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Proposal for a Set of Business Incubator Performance Metrics Based System and Model Analysis

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Abstract: Business incubators performance is usually examined in econometric terms rather than process functional operation, efficiency and effectiveness. The research being conducted focuses on the identification of a model describing BI operation, the points of need/provision of information as necessary to support decision-making for the management and monitoring of the system efficiency and effectiveness. One of the by-products of the conducted research has been the opportunity to suggest some metrics and Key Performance Indicators (KPI) specifically designed to measure process operation effectiveness and efficiency (including the impact of residents' failure before or after graduation). The defined metrics and KPI address mostly the internal operation and management of a Business Incubators with the aim to maximise efficiency and effectiveness of the process while catering for residents' needs.
Keywords: *Business Incubator, Operation Model, Operation Process, Metrics, Key Performance Indicators, Efficiency, Effectiveness, System Monitoring & Management.*

Introduction

Most of the work present in literature with respect to Business Incubation/Acceleration, focuses on the econometric aspects. Most authors consider Business incubators as ways of fostering innovation and as such develop the economy, however, despite over 50 years of operation, there is still some disagreement on what Business Incubators are as well as doubts on their real impacts.

Several definitions have been formulated and plenty different models developed as clearly evidenced by (Ryzhonkov, 2014). The overall residence period varies from few weeks to 2-3 years and data available mostly refers only to the success cases. The massive disparity reported by (Ryzhonkov, 2014) between Business Incubators' applicants (around 1000) and accepted residents (30-40 at most) is a clear testimony of the scarcity of resources available to support startups.

Such a strict selection should also assure a high success rate, however, according to the NBIA, only "*87 percent of the firms that have graduated from the incubators are still in business, which is pretty satisfying considering that 9 out of 10 startups usually fail*" ((NBIA, 2011) cited in (Tsaplin & Pozdeeva, 2017)). This in turn, points out the weaknesses and uncertainties of the system, its administrative complexity and the extremely high rate of failure.

While the administrative and acceptance rate issues could be possibly addressed by the introduction of Virtual Incubators, at least according to (Ryzhonkov, 2014), yet, it is still

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necessary to find a way to increase the overall efficiency and effectiveness of the process (Galiyeva &Fuschi, 2018).

Literature Review

The first known business incubator dates back to 1959 (Peters, 2017), while the first model has been proposed by (Campbell et al., 1985) and subsequently refined by Smilor (1987) who argued that incubators provide a transformation mechanism that assist entrepreneur in building a venture and focused on the relations among actors and their role in the process. Both models are interested in the business process. In 1988, Nijkamp proposed a combination of Campbell and Smilor models to which Smilor further contributed (Malecki & Nijkamp, 1988) where the focus is on the interaction among business incubation, entrepreneurs and community. This has been later revised by (Carter & Jones-Evans, 2000) and further by (Carayannis & Zedtwitz, 2005) providing the first conceptualization of the business incubation flow.

Based on the findings within the IT industry, (Nowak & Grantham, 2000) proposed the Virtual Incubation Model that focuses on *"best practices"*, industry and management experience, resources for international marketing, sales and distribution. Booz, Allen & Hamilton (2002) proposed a Corporate Incubator Model aimed at enhancing organization's capability to innovate. They explicitly described the process, its pros, and cons, as well as key success factors that could help corporations to boost innovations.

Lazarowich and Wojciechowski (2002) stress the need to examine *"best practices"* of setting up and operating business incubators to extract a blueprint for the establishment of a Business Incubator and the creation of a model suitable for local environment.

On the same lines of (Smilor, 1987), (Sahay, 2004) clearly described the role of Technology Business Incubator, Angel Investor and Venture Capital funding in industrial development and used a simple model to show the main building blocks of business incubator while (Hackett & Dilts, 2004b) state that the performance of business incubation depends on the incubator's ability to create options through which the selection of weak-but-promising firms occurs and can be computed as:

$$\boldsymbol{BIP = f\,(SP + M\&BAI + RM)} \qquad \text{(Hackett \& Dilts, 2004b)}$$

where ***BIP*** stands for Business Incubation Performance, ***SP*** for Selection Performance, ***M&BAI*** for Monitoring & Business Assistance Intensity, and finally ***RM*** for Resource Munificence.

This formulation suggests some interesting metrics to be used but is still strongly connected with an Econometric approach (Hackett & Dilts, 2004a, b).

It is worth pointing out that (Bergek & Norrman, 2008) reject the principle of a black box incubation model centred merely on results. They insist on the relevance of the selection process as one of the most important aspects which needs to be aligned with the business incubator's characteristics and goals.

A different approach has been adopted by (Chandra & Chao, 2011) focusing on the flow of the resources between the key stakeholders in the innovation ecosystem that is Government, Universities, business incubators and would-be-entrepreneurs. Gassmann & Becker (2006), differentiate non-/for-profit incubators on the one hand and, on the other, focus on the mission, structure, process and resources needed, and how the Universities can learn from the Corporate's approach.

