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A Research Proposal for Measuring the Effectiveness of Business Incubators

Nadezhda Galiyeva* and David Luigi Fuschi**
*Belorussian State University of Informatics and Radiocommunication**
*Kiit University, Faculty of Applied Sciences, Bhubaneswar***

Abstract: Business incubation is a growing area attracting substantial interest both from governments and the private sector. Unfortunately, it is difficult for "would-be-entrepreneurs" to operate an informed choice given the large variety in nomenclature, programmes, services offered, underpinning business models, and the frequent lack of availability of performance data, or a common set of metrics that could be used to compute (and provide) widely acceptable KPI useful to facilitate the choice. Additionally, the role of the Information Management System has been under investigated. The present paper presents the research being conducted for the design and implementation of a modular information management system expressly designed to adapt to the needs of business incubators irrespective of the business model and approach adopted. The design is informed of the most relevant different business models presently adopted, the set of services and programmes offered, and the guidelines proposed by the European Union and the CSI federation. Best practices adopted in the UK and Europe have also been considered along with Cabral-Dahab principles. Finally, we identified a set of metrics that can be easily collected and used to generate valuable KPI able to support both the business incubation management as well as the applicants.
Keywords: *Business Incubator, Information Management System, Metrics, Effectiveness, Efficiency, KPI.*

Introduction

The concept of business incubation is not new; it emerged in the USA in 1959 when Joseph Mancuso opened the Batavia Industrial Centre (Lewis et al., 2011). At the time, the aim was neither philanthropic nor supportive of economy development but rather opportunistic and aimed at exploiting a resource that otherwise would simply represent a cost (Lewis et al., 2011). Since then, business incubation underwent significant expansion, initially in the US - during the 1980s - and then in the UK and Europe respectively giving origin to: innovation centres, techno-poles/science parks, etc. (UNESCO, 2017). At present, Business Incubation is a fairly consolidated practice, however, as clearly pointed out by (Xiao and North, 2017), previous research work tend to focus on case-studies and as such do not allow for comparative analysis, additionally, while much of the existing literature focus on the western world, little is known about emerging and transitional economies - especially in Asia - (Xiao and North, 2017).
According to the UNESCO's analysis of the business incubation phenomenon, the way it has evolved and expanded is mostly the result of the entrepreneurial aspiration of some open-minded managers of USA universities that understood - and grasped - the opportunity for exploiting the results of the research they were conducting (UNESCO, 2017). In particular, Stanford University has been able to transform the *"Silicon Valley area from one of the poorest regions in the USA into a global centre of technology, finance, education and research"* (UNESCO, 2017).

Being a research intensive university, Stanford labelled its initiative as *"science park"* rather than as *"business incubator"*, however, according to the United Kingdom Science Park Association (UKSPA), a science park *"encourages and supports the start-up and incubation of innovation-led, high-growth, knowledge-based businesses"* (cited in UNESCO 2017), thus the two terms can be used interchangeably as synonyms. Additionally, *"science park"* are often labelled also as: *"technopolis, science city, cyber park, hi-tech (industrial) park, innovation centre, R&D park, university research park, research and technology park, science and technology park, science town, technology park, technology incubator, techno-park, techno-pole, and business incubator"* (UNESCO, 2017).

This large variability in the denomination is reflected also in the offering to potential incubatee as well as in the implementation of business incubation irrespective of their naming as clearly pointed out by (Ryzhonkov, 2012). In his analysis are reported 20 different approaches to business incubation, spanning from lengthy to accelerated programs with a wide set of services and facilities offered. This wide spectrum is further expanding with new models and denomination emerging. This accounts for the difficulty in monitoring and measuring the effectiveness of a Business Incubator. Furthermore, not all business incubators are willing to openly share their performance data as clearly reported by Cabral[1] in the course of the data collection phase of this research.

