frame of this paper to participate in a still open and vividly carried out in literature discussions of the notion of innovation; the interested reader can find a good survey of innovation definitions and models in [1, 5, 6, 19].

However, a few remarks are necessary for the sake of this paper. First, it is interesting to note that nowadays the notion of innovation is mainly associated with technology and business and rather seldom with societal matters. Yet many challenges of the contemporary and future world will require social innovations. What is then social innovation? Briefly, it can be defined as a set of concepts, ideas and measures aimed at developing, improving and strengthening civil society in its private and public spheres by providing better working and living conditions, education, health, and security. Good examples of social innovation are microcredits and the Grameen Bank set up by Mohammed Yunus of Bangladesh and a sustainable urban transportation system in Curitiba, Brazil. More elaborated insightful definitions and analysis as well as inspiring real-life examples of social innovation can be found in the book [8]. The second remark refers to the notion of *open innovation* proposed and developed by H. Chesbrough in the year of 2003. The open innovation model assumes that innovation is organized in an open shop environment in which internal ideas and proposals generated in a company are combined with the external ones. Moreover, internal and external research resources and paths to market for advancing the development of new technologies,

products and services are fused and exploited [4]. With certain reservations and reluctance mainly caused by a serious concern that innovative solutions could leak to competitors the open innovation formula gradually gains adherers, as argued in [12]. The third comment is that innovation and innovativeness are the terms that are widely used and overused. As of this writing, the Google browser returns some 781 million hits to the query ‘innovation OR innovativeness’. Among a myriad of opinions, claims, and discussions on innovation one can find a number of false or misleading assertions and misinterpretations. Here are a few myths regarding innovations: (i) innovation can neither be tamed nor managed – on the contrary, innovation can and actually is planned and managed in ‘real-life’ settings and projects; there is an analogy with quality that in the past was also considered unmanageable, yet through such approaches as Total Quality Management it turned out to be eventually manageable; (ii) failure is not an option – the reality proves that failure is a permanent companion of innovators who are aware of a well known adage: “ok to fail”; innovators do not recognize the failure fallacy; (iii) innovation mainly consists in coming out with a new idea – practice shows that a good idea is only about 10 % of the total cost to succeed with the innovation; the rest is research, prototyping, experimenting, and testing based on perseverance and readiness to take risk. For an interesting collection of innovation myths and the way they are debunked the reader is referred to [2]. The last remark refers to the following assertion by P. Drucker: “*Innovation is the specific instrument of entrepreneurship*” [7]. Given that a digital native generation who is information and media literate and fluent in making use of cyberspace enters the business stage Drucker’s opinion encourages research on the role of ICT, and especially new ICT methodologies and tools, in the area of modern entrepreneurship and innovation. Some suggestions towards this end were given in [12].

3. ICT Information Facilities and Services for Innovation

In what follows it is assumed that an innovation endeavor takes place in a company. Innovation is a process composed of a few stages whose simple model is depicted in Fig. 1. The process starts with identifying and defining the problem that is subject to innovation, then a team to undertake the job needs to be set-up or outsourced. At this point the actual work can start; it begins with a research and collection of information on the innovation subject. This is a crucial stage of the process since the quantity and quality of concepts and ideas to be generated during the next stage by the innovation team members in a large measure depend on the harvested information. The concepts and proposals generated by the innovation team are carefully evaluated and filtered given the objectives of the expected innovation, implementation feasibility determined by such factors as the state-of-the-art of technology, capacities and re-

sources of the company owning the innovation process, and market situation. Those few ideas that passed through a scrutiny sieve move to a real test of their validity which is prototyping and then, again after a cautious evaluation, they move to commercialization by marketing specialists of the company. Needless to note that the whole process is iterative, practically at each stage, i.e. it might be necessary to backtrack the work to previous stages as a result of intermediary analysis or evaluation. This situation is represented by feedback loops in Fig. 1.