In all these studies, the model focus has been either in terms of process or actors or the interaction among these rather than on metrics and indicators to measure the effectiveness and efficiency of the process. Overall, the economic impact has been prevalent in the analysis.

In 2000 the UN published a very complete and detailed *"Technology Business Incubator Manual"* intended to guide planners, educators, sponsors and management teams in exploring and establishing a successful program (Lalkaka, 2000). While in 2002 the European Commission Center for Strategy & Evaluation Services published a benchmarking study including a general model of incubation which – according to (Ryzhonkov, 2014) – is based on previous work done by Costa-David, Malan, and Lalkaka for NBIA. However, the benchmarking is based on econometric aspects and not on process performance metrics or indicators. A pragmatic approach has been adopted by the World Bank Group in their program to promote entrepreneurship and innovation (InfoDev), that was developed and published, in the period 2010-2016 in terms of guidelines and training targeted at those who are creating business incubators (InfoDev, 2010).

According to Ewan Jones, there is an *"incubation chain"* characterised by entry policies, an incubation program (divided in early stage – about 2 years – classic incubation – about 2-3 years – to be followed by a graduate programme lasting ~ 1 year) as well as graduation policies and procedures (Friesi, 2011). Furthermore, the incubation program should be *"tailored service focused on client need"* and all these steps are interconnected (Friesi, 2011). However, its extensive duration (~5-6 years) significantly limits the number of potential attendees. The aspect of incubator capacity is further stressed by (Ryzhonkov, 2014) who estimates that for every 1000 annual requests for access to the incubators, only 20 to 40 annual projects of some success are generated. At the same time (Relan, 2012) argues that 90% of incubators and accelerators may/will fail, as in many cases the BI itself is a start-up. This leads back to the paramount relevance of carefully selected residents as well as cast doubts on the real effectiveness of Business Incubators as per (Tavoletti, 2013). An interesting approach that combines Econometric with Organisational, Scientific and other factors is available in (Olkiewicz, et al. 2019). Overall, is clear the need to focus on the process, its efficiency and effectiveness rather than on the amount of funding start-ups have managed to acquire which appears to be widely the practice.

Methodology

The research adopted an integrative review approach (Jones-Devitt, Austen, Parkin, 2017) to identify what has been done in terms of business incubator performance and best-practices. The integrative review undertaken has brought together and integrated the knowledge produced on business and management performance measurement for Business Incubator with the aim to support a data-driven decision making process thanks of metrics, indicators and KPIs. There are 126 journal resources listed in Scopus that fall under the 3 subject areas related to Business and Management, that is:

- Business & International Management,
- Business, Management & Accounting (Miscellaneous),
- General Business, Management & Accounting.

If we consider only the *Open Access*, the count is reduced to 70. If we focus only on *"Business & International Management"* and having Open Access, the available articles accessible are very few, thus was necessary to further identify reputable sources using Google Scholars. As inclusion criteria we considered articles, papers, reports, studies, and sources that were fully accessible and fully matched the search criteria. As exclusion criteria we considered articles, papers, reports, studies, and sources that could not be fully accessed or were too dated or did not fully matching the search criteria.

The search fields used were restricted to *"Title", "Abstract", and "Keywords"* only. Additionally, officially published documents by INBIA, and NESTA plus regulations, international and national documents, guidelines, manuals and reports officially published by EU, UN, World Bank, and CSI official sources were also searched and used.

Given the nature and focus of the research on the performance of the business incubation process rather than its economic achievements an inductive approach in the context of an Interpretivist research philosophy was perceived as the best approach that would best serve compensate for the strong resistance to provide information on certain aspects such as resident failures. It is also believed that this resistance originates from the desire to avoid a thorough scrutiny of performances as pointed out also by (Tavoletti, 2013). Archival research has been used to supplement literature exploiting several reports and case studies, a direct involvement in and observation of a few Business Incubators, some semi structured interviews and a small survey.

Table 1 - Systematic results of the literature and sources search

Search term(s)	Identified		Selected	Used
	GS [2]	S [3]		
"Business Incubator performance"	243	9	16	4
"Business Incubator" AND efficiency	5 [4]	38	14	4
"Business Incubator" AND effectiveness	36 [5]	64	16	4
"Business Incubator" AND metrics	2 [6]	5	11	4
"Business Incubator" AND "Key Performance Indicator"	127	2	16	5
"Business Incubator" AND "systematic review" OR "literature survey"	408	7	13	4
"Business Incubator model" AND "systematic review" OR "literature survey"	52	0	10	4
"Business Incubation model" AND "systematic review" OR "literature survey"	48	1	4	1
			100	**30**

Analysis of the process

The process analysed covers all aspects of the BI programme execution to measure, appraise and improve its outputs (i.e. graduated companies), maximise their chance of survival and, therefore, have a positive impact on the economy and the overall socio-economic context.