Overall, Business Incubation is perceived as a positive support to economy and entrepreneurship; however, it represents also a difficult industry to analyse due to the partial lack of transparency and the absence of a clear and commonly accepted definition and implementation strategy. Different entities offer similar services, however it is difficult to identify common parameters, metrics, indicators and KPI to effectively measure and compare the performance of such entities (Mian, 1996a; Mian 1996b; Bergek, 2008; Lewis et al., 2011; Aruna, 2011; Aruna, 2014).

According to Stefan Trifonov, Associate Doctoral Researcher at The Alexander von Humboldt Institute for Internet and Society (HIIG), accelerators, in particular, could be more transparent when it comes to their performance and more rigorous in gathering data on the progress of their start-ups (cited in Anca, 2017).

This accounts for a clear gap in the analysis of the performance of business incubation, furthermore, from the study of the related literature it is apparent that researchers have not addressed an important aspect of the operational part of the performance analysis, that is the design and structure of the Information Management System that would best support the collection and computation of KPI suitable for an objective measurement of the business incubation performance.

The research is being conducted in the context of a PhD programme hosted by the Belarus State University of Informatics and Radioelectronics (BSUIR) that has recently opened a Business Incubator that is the test-bed for the present research. Presently, in most of the former USSR countries the governments are promoting the establishment of Business Incubators as a means to boost the economy and attempt resolving the economic situation created by the exit from the USSR planned economy prior to have created the infrastructure required. This interest in Business Incubation is also reflected in the recent issuing of the *"Guidelines to improve the efficiency functioning of business incubators and accelerators"* by the Government fund of funds Development institute of the Russian Federation (RVC, 2017).

The research starts from the critical analysis of the Cabral paradigm and the literature related to science park and business incubators as well as informed by the guidelines provided the

[1] Prof Cabral is supporting the present research and has shared not only relevant publications but also exchanged views with the researchers authoring this paper.

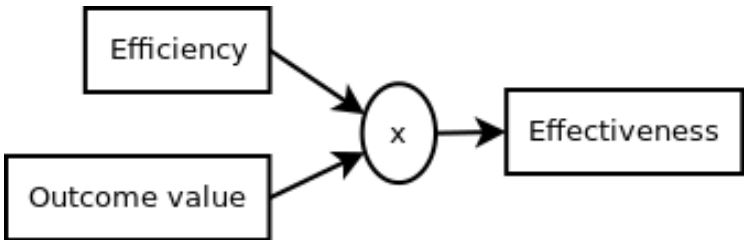
Government fund of funds Development institute of the Russian Federation (RVC, 2017) and NESTA and EU reports on the subject with the objective to attempt to:

- Provide a widely acceptable single definition and model of Business Incubator Information Management System that accounts for a minimum common denominator among the over 20 different ones presently adopted, thus contributing a unifying approach to the design of an information system that could support any presently foreseen business incubator underpinning business model
- Provide a UML description of the defined model embedding a common approach for measuring the effectiveness and efficiency of a Business Incubator or Science Park
- Define a set of metrics that can be easily collected and used to generate KPI capable to provide a clear picture of the performances
- Demonstrate that it is possible to use UML and XML parsing tools for generate respectively the database structure schema and derive in automatic from it a functioning database structure

Literature Review

In English, *effectiveness* is defined as the degree to which something is successful in producing the desired result, while *efficiency* is defined as achieving maximum productivity with minimum wasted effort or expense for a system or machine, or as working in a well-organized and competent way for a person (Oxford Dictionary, 2018). However, Anckoff (1999) says that *"Effectiveness is evaluated efficiency. It is efficiency multiplied by value, efficiency for a valued outcome"*. This definition provides a way to correlate Effectiveness and Efficiency and taking into account that since the time of Scientific Management it is well known how to compute the efficiency of a process (see Taylor, 1911), it is then possible to extrapolate effectiveness from efficiency metrics and metrics such the Earned Value.

Fig.1 - Logical framework adopted to define the relation between effectiveness and efficiency



(adapted from Anckoff 1999)

It is suggested to use Earned Value Management Metrics in combination with efficiency metrics as one of the primary objective of our research is to provide a simple and widely acceptable solution to measure Effectiveness of Business Incubators and Science Parks.