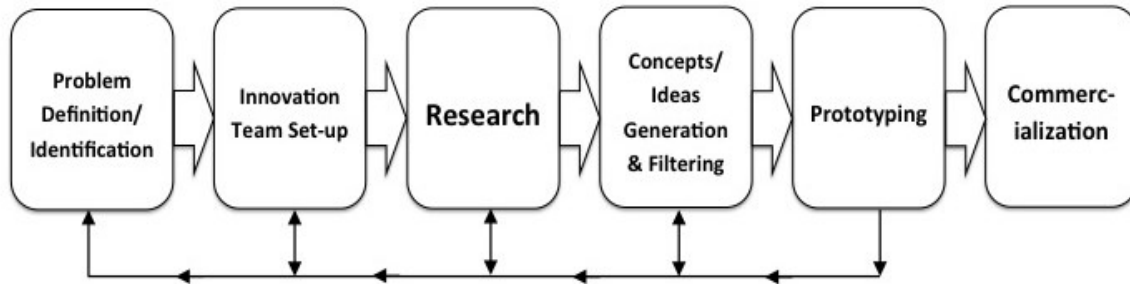


Fig. 1. A General Scheme of Innovation Cycle
Rys. 1. Schemat ogólny cyklu innowacyjnego

The stages of the innovation process will now be looked from the informational perspective. For innovation to happen they need to be supplied and supported by ICT based information and knowledge resources and knowledge-based services. Some of them are internal, namely they are proprietary assets of the company whereas the others are outsourced from the external environment. Below we briefly survey these innovation boosters.

Internal Expertise. A company has at its disposal its own staff that is specialized in the bottom line products or services delivered by the company. The staffers are carriers of skills, experience, and the so-called tacit knowledge. A subset of the qualified staff of the company can be deployed to execute the innovation project. For the innovation team to purposely and efficiently cooperate a number of ICT tools can be employed and deployed starting with widely available communication facilities (ex. Skype), to wikis and virtual discussion fora, to simple or more advanced ICT collaborative work platforms (ex. Google Groups and MSN Groups, respectively) that allow employees to share the project virtual space and contribute to the project progress in a synchronous or asynchronous manner.

Internal Info Resources. Each company is a treasury of computerized information and knowledge that take various forms and require different access modes. Among other assets one can mention the following: company internal legal regulations, maps and descriptions of internal business processes, organization structure and information flow charts, staff and collaborators rosters, internal repositories (reports, memos, notes for file etc.), thematic databases, warehouses, computer application programs, email archives. All these facilities are maintained by means of software tools specific for a particular entity, for instance domestic databases are typically implemented as relational or object-relational database systems run-

ning on commercial platforms such as Oracle or DB2, business-oriented applications supporting human resources management or accounting also employ commercial packages (ex. SAP). A real issue and challenge to a company is to integrate all these resources and platforms towards having a unified corporate information system. This is a Herculean job, indeed, and rare are the companies that can enjoy having such integrated systems.

CRM (Customer Relationship Management System). CRM is a well-established methodology in the corporate world and supported by many commercial software (see <http://crm-software-review.toptenreviews.com>). In [9] the following concise definition of CRM can be found: “*CRM involves all of the corporate functions (marketing, manufacturing, customer services, field sales, and field service) required to contact customers directly or indirectly*”. A survey of CRM methodologies and a proposal of a CRM architecture focused on informational aspects can be found in [10].

CEM (Customer Experience Management System). CEM is a relatively new concept introduced by E. Schmitt, which is defined as “*the process of strategically managing a customer’s entire experience with a product or a company*” [15]. In [11] the CEM concept was further elaborated as a process-oriented satisfaction concept aimed at establishing wide and rich interactive relations with customers. It takes into account not only the product and functionality, but also lifestyle, aesthetics, and social aspects such as prestige, networking, etc. In order for CEM to work it has to be seamlessly embedded in the company culture and be a unification platform of the company’s business processes.

Hot Line & Help Desk. This facility is particularly vital for a company. Help Desk is especially important to keep the daily operation running smoothly and to learn problems dogging the staff. Also Hot Line is a valuable source of feedback information about the company and its products or services since it provides the company with customers opinions, complains, and requirements. Today, both Hot Line and Help Desk need advanced ICT tools to support their operations. There are many tools towards this end; a survey of popular help desk software can be found at <http://www.helpdesksoftware.org/#popular>.

Business Intelligence. In order to gain and maintain comparative and/or competitive advantage companies need to learn about what their competitors are doing, what is their offer, what the marketplace situation looks like, what are short-, medium- and long-term trends on the marketplace, etc. Towards this end, companies explore available information resources, mainly on the internet, collect information and analyze it. Advanced business intelligence exploits sophisticated semantic based technologies developed by artificial intelligence such as web farming, data and text mining, collaborative filtering, social network analysis, etc. Business intelligence also taps into the technology of web agents that are small programs penetrating the cyberspace looking for information and accordingly updating company’s repositories,

and performing other pre-defined tasks. Business intelligence tools have become customary parts of database management systems and/or warehouses (ex. Oracle, DB2). They usually include advanced visualization tools to present the results of analysis in a human friendly way (ex. OLAP software).