As the incubation process is aimed to supporting companies in their early stages and subsequent evolution, understanding the process that leads to the creation and evolution of a company is essential. Based on observation and analysis of the literature, such process can be schematically summarised in the following stages:

1) Conception [A],
2) Proof-of-concept [B],
3) Prototype development [C],
4) Minimum-Viable-Product (MVP) [D],
5) Operation launch [E].

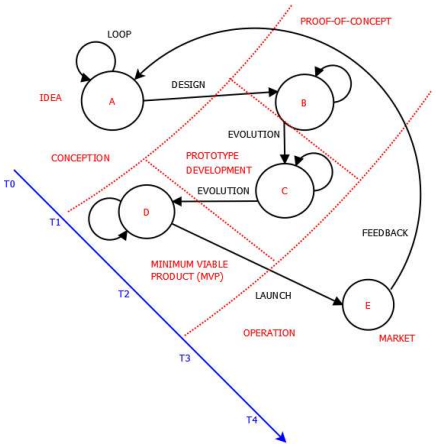


Figure 1: From Idea to Market as state machine
(Source: Authors)

The first four stages A-D (Conception, Proof-of-concept, Prototype development, and MVP) exhibit auto-loops as the process can remain in the stage while things refine and only when mature enough transit to the next stage. This is an important aspect as per (Relan, 2012) observation that not all ideas will have traction.

The experience gained in every step can be fed back and spark new ideas and improvements which can be injected in the project and its outputs (including new products). This approach, however, points out the complexity of the system and it is worth recalling that increased complexity can create dangerous vulnerabilities (Bonabeau, 2007).

[2] Google Scholar
[3] Scopus
[4] The search has been repeated using *"Business Incubator efficiency"* to reduce results from the 13100 originally identified
[5] The search has been repeated using *"Business Incubator effectiveness"* to reduce results from the 15400 originally identified
[6] The search has been repeated using *"Business Incubator metrics"* to reduce results from the 2910 originally identified

When looking at the process from the point of view of the BI and its resident; things evolve from the initial conceptual phase up to the start of the operation in the market. It is possible to note that ideation occurs before Incubation (pre-Incubation phase), and the quality and viability (along with the perceived/proposed) profitability will be the main selling point of the applicant at the time of application, although some applicants approach BI when they have already developed some proof of concept, which highly increases their application success chances.
Once incubation (or acceleration starts) the idea is progressively developed up to the point it becomes a minimum viable product (MVP). This is the stage where additional capital is usually sought after via crowdfunding, Venture Capital (VC) or Business Angels (BA) thus facilitating the exit from the incubator/accelerator and the pay-out of the equities agreed at the beginning of the process. The MVP will undergo further testing (usually with early adopters) leading to the market-launch, which often marks the start of the company independent operation. Often, at this point in time the ties with the BI cease.
Our research focus is on the process before market entry to support the decision and strategy making processes thanks to a thorough understanding and measuring of the process and its efficiency and effectiveness assimilating each incubated company to a project, from the management perspective, as also advocated by (Voisey, et al., 2006).
The process per se is important, but even more so the actors, actions and objects involved in it. While resources are crucial to the implementation of any project, people and ideas are fundamental, without ideas and skilled people nothing will happen or at least results will not be as good as they could be (Haelg et al, 2020), (Likhi & Sushil, 2005). In **Error! Reference source not found.** are highlighted the key actors involved in the BI process, their main actions and the main objects used. In terms of main actors, we have substantially two categories:

1) The people managing the BI - *"Manager"* - provide and control the functioning of the system.
2) The users of the system - *"Residents"* - are the main actors of the incubated projects.

The objects used in this context are:

a) Services,
b) Resources,
c) Courses
d) Mentors.

The Mentors can be considered a special kind of resource available to BI resident, in most cases to support and facilitate the residents' development helping them grow and develop, being in control of the process rather than passive actors (St-Jean et al. 2017). Training plays a crucial role in the BI process (Cabral, 1998a).