Evaluating information system effectiveness is a long debated topic and it has been addressed in several different ways including, but not limited to, user satisfaction & system usage, system usage & performance, performance & productivity, productivity & cost justification, etc. (Cyrus, A.W., 1991).

Evaluating efficiency is a very consolidated practice since the publication of Taylor's work The Principles of Scientific Management (back in 1911), however, in the case of business incubation, the variety of models adopted under the same nomenclature end the ambiguity in the usage of the term to describe the same process, poses a real challenge when it comes to collect and analyse performance data.

The academic literature presents contrasting opinions on the effectiveness of business incubation. Some experts clearly point out the positive side and benefits (Mian, 1996a; Mian 1996b; Bergek, 2008; Lewis et al., 2011; Aruna, 2011; Aruna, 2014;Aerts et al.,2007; Rogova, 2014), while other have some doubts or even hint that Business Incubator unbalance the market and in some cases even disrupt it (Allen and Mccluskey 1991; Mian 1997; Schwartz, 2011; Tavoletti, 2013; Ratinho and Henriques, 2010; Ratinho, 2011; Kim and Chang 2010).

However, as already noted, (Xiao and North, 2017) point out that previous studies and much of the existing literature focus on the western world, while little is known about emerging and transitional economies - especially in Asia. Kazakhstan is starting to develop a network of business incubators to support the vision of its President, Nursultan Nazarbayev as set forth in the published article titled "Course towards the future: modernization of Kazakhstan's identity", in which he set out his vision for the modernization of Kazakhstan's identity and society as well as in his official strategic plan for the "Third Modernization of Kazakhstan", which involves creating a new model of economic growth that will ensure the country's global competitiveness to bring Kazakhstan within the top 30 most developed countries by 2050 (Nazarbayev, 2017).

In order to develop a Management Information System suitable for better supporting the data collection and analysis required for the understanding of Business Incubators effectiveness performance, it is necessary to start from a clear understanding of the system under exam and this also entails to have a clear and unambiguous definition.

Based on the analysis of the relevant literature and in order to be as general as possible, for the purpose of the research being undertaken, we have adopted the definition of *Business Incubation* as provided by the Diogenes Business Incubator (DBI) which is a high-technology business incubator resulting from the partnering of the National Business Incubator Association (NBIA), the United Kingdom Business Incubator Association (UKBI), Cyprus Business Incubator Association (CyBIA), and the Cyprus Chamber of Commerce and Industry (CCCI) and aiming to commercialize R&D results by creating business value.

DBI defines Business Incubation as ***"a unique and highly flexible combination of business development processes, infrastructure and people designed to nurture new and small businesses by helping them to survive and grow through the difficult and vulnerable early stages of development"*** (DBI, 2011).

The choice is motivated as follows:

- Business Incubators, Science Parks, accelerators etc. all deal with innovative (potentially high risk) novel ideas and business concepts.
- DBI embeds several of the main stakeholders involved in Business Incubators, Science Parks, accelerators etc.
- The provided definition implies a benefit for the economy as well as the would-be-entrepreneur as if the incubated company survives the start-up phase it will contribute to the economy and also realise the entrepreneur aspiration.

Based on the adopted definition - and being the Management Information System a crucial part of the infrastructure - the (Cabral and Dahab, 1992) Science Park Management Paradigm can be used to maximise the system effectiveness as already proven in the successful establishment, management and evaluation of science parks, as well as business incubators, around the world (Cabral and Dahab 1992; Cabral 2004). According to Cabral it is necessary to:

- Have access to qualified research and development personnel in the areas of knowledge in which the park has its identity.
- Be able to market its high valued products and services.
- Have the capability to provide marketing expertise and managerial skills to firms, particularly Small and Medium Size Enterprises, lacking such a resource.