Market Research. It is a classic business activity that is aimed at collecting information about customers, products, services, and marketplace. Typically it has to cope with large sets of data and therefore software tools are irreplaceable to perform the tasks at hand. A good source of information on market research and ICT tools to support it the reader can find in [3].

Social Networking. The cyberspace is populated by billions of people. A significant part of this population, counted in hundreds of millions, practices social networking that has become a valuable source of opinions and knowledge. Facebook, MySpace, Twitter, or many other systems and services of similar purposes and kind bring up unceasingly new information and offer crowdsourcing opportunities for innovation team. In [18] J. Surowiecki described *crowdsourcing* as a mechanism to tap into a collective intelligence of customers, suppliers, and a general public operating on the internet in order to collect creative, unbiased, and often unexpected solutions. Input obtained through crowdsourcing can substantially contribute to the innovation exercise carried out by the innovation team of the company.

Prosumers. One of the latest techniques for the companies to enhance their competitive advantage is to implicitly or explicitly involve some customers for identifying new products and/or value-added services or to get them involved in prototyping or evaluation. Customers transform themselves into so-called prosumers, as Alvin Toffler called such customers in the 80ties of the previous century. Yet only recently this concept has gained popularity owing to the web 2.0 and progress in e-commerce and social networking.

Patents, IPR (Intellectual Property Rights). Checking out patent situation is a routine task within innovation projects. In general, IPR is particularly a sensitive topic since any omissions in this respect can cause various undesirable implications such as court summons to face charges of infringing patents, financial penalties, and if worse comes to worst, can severely hamper the image of the company. In addition, the analysis of patents can be an inspiring exercise guiding and boosting the process of generating ideas and concepts. ICT tools significantly facilitate the process of checking out and verifying patent questions as well as authoring patents and submitting and monitoring applications (ex. PatentIn 3.1 is a software tool for authoring and expediting patent applications including nucleic and amino acid sequences).

Statistics. Statistical data is not to be ignored when conceiving and designing new products and services, especially when it comes to demographic data and data characterizing the

standards and conditions of living. Official statistics are regularly issued by national statistics bureaus, governmental agencies, and produced by various professional research and analytical agencies as well as NGOs. Currently, there is a new trend, namely *open data* [13] that is based on the assumption that certain sources of data and information should be available for free for further use to anyone without any copyright restrictions and control. In its more extreme form it assumes that in addition to the data access users will be provided with analytical and presentation ICT tools operating on the obtained data. Noteworthy, the open data movement subscribes in the movements of open government and open access that nowadays gain popularity.

External Consultants. Owing to their mobility and involvement in many different projects throughout the world external consultants and experts are natural carriers of cutting-edge best practices and experiences, therefore, while applying a non-disclosure agreement hiring external specialists can bring up a valuable contribution to the innovation team. ICT mobile technologies combined with collaborative work platforms allowing external consultants to remotely collaborate with the team are particularly useful. A recent technology of cloud computing [17] lends itself to organize collaboration of internal and external experts. In a nutshell cloud computing consists in putting the computing power, data, and applications in a virtual place, in a cloud, to which access is possible around a clock via the stationary or mobile internet.

Open Innovation Stakeholders. In Section 2 the concept of open innovation was mentioned as a new form of conducting projects aimed at developing innovative products or services. This model assumes that various types of stakeholders can participate in such projects, namely: (i) – universities, including research scientists, university administrators, and designated officers of technology transfer; (ii) – entrepreneurs, including start-up companies and venture capitalists; (iii) – other companies that collaborate with the company that hosts the project; (iv) – potential technology (early) adopters and downstream producers who will use the technology; (v) – government regulators; (vi) – NGOs, environmental and other special interest organizations; and (vii) – consumers. These stakeholders along with their assets they give at the disposal of the innovation project constitute an *open innovation ecosystem* in the sense defined in [4]. The diversity of stakeholders while each of them contributes unique knowledge, expertise and assets fuels and enriches the innovation endeavor yielding better outcomes than a single-company innovation pursuit.

Table 1 shows the mapping of information assets and information based services (facilities) onto the stages of the innovation process that is depicted in Fig. 1. The ‘X’ character in a cell that lies on the intersection of the row of an information facility and the column of

a process stage indicates that this facility along with ICT tools supporting it boosts the sub-process occurring in this stage.