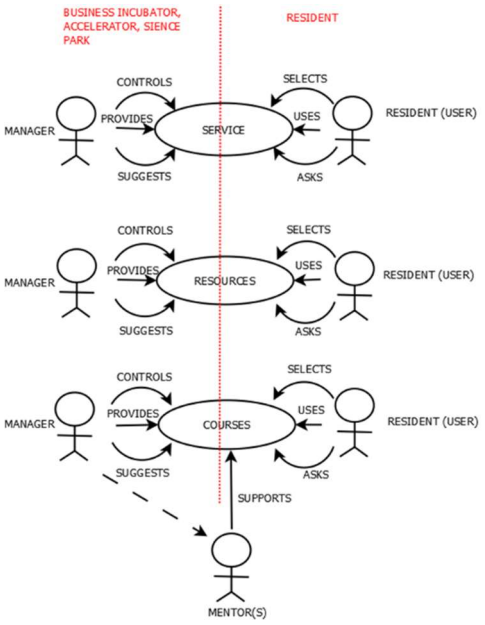


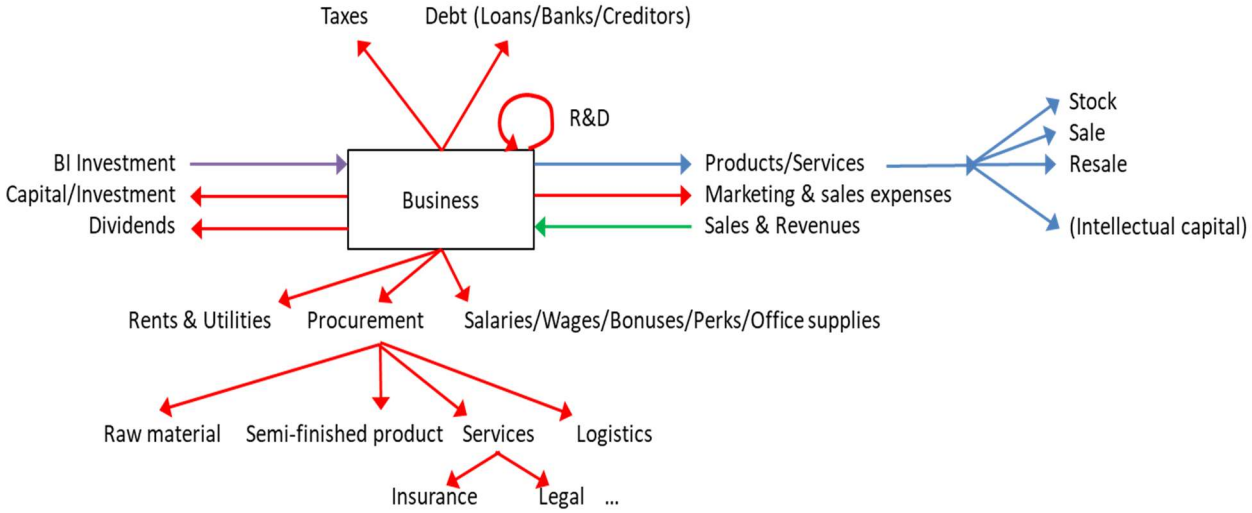
Figure 2: Main Actors, Actions and Objects involved in the BI program (MAAO) (Source: Authors)

R&D as well as Innovation create intellectual capital (Kim and Kumar, 2009) and most start-ups focus-on/create innovation. Training and services are often crucial but can also be seen as nice complements to the availability of working space and facilities and greatly de-risk the initial difficult phases of company launch (Marimuthu & Lakha, 2015).
Often companies trying to expand or exploit their innovation apply for acceleration programs, however, it has been noted that projects are *"how businesses achieve/introduce change in what is their business-as-usual operation"* (AXELOS, 2017). As per Prosci ADKAR Change Model

(Rohmah & Subriadi, 2020), change implies training which ultimately justifies entering a training programme and approach the whole as a project.
Project management methods have been applied to the set up and launch of start-ups (Dean, 1986), (Kiznyte et al. 2016) and BIs work in batches or cohorts, thus it is possible to argue that each Resident is equivalent to an R&D project in a portfolio or program where intellectual capital is created. Therefore, the research equates the start-ups being incubated to a project as they are the BI product.
This offers the possibility to use Earned Value Management (EVM) as the elective tool to monitor performances of the Resident and – ultimately – of the BI and practically compute (Hackett & Dilts, 2004b) BI Performance.
As EVM compares planned versus actual costs as well as planned versus actual value generated, it is necessary to describe the entire system in terms of monetary inputs/outputs including the external factors that affect the system overall.
Consequently, it was possible to apply several simplifications to reduce the number of assumption necessary in the modelling. The various fluxes of income and expenses of a generic business were considered.
The specific support/shelter role played by the BI was also considered as a BI substantially shelters residents from some of the issues they would encounter if they were to directly address the market. BIs can provide seed-funding or investors to the Residents. This is equivalent to capital injection and offers Residents' and unparalleled advantage compared with non-residents.
In line with this approach, to describe the functioning of the system, be it the BI or a Resident, it is necessary to identify all the Inputs/Outputs along with the other factors conditioning the operation. Overall, if the balance is positive then it is possible to have profit that could then be re-invested, distributed or both.
The need for considering the actors and the objects involved in the process stems from the need to measure the project performance that depends on the actors' actions within the process, the object they use and produce. Businesses depend on their own resources to create products or services, the access to the market in order to sell its products, the market's mood and expectations to define what products or services are required or could be well received by the market and thus create a source of income (Watson & Hogarth-Scott, 1998).
The success of a business depends not only on the product/services it generates and delivers, and their quality, but also, and principally, on the quality of its ownership/management decision-making process (Ireland & Miller, 2004).
Timely, quality, efficient and effective decision making, based on facts and data, ensures the possibility to cater for customers/suppliers/partners' needs, take advantage of opportunities and mitigate/avoid issues by adequately managing risk, which is the only certain thing in business like in project management.
Feedback coming (directly/indirectly) from the implementation and evaluation of decision taken is crucial to the quality of the decision-making process as well described in the PDCA cycle. If decisions are not evaluated, their impact may create unwanted consequences (Ireland & Miller, 2004).
The national culture and personal attitude will have a significant influence just like the political, socio-economic, technological, market and environmental context (Rodrigues et al., 2014; Robinson et al. 1991). Time also plays a crucial role in the decision-making process along with the availability of the right data (Ahituv et al. 1998; Green et al. 2007). Therefore, data gathering (via metrics) and processing (to extract indicators, indexes and KPI) is crucial to an efficient and effective decision-making process (Serrador and Turner, 2014). Collecting too much data is a waste of resources; collecting the wrong data will lead to wrong decisions.