- Be inserted in a society that allows for the protection of product or process secrets, via patents, security or any other means.
- Be able to select or reject which firms enter the park. The firm's business plan is expected to be coherent with the science park identity.
- Have a clear identity, quite often expressed symbolically, as the park's name choice, its logo or the management discourse.
- Have a management with established or recognised expertise in financial matters, and which has presented long term economic development plans.
- Have the backing of powerful, dynamic and stable economic actors, such as a funding agency, political institution or local university.
- Include in its management an active person of vision, with power of decision and with high and visible profile, who is perceived by relevant actors in society as embodying the interface between academia and industry, long-term plans and good management.
- Include a prominent percentage of consultancy firms, as well as technical service firms, including laboratories and quality control firms

(Cabral and Dahab, 1992)

These principles do no directly mention the IT-ICT aspect of the business incubation; however, IT-ICT pays a crucial - and constantly growing - role in expanding the economic opportunities and supporting the viability of businesses (Kramer, Jenkins and Katz, 2007). According to Forbes (Newman, 2016), ICT has become a driving force into all aspects of business. IT departments now have a role in customer service, sales, and even business strategies. Information Management Systems, Knowledge Management Systems, Content Management Systems and Decision Support Systems are becoming integral part of every company.
Therefore, ICT is even more relevant in the case of a business incubator that has to contemporaneously provide IT-ICT services & support to the incubated business as well as have an efficient and effective internal set of IT-ICT systems and services.

Methodology

The present research is interpretive in terms of philosophical approach as one of the primary aims is to better understand a phenomenon that has been established since the 1950s and yet is not fully understood in terms of effectiveness.
We have adopted and exploratory approach based on the fact that there is substantial disagreement on what makes a business incubator effective or how it is possible to measure and compare the characteristics of the offering of a specific Business Incubator with the one of another.
The number of definitions available (often with only subtle variances) and the number of business models used (even within context adopting the same definition), advocate for some clarifying contributions aiming at providing a better understanding of the relevant aspects of Business Incubators for enabling better measuring of their effectiveness and efficiency and thus contribute to (possibly) address the present lack of clarity in the evaluation of Business Incubator. In this respect we took inspiration from Lord Kelvin assertion *"to measure is to know" ... "If you cannot measure it, you cannot improve it"* (cited in Ryan et al., 2009, page 5).
The research operative approach has been inductive, starting from the collection and analysis of the various definitions presently available for business incubator and then progressively identifying the common minimum denominator. The second step has been similar but focused on the underpinning business model and how to identify the commonalities. We then looked for the best practices and guidelines available in respect of the establishment/management of business incubators and identified a reference model the Cabral-Dahab Science Park

Management Paradigm (Cabral, 1998a) that could be used to compare and assess the observed models of business incubators (directly or in literature).
In terms of research strategies we have been following a mixed approach with a number of interviews with 30 Business Incubators and Science Parks (some in presence, some via telecommunication means) as well a case study in Kazakhstan (Kokshetau State University - KGU) and one in Belarus (Belarusian State University of Informatics and Radioelectronics - BSUIR). We have also submitted two questionnaires to all the contacted entities (a preliminary short one and a full one later on). We also used secondary data inclusive of reports, guidelines, thesis etc. The questionnaire was elaborated based on literature and more specifically on the survey conducted by (Aerts et al., 2007), (Ratinho, 2011) and (Rogova, 2014). Additionally, we also used the INBIA IMPACT survey as a further reference as this is questionnaire used by INBIA on a yearly basis for the data collection from all its members (business incubators, accelerators, co-working space, science parks etc.). Thus, overall the research is qualitative in nature and in terms of time horizon it is cross sectional.