Table 1
Mapping of Information/Knowledge Resources & Services onto Innovation Process Stages

| | Problem Definition/ Identification | Team Setup | Research | Ideas Generation & Filtering | Proto-typing | Commer-cialization |
|------------------------------|------------------------------------|------------|----------|------------------------------|--------------|--------------------|
| Internal Expertise | X | X | X | X | X | X |
| Internal Info Resources | X | X | X | X | X | X |
| CRM | X | | X | | | X |
| CEM | X | | X | | X | X |
| Hot Line & Help Desk | X | | | | | X |
| Business Intelligence | | | X | X | | |
| Market Research | | | X | | | X |
| Social Networking | X | | X | | | |
| Crowd-sourcing | | | X | X | | |
| Patents, IPR | | | X | | X | |
| Statistics | | | X | | | |
| Prosumers | X | X | | | | X |
| External Consultants | X | | | | | |
| Open Innovation Stakeholders | | X | | | X | X |

4. Final Notes

It is not rare that ICT is considered a Swiss Army knife that lends itself to resolve or at least to facilitate the resolution of complex and sophisticated problems of various natures. Despite a tremendous potential of ICT methodologies and tools they have their inherent boundaries. Their effectiveness in a large measure depends on skills and experiences of people who use them. This is particularly true when it comes to supporting innovativeness by means of information and knowledge resources and services implemented on ICT platforms. In this paper we claimed that a particularly efficient way to boost innovation is to configure information facilities and other resources in a way they constitute an open innovation ecosys-

tem in which a human factor plays a vital role and ICT overwhelmingly supports the information infrastructure. A recent example of how ICT can boost innovation and innovativeness and to combine technological and social innovation is the on-going project, whose name is SYNAT, <http://www.synat.pl>, devoted to the establishment of a versatile and open platform for communication and hosting networked information resources to be used by scientific and education communities in Poland. For one thing, one of the authors of this paper coordinates this project activities and can witness on a daily basis how advanced ICT tools, especially those that are dedicated to semantic processing and providing collaborative work platforms encourage and trigger innovative concepts, methodologies and solutions. For another thing, both authors have been participating in an experimental open innovation ecosystem establishment to pursue innovative research and application projects in the field of mobile technologies placed at the BRAMA Laboratory of the Faculty of Electronics and Information Technology of Warsaw University of Technology, <http://brama.elka.pw.edu.pl> [14]. It is worth mentioning that students of the Faculty are as a rule members of the projects executed in the Laboratory and that their innovative contributions are fairly often of actual application value.

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Submitted on the 31 January 2012.

Omówienie

Informacje i wiedza w znacznym stopniu determinują rozwój techniki, gospodarki i instytucji społecznych. Bazy danych, repozytoria i inne systemy informacyjne oraz usługi oparte na wiedzy, stanowią kluczowy element innowacyjności, która stała się ważnym czynnikiem wzrostu firm, społeczności i narodów. Innowacyjność jest procesem, którego generycznymi etapami są: zidentyfikowanie i zdefiniowanie problemu, powołanie zespołu innowacyjnego, przeprowadzenie kwerendy w poszukiwaniu relewantnych informacji, generowanie idei i pomysłów, a następnie ich filtrowanie, realizacja prototypu(ów) i komercjalizacja (patrz rys. 1). Techniki informacyjne i komunikacyjne (ICT) mogą wspierać ten proces na każdym etapie. Artykuł podaje typy systemów ICT i usług wykorzystujących platformy informatyczne do wspierania innowacyjności na wszystkich etapach procesu innowacyjnego. Łączy także systemy ICT z poszczególnymi etapami tego procesu. Artykuł opowiada się za tym, że szczególnie efektywnym

sposobem wspierania innowacyjności jest skonfigurowanie systemów ICT oraz innych zasobów, tak aby tworzyły otwarty ekosystem innowacyjny, w którym główną rolę odgrywa człowiek. Bieżącym przykładem wspierania innowacyjności technologicznej i społecznej za pomocą systemów ICT jest system SYNAT, <http://www.synat.pl>, którego celem jest stworzenie uniwersalnych, otwartych, repozytoryjnych platform hostingowej i komunikacyjnej dla sieciowych zasobów wiedzy, dla nauki, edukacji i otwartego społeczeństwa wiedzy.

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