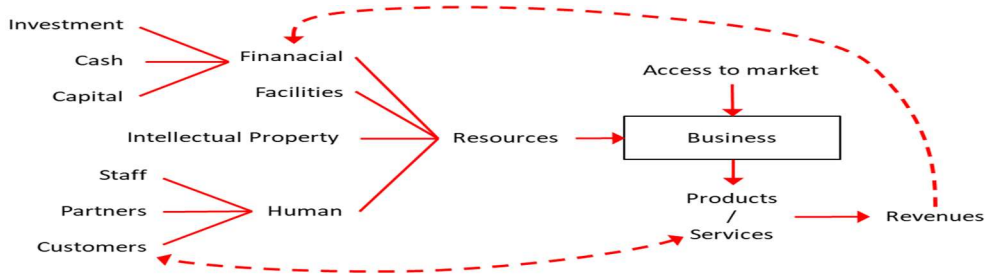
In the context of Business Incubation and/or Acceleration, the process describing the evolution of an idea into a business is interacting (as already mentioned) at some point with the process of Business Incubation and/or Acceleration which undergoes an initial phase similar to the one of any other business (conception, viability check, resourcing, etc.) but then operates on a cyclic base and in batches until circumstances (or significant changes in the operating context) either require a change in the process or lead to ceasing operation.

Figure 3: The fluxes of assets and cash/finances connected to a business as modelled by the authors



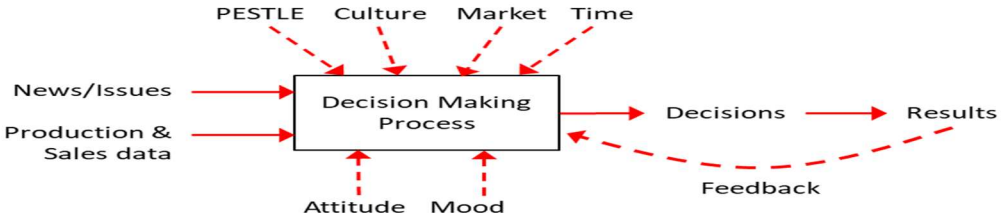
(Source: Authors)

Figure 4: Relation between resources available and generated by a business as modelled by the authors



(Source: Authors)

Figure 5: Inputs, outputs and parameters influencing the decision-making process in a business



(Source: Authors)

The fact that the two systems interact in the abovementioned approach draws a parallel with the education system which once established operates with a specified program (which may be periodically updated according to the needs, circumstances and context), in batches (intake cohorts) and successfully graduates those that have successfully completed the program and met the established graduation criteria. This greatly facilitates the analysis of the system as it allows to compare norms and practices of one with those of the other offering the unique possibility to improve both.

In the education context many theories have been developed in time to explain and support at best the learning process and experience while considering both the need for an efficient and effective knowledge transfer and the needs of all parties involved (teachers, trainers and students). Similarly, in Business Incubation and/or Acceleration several models have been developed looking at their structure or process. The analysis and approach of Hackett & Dilts (2004b) help to understand the essence of the operation of a typical business incubator. In their model, incubation is seen as a mechanism for new venture creation and resource allocation. Additionally, incubation creates an environment and perception of reduced risk and security within a confined physical space and establishes a direct and deep connection between incubator and resident. Finally, incubation facilitate creating a *"network behaviour- a system of increasing client firms' network density"* where Residents are admitted based on a strict selection following a predictable and controllable process (Hackett & Dilts, 2004b).

All models reported in literature give relevance to the transformation process occurring during incubation, however, not all of them present enough focus on the education/personal development of the resident. In our approach education/training, alongside mentoring and coaching, represent a crucial part in the process – if it has to be successful and with long term lasting effects – on the personal/professional growing of the residents.