Results and Discussion

In the initial phase of the work we have been contacting business incubators and science parks in Kazakhstan, Belarus, Slovenia, Italy, Spain, and China. The initial contact has been focused on explaining the research and asking for availability to share data and provide time of senior manager for being interviewed. Once the agreement for cooperation has been secured, our next effort has been placed in collecting as much data as possible from the entity in terms of secondary data as well as primary data. Collected data has been catalogued, classified and archived for further reference and processing. In the very initial stage of data collection the following questions based on (Aerts et al., 2007) have been submitted to all entities we interacted with:

- Number of services offered?
- Nature of services offered?
- What infrastructure is available?
- Number of training offered?
- Nature of training offered?
- Duration of company stay?
- Do incubated companies pay any service or training?
- Number of companies incubated?
- Number of applications received?
- Number of applications accepted?
- Number of failed incubated company?
- Number of incubated companies graduated
- Number of incubated companies alive 5 years after the program end
- What metrics are collected?

Question 13 (about the survival rate after 5 years), was originally formulated given the consolidated establishment of business incubators and science parks in US, UK and Europe (as reflected also in the literature). However, we found that most of the business incubators established in the area are fairly new (in some cases they have not even yet had the first set of graduated residents), for this reason we had to revise the question so as to provide alternatives more suitable to collect data and avoid respondents skipping it.
The main questionnaire consists of several parts. The first part is related to the Incubator characteristics covering aspects such as name, date of opening, operating sector(s), and ownership, the second part is focusing on the services offered. A third part is centred on general indicators covering aspects such as number of employees, average annual turnover, average life-cycle of tenants, survival rate of incubated companies, length of the offered programme, requested equity/share, available resources, number of residents in a year, number of offered

consultancies, partnership, special facilities availability, cost for use and rate of use in a year. The next section is dealing with managerial aspects covering items such as staff, number of experts, consultants and managers, data collection, rules and procedures. There are also sections related to the Potential/actual resident (all held in a second file sent to the over 30 contacted incubators) focusing on the enterprise characteristics covering aspects such as name, date of establishment, operating sector, number of employees, nature of the enterprise and primary product. Then entrepreneurs' characteristics covering aspects such as number of partners, age, qualification, prior entrepreneurial experience, prior work experience, specific training, relation to the incubator covering aspects such as date of entry, perceived difficulty of the acceptance process, expected date of exit. We also ask information in relation to the start-up development and support covering aspects such as encountered problems and received support, enterprise growth (i.e. size at survey/interview time and in the 2 years before if applicable). The final part of the questionnaire is focusing on metrics with the twofold aim to assess the perceived value of the proposed metric set (based on the IMPACT Survey) and the intention/disposition for adoption of such metrics.

The quantitative data collection is still undergoing as the data collection is very slow and requires constant interaction to remind and elicit provision of the completed questionnaires. Aim of the quantitative analysis is mostly to verify the acceptance (and therefore likelihood of usage) the metrics defined on the basis of the IMPACT Index form InBIA in the CSI and ex USSR context. Additionally, the results will also provide an indication on the likelihood of adoption of the proposed Information Management System.

At the same time the design work has started exploiting the outcomes of the literature analysis and the preliminary results of the qualitative data collection based on the interviews and the reduced question set previously presented. The design is based on a fast prototyping approach using UML and automation tools that allow generating both database structure as well as code starting from the UML modelling. It is expected that the present model (described in the next section) will undergo several full revisions following the results of the quantitative data analysis and the experimentation in BSUIR and Italy.

Findings from the literature relevant to the planned development

We have analysed a number of official reports and studies related to Business Incubation, its implementation and the recommendation for a successful implementation. The most relevant emerging finding is a clear difference in the approach between former USSR (now CSI) countries (including Belarus and Kazakhstan) and the rest of the world (and in particular USA, UK and EU). In more detail, we could ascertain that NESTA and EU reports - as well as International Business Innovation Association (InBIA), National Business Incubation Association (NBIA) - all have similar approaches and definitions for describing business incubation, while the Government fund of funds Development institute of the Russian Federation provides a different classification and approach which is somehow amenable to the "planned economy" vision that is still very much present in the former USSR countries as apparent from President Nazarbayev strategy for Kazakhstan (see Nazarbayev, 2017). These findings are summarised in Table 1 hereafter highlighting the prominent characteristics that differentiate accelerator, incubator and techno-park in the CSI experience compared to the rest of the world. Here it is apparent that what is considered an accelerator in CSI is an Incubator elsewhere and vice versa although there are many common points (as one would expect). The discording aspects re embolden.