Metrics

A key output of the research carried out is a functional model of the incubation process from the point of view of process performance (Fuschi & Galiyeva, 2022). The model has helped in identifying the relevant information to be collected via an adequate set of metrics. The analysis of the *"ten principles of Cabral"* (Cabral, 1998a, b), the best practices and guidelines provided in the UK (NESTA, 2014; BEIS, 2018; Clarysse et al, 2015; Dee et al, 2015; Miller & Stacey, 2014; Dee et al, 2011; Miller & Bound, 2010), EU (Anca, 2017; Avnimelech et al, 2007; Frenkel et al, 2008), the USA (InBIA, 2016) and Russia (RVC, 2017), exposed the complexity of the system and guided in the definition of several sets of metrics to measure respectively:

1) efficiency and effectiveness of the resources (infrastructure) available-for and provided-to the residents.
2) efficiency and effectiveness of the support and training provided to the resident.
3) overall effectiveness of the program in terms of selecting the right candidates and equipping them with all that is needed to face the market and survive beyond the initial stage.
4) survival rate of graduated companies and their economic impact.

Our empirical findings are based on the in-depth case studies of 15 Incubator/Accelerator, 25 semi-structured interviews with managers of Incubator/Accelerator in Europe, Belarus, Kazakhstan and Egypt, two EU-funded incubators' benchmarking surveys, four guidelines for business incubator development, several reports on business incubators best practices and interviews with the heads of technology transfer offices of two top technology universities in Kazakhstan and one in Belarus.

From the interview and the collected data, it is apparent that after graduation from the incubation/acceleration program, the businesses will evolve autonomously. Although this process is dependent on the training received, decisions are taken and objectives are set by the

business management, this will determine the overall business outcomes, however, if the founders have been adequately supported and trained, the probability of success will increase. For this very reason we will not focus on the econometric analysis of graduated companies' performances but rather on the other set of measures that are much more focused to the inner processes of the business incubator/science park and that need to be adequately supported by an Information Management System (IMS). One of the main outputs of our research is the suggestion of an IMS architecture specifically tailored to cater for the needs of a Business Incubator.

There are different kinds of metrics that the ideal IMS allows to collect. Each set has a specific purpose; some refer to the operation and allow measuring the performances, other refer to the nature and allow planning and adjusting the strategy. Some other, refer to the residents and finally some can be used both for the strategy and the promotion/expansion of the operation, or its revision. Most of the metrics, if used retrospectively, should allow planning operation, understand trends, potential risks, and inform decision making for both the incubator/accelerator/science-parks, as well as the applicants (the latter only if the data is publicly accessible). In the following we present the various metrics grouped according to their main function.

The proposed set of metrics could be collected to allow the management exploit valuable data for the analysis, strategy definition and decision making. It provides also a simple and effective opportunity to compare business incubators characteristics thus facilitating benchmarking exercises and inform applicant choice.

In appendix, each metric is briefly explained and justified, most are based on the definition of the nature of a business incubator considering all aspects reported in the various definition available. The metrics on duration and survival of the incubated companies are substantially based on the description of the phases required for the development of small companies (Lewis at al 1983; Mel et al 1987), and (Daepp et al 2015) analysis of company mortality.

There are different categories of metrics that have been considered, some are providing the demographic of the institution and can be used for planning (**Error! Reference source not found.**), other are related to the program and contribute to the assessment of the performances (**Error! Reference source not found.**), other are related to the residents (**Error! Reference source not found.**). The latter are further divided into those providing the demographic of the cohort (**Error! Reference source not found.**) and those related to the drop-out/graduation/survival of the residents and fundamental for understanding the effectiveness of the system (**Error! Reference source not found.**). Some of the metrics are very basic but are needed to compute KPI and stir the overall strategic and operative planning of the system. Among the various metrics related to the residents, those referring to the failure, during or after the program, are particularly important in the analysis of the effectiveness as well as in the evaluation of performances of the system and will significantly influence the output of periodic or exceptional process performance assessment potentially leading to its redesign or adjustment.

In terms of metrics that provide a better understanding of the Incubator/Accelerator structure and capacity, the number of sectors/market covered by the Incubator/Accelerator should be used in the resources and recruitment planning as it will help better understand the needs in terms of infrastructure, services, trainings and, overall, resources needed as well as the potential number of applicants to be acquired per cohort and how they should be split. The higher the number of sectors covered, the broader the scope and therefore the need for resources and variety of mentors and investors.

The number of years in operation sets the analysis perspective as if lower the program duration performance results cannot be generalized or compared with those of others, while if higher it allows retrospective performance analysis and benchmarking.

The program duration is designed at the very beginning and is an integral part of the program itself, it needs to be long enough to provide the required skills/knowledge as well as not too long. Additionally, the programme depends on the adopted business model and is a major differentiator among incubators, accelerators, co-working spaces and science/technology parks.

The number of services/facilities/trainings offered forms part of the cost/effectiveness analysis once combined with the cost information and usage information. The lower this is, the less targeted and supportive is the portfolio offered, therefore a strategy and program revision is required. The number of services/facilities/trainings offered for free should be used in the resource planning and budgeting efforts in combination with the analysis of the number of services/training and facilities use by the previous residents. If resources are not sufficiently used their cost is not justified and thus either they should be reduced/revised, or the cost is to be partially/totally passed on to the resident.

Similarly, the number of services/facilities/trainings offered at a fee should be used in the resource planning and budgeting efforts. If the financial resources are not sufficient to cover the needs of the residents or if they are not affordable, their costs and provision needs revision and so, possibly, their cost.

Other important aspects to consider are the standard size of the space provided to a resident as available office, the overall size of the space available for shared use by residents, the overall size of the space allocated to the management of the system inclusive of offices and service-related space (server room…).

The overall dimension of the space available to the system to provide services, facilities and working space to residents are quantities partially fixed in the initial design of the system and should be used in the planning of the system layout and structure. These parameters are also needed to assess the potential requirements for expansion based on the percentage of usage and the ratio of usage of communal space by residents

The overall percentage of occupation time of communal resources in general and in the period is also very important in terms of operation management and planning as communal resources are shared and their usage is subject to booking. The ratio of booking to the availability/use during the period is an important indicator. If shared resources are not available due to use by other residents, certain activities may be hampered and therefore when the index is >80% it is necessary to plan for reorganization/expansion of the communal resources.

Coming to the metrics concerning the Residents, it is important to note that the focus is on providing insights into the operation of the Incubator/Accelerator as emerging from the management of its Residents.

The cumulative count of companies incubated since inception/reformulation of the program, is a sign of the system success, in particular when analysing its trend over time. The count of companies enrolled in the current cohort allows extracting and comparing trends to assess program and overall system success; it also helps understanding of the overall capacity of operation and (to some extent) its focus (quantity or quality) as large incubators can be less focused on the individual resident and therefore less effective. Large cohorts present a similar problem and, in both cases, when resident numbers are large access to certain resources may be more constrained

The number of total application received accounts for the popularity of the system and associated program, especially if rapidly/exponentially growing.

The total per cohort provides an indication of how the program is evolving and can be an early indicator of problems in case of sudden reduction, either with the overall operation context or the program, it helps understanding the popularity of the system, its program and is a component of the system reputation.

The number of total applications accepted accounts for the seriousness of the system and associated program, while the total per cohort provides an indication of how selective and stringent the selection process is. Combined with the info on the success rate provides also an indication on the validity of the selection criteria.
The number of failed incubated companies, in total and per cohort, is a potential indicator of underlying issues in the program or resident selection, but it needs to be considered in combination with other metrics to ascertain if the origin of the failures. The number of failures per cohort should be stable across cohorts, if decreases is positive but if increases it highlights issues in recruitment or execution. The total number of failures should be limited and exhibit an almost flat trend, a pronounced or steep increase is a signal of issues either in the recruitment, the program or the management of the entity but could also be seen as an indication of the difficulty/quality of the program
The number of graduated companies provides a measure of how efficient the conversion of application to actual established companies is, however, it cannot be considered in isolation as only the survival rate in time is clear evidence of incubation success. Usually, it is provided as a measure of the success of a program, however, it is not a sufficient indicator unless the failure indexes are also known.
The number of incubated companies active 3/6 months after graduation helps detecting the presence of potential issues either in the program or the selection of the candidates as the premature death of companies that were successfully incubated is not part of the expectations. The trend of these metrics is particularly important to understand the effectiveness of the program especially when considering (Daepp et al, 2015) analysis of company mortality. It is worth pointing out that this, usually, is a kind of information not publicly provided. However, knowing how many incubated companies are still active shortly after graduating is potentially less relevant than knowing how many failed in the same period as this is a clear warning of the presence of potentially serious issues either in the program or the selection of the candidates.
Similarly, although less relevant, are the same info but related to a period of 1/2/5 years. They clearly help understanding the effectiveness of the program. If the first year is passed successfully, this means the company has potential and the entrepreneur resilience as usually the first year is the most difficult and often closes with losses due to investments. On average, healthy companies should be profitable after 3 years (Davidson, 2019) and therefore still active, if they reach the 5 years mark, this should provide a clear indication of program overall success.
The number of ceased/failed companies within a period of 1/2/5 years from graduation is potentially more significant to evaluate the effectiveness of the program, as according to (CB Insights. 2021), *"70% of upstart tech companies fail — usually around 20 months after first raising financing (with around $1.3M in total funding closed)"*.
The Graduated Companies Active provides an overall indication of the effectiveness of the program as the main purpose of the program itself is to prepare the incubated companies to face the market and succeed in surviving the difficulties of the early stages and is an indicator of the overall success of the program.