Table 1 - The main differences between accelerator, incubator and techno-park (the CSI experience versus the US/EU/UK one)

	Accelerator		Business Incubator		Techno-park	
	CSI	**US/EU/UK**	**CSI**	**US/EU/UK**	**CSI**	**US/EU/UK**
High selective criteria	+	+	+	+	+	+
Membership fee	+	-*	-*	+	+*	+*
Focus on service	-*	+	+	-*	-*	-*
Focus on space	+	-*	-*	+	+*	+*
Open ended duration	+	-	-	+	+	+
Fixed duration	-	+	+	-	-	-
Cohort based	-	+	+	-	-	-
Rolling admission	+	-	-	+	+	+
Share acquisition	-*	+	+	-*	-*	-*
Provision of investment	+	+	-	+	-	-
Access to bank loans, loan funds and guarantee programs	+	-	-	+	-	-
Access to angel investors or venture capital	+	+	-	+	-	-
Business consulting and mentoring	+	+	+	+	+	+
Advisory boards and mentors	+	+	+	+	+*	+*
Technical / technological consulting	-*	-*	-*	+	+	+
Technology commercialization assistance	+	-*	-*	+	+*	+*
Legal / patent advice	-*	+*	+*	+	+	+
Help with regulatory compliance	+	+*	+*	+	+	+
Intellectual property management	+	+*	+*	+*	+*	+*
Outsourcing of accounting functions	-*	+*	+*	+*	+*	+*
Help with accounting/financial management	+	+*	+*	+	+*	+*
Provision of equipped workplaces	+*	-	+	+*	+	+
High-speed Internet access	+	+*	-*	+	+*	+*
Rent of premises	-	+*	+*	-	+	+
Assistance in attracting partners / investors	+	+	+	+	+	+
Technology commercialization assistance	+	+	+	+	+*	+*
Access to angel investors or venture capital	+	+	+	+	+	+
Links to strategic partners	+	+	+	+	+	+
Networking activities	+	+	+	+	+*	+*
Links to higher education resources	+	+	+	+	-	+
Outsourcing of production functions	+	-	-	+	-	+*
Comprehensive business training programs	+	-*	-*	+	-	-
Marketing assistance	+	-*	-*	+	-	-
Market Research	+*	-*	-*	+	-	-
Management team identification	+	-	-	+	-	-
Help with business basics	+	-*	-*	+	-	-
Help with presentation skills	+	-*	-*	+	-	-
Help with business etiquette	+	-	-	+	-	-
High-tech	+*	+*	+*	+*	+	+
Triple Helix Model	-*	-*	-*	-*	+*	+*

* Exceptions possible

(based on Bone at al., 2017; RVC, 2017 and conducted interviews)

Findings from the initial round of interviews (30 entities)

Of all the entity contacted, the vast majority has been open to provide data (albeit with some restrictions and concerns about the funding and overall quantitative performance).

All have agreed on the relevance of collecting metrics, although a couple were saying they do not collect such information.

A clear distinction was emerging differentiating state own and privately own (or sponsored) entities. While the state own were open to provide data including success rate, survival rate and investment occurred, the private (or sponsored) ones were far less open to share openly data in this respect although the techno-parks did not exhibit such reluctance. Our understanding of this aspect is that when external investors are significantly present, there is a strong and clear pressure for disclosing success-related information and transparency on how funds have been used, while when the entity belongs to a private owner (University or company) there is more interest in keeping these data confidential or to ensure there is enough lack of transparency to allow for internal manoeuvring and adjusting.

In terms of Management Information System, the large majority of the entity contacted is not using a specialised system and some do not have one. All entities have access (and provide) IT/ICT services to their tenants, however, the vast majority do not have a devoted system (except for the Techno-park and the State BI which are fully independent entities). The majority simply share the IT/ICT system available in the hosting / parent university.