Indicators extracted

As for the metrics, the formulation and all details are reported in **Error! Reference source not found.**.
In terms of services, to estimate the Service Cost Index will be useful in estimating the impact of expanding/reducing the facilities available to the residents, while the Service Cost Variance allows understanding how accurate will be a cost estimate for expanding available facilities based on the average facility cost and the Service Adoption Index, provides un understanding of the level of use of available resources, when above 80% should trigger an analysis of opportunities/needs for expansion. The Service Cost Index provides an indication of the level

of resources potentially wasted by providing services that are not used by the resident and should never exceed 5% of the service cost budget.
Similarly, to estimate the Facility Cost Index will be useful in estimating the impact of expanding/reducing the facilities available to the residents, while the Facility Cost Variance allows understanding how accurate will be a cost estimate for expanding available facilities based on the average facility cost. The Facility Use Index provides an understanding of the level of use of available resources, when above 80% should trigger an analysis of opportunities/needs for expansion, while the Facility Cost Index provides an indication of the level of resources potentially wasted by providing facilities that are not used by the resident and should never exceed 5% of the service cost budget.
To estimate the Average Training Cost will be useful in understanding the impact of expanding/reducing the training offering available to the residents, while the Training Cost Variance allows understanding how accurate will be a cost estimate for expanding available training offerings based on the average training cost. The Training Use Index provides an understanding of the level of use of available training, when below 80% should trigger an analysis of opportunities/needs for revision of the program as resources are potentially wasted, while the Training Cost Index provides an indication of the level of resources potentially wasted by providing trainings that are not used by the resident and should never exceed 5% of the training cost budget
The ratio among free and paid services, training and facilities is particularly important in the planning and dimensioning of the system as the more *"free resources"* are provided, the higher is the management cost. At the same time, the less the resident will feel stimulated to make good use of the available resources as they are provided for free. It is important to strike a balance in terms of the cost passed to the resident as this must be kept affordable if the system wants to really facilitate the successful development of the residents.
Finally, the Overall Space Saturation Index should be computed as the percent ratio between the sum of all spaces used by residents for work plus the communal and administration to the overall space available is particularly important to assess the growth capacity of the system.
A too low or too high value of the Acceptance indicates a problem in the residents' recruitment process. If the recruitment process is working well, the acceptance ration should remain stable. Sharp or significant variations need to be understood and the related root-cause identified. This is, however, a cumulative value; the Cohort Acceptance Ratio provides an understanding of the overall socio-economic, education and innovation context. Small variations may be related to the quality of applicant in the specific time, while large variations could be a symptom of problems in the operation context or the recruitment process
The Cohort Companies Failure Index provides an indication of how successful the current cohort has been, and when mapped in time allows comparing the cohorts. The Companies Failure Index provides an indication of how successful the program has been, if it increases in time, it is likely to have a problem in recruiting or execution of the program as otherwise it should decrease or stay stable depending on the difficulty of the program itself. The Companies Failure Index provides an indication of how successful the designed system has been so far and should (ideally) stabilize asymptotically until major changes to the system are applied. If the Incremental Companies Failure Index is lover than 1 it means that the cohort failure rate is decreasing (or in other words, the success rate in incubation is increasing). If it is greater than 1 it points out a problem with the cohort or the system that need attention and investigation
The Cohort Companies Graduation Index provides an indication of how successful the current cohort has been, when mapped in time allows comparing the cohorts; a decrease points to a problem in recruiting or execution of the program as otherwise it should increase or stay stable depending on the difficulty of the program itself. The Companies Graduation Index provides an indication of how successful the designed system has been so far and should (ideally)

stabilize asymptotically until major changes to the system are applied. If the Incremental Companies Graduation Index is lover than 1 it means that the cohort success rate is decreasing (or in other words, the failure rate in incubation is increasing). If it is greater than 1 it shows a clear positive outcome for the program.

The Graduated Companies Survival Rate and Mortality Rate indexes (at 1, 3, or 5 years) and the Global Mortality Rate, are major indicators of the program success as the main objective of incubation is to facilitate the safe crossing of the chasm existing at the beginning of a business launch and, overall, allow the thriving of the applicant. The mortality rate especially is important to be assessed as the earlier incubated companies fail the more likely is that there are issues in the program and its execution.

The closer to zero (0%) is the Global Mortality Rate, the better as it means that the graduated companies manage to overcome the difficulties of the passage from a protected environment to the market. If it increases is crucial to understand the causes and the maturity level of the companies that have ceased operation as the younger they are (in terms of time from graduation) the more it is likely there is a problem in the incubation/acceleration process.

Conclusions

The conducted research has allowed formulating a functional model of the incubation process and subsequently deriving a