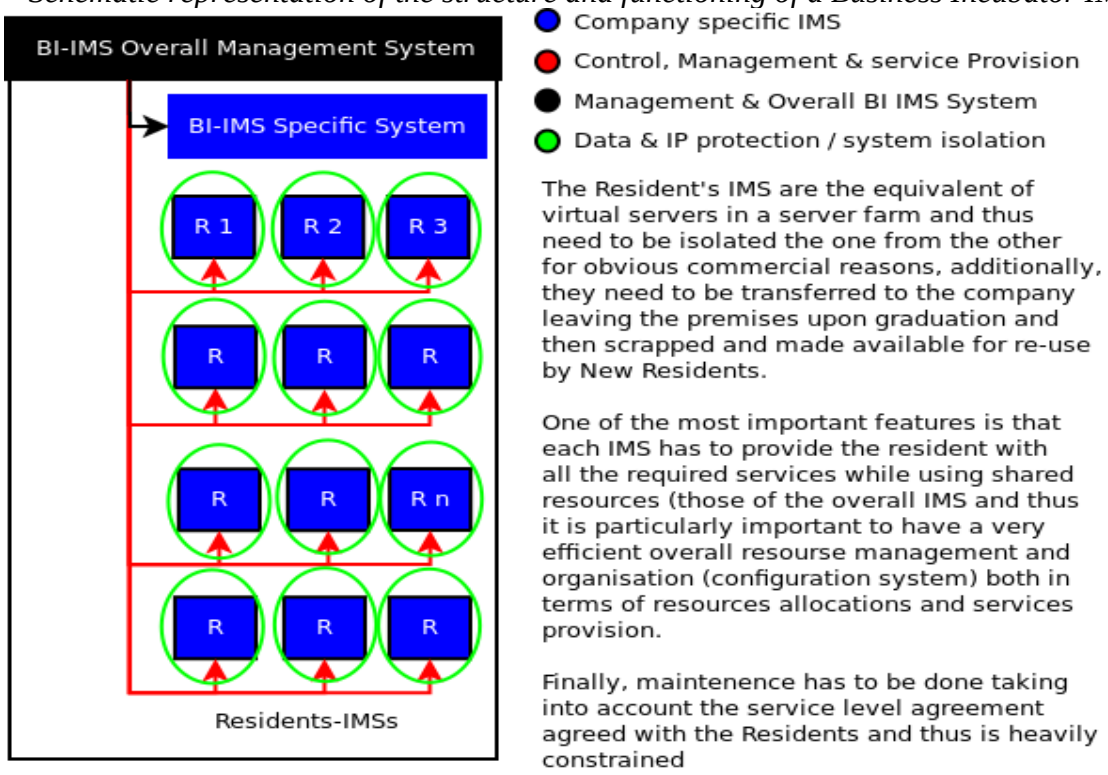
We expect to be able to provide better insight on these aspects once the quantitative data collection will have been completed.

Initial design of the proposed Information Management System

From the analysis of the literature and in particular of the Cabral-Dhab principles (Cabral and Dhab, 1992), the CIS guidelines for BI development (RVC, 2017) and the EU and UK reports on BI systems performances, as well as the IMPACT Survey has emerged that the quantity of data to be collected is significant (the IMPACT survey requires around 40 minutes to be completed).

Another important aspect that has emerged from the analysis of the literature and available reports and guidelines, is that the role and structure of the IT/ICT support is not adequately addressed. This confirms the findings of the qualitative investigation carried out with the contacted business incubators and science-/techno-parks. Overall, this is surprising as the very purpose of Business Incubation is to provide "a unique and highly flexible combination of business development processes, infrastructure and people designed to nurture new and small businesses by helping them to survive and grow through the difficult and vulnerable early stages of development" (DBI, 2011). In a business world where ICT is becoming dominant (Big Data, Artificial Intelligence, Machine Learning are all becoming part of business as usual activities, lack of attention to information management system seems a contradiction in terms.

Fig.2 - Schematic representation of the structure and functioning of a Business Incubator IMS



(Developed by the authors)

The mentioned approach to measuring effectiveness proposed by (Anckoff, 1999) and the structure of the IMPACT Index combined with the present approach to Information Management System design and Server Farms service provision approach, has led to the conception - and initial design - of a modular, flexible Information Management System (IMS) that could be easily adapted to the changes occurring in the organisation using it. Another key aspect accounted for in the design has been the fact that, by nature, business incubators, accelerators, science-/techno-parks are all dealing with innovation and such they have to handle a significant amount of intellectual property that is crucial for start-ups (Peña, 2002; Huges et al., 2007; Halt et al., 2017 pg185-196, 197-203, 229-234). From the analysis of literature (Logaiswari et al., 2017) - as well as our qualitative data - this aspect has not been sufficiently addressed when adopting the Information Management System.

In our approach the IMS of a Business Incubator can be described as a matrix of smaller IMSes with an overall Management System controlling and managing the overall resulting system. In Fig.2 is provided a schematic of the proposed structure and functioning. The crucial aspect of this kind of systems is two-fold: on the one hand it has to offer its services to the business incubator as a company (i.e. cover the accounting, human resources, etc.) and on the other hand has to provide IMS services to the resident companies. The level of services provided to the residents differs according to the BI business model (and therefore also the complexity of the system), therefore, we have considered the "ideal" case in which each resident is provided with a fully-fledged IMS. Additionally, we have considered that - being a business incubator main aim to foster innovation - the activities of each of the resident are innovative and as such very sensitive (i.e. require a proper level of security and confidentiality), therefore "logical-isolation" between the residents' IMS has been considered as a mandatory requirement. In other words we propose a virtualisation approach to the residents' IMS based on the standard practices adopted in server farm and virtualisation.

For the design we have opted for a simple approach that grants the possibility to easily revise and adapt and incorporate feedback coming from the experimental phase. We perform the

modelling of the IMS using UML followed by the automatic generation of the underpinning database (DB) structure using a UML-Based DB compiler exploiting existing tools. The justification of our approach lays in the fact that:

- a business incubator is substantially a "company" offering services to other companies all co-existing into the same physical/virtual environment
- confidentiality and IP protection are paramount in a context of innovation nurturing
- adaptation to tenants' needs is crucial to their successful development
- the possibility to easily export the tenant IMS from the BI to a commercial service upon graduation is a significant benefit
- the growing adoption of business incubators and the huge variety of reference models requires flexibility and adaptability
- transparency on offerings and effectiveness is crucial for a potential applicant to make an informed selection among the available offerings.

The foreseen model takes into account the definition of metrics for measuring the performance, the effectiveness, as well as the efficiency, of the Business Incubator Information Management System.

The first step has been the identification of a common minimum denominator across all BI/Science Park ICT supported service offerings, followed by building a catalogue (including training) and then to use it to define the architecture of business-incubation-oriented information management system. Furthermore, we have identified a set of metrics (and KPI) that could provide an objective set of criteria to measure and compare incubation/acceleration processes and support the choice of the best suited one for a specific applicant and reflected these into the design of the proposed information system architecture.

Conclusion

The present research has attempted to identify a widely adoptable definition of business incubator and used it as the basis for the analysis of BI performance effectiveness. We have analysed the different business models and guidelines for implementation along with Cabral-Dahab principles and thus identified the common minimum denominator across BI service offerings so as to define the required functions and service (including related metrics) and proposed the architecture of an effective, flexible, and modular information system business-incubation oriented that could best support the evolution of the business incubator as currently being noted in literature with a progressive shift towards acceleration programmes. Finally, we have identified a set of metrics (and KPI) that could provide an objective set of criteria to measure and compare incubation/acceleration processes and support the choice of the best suited one for a specific applicant.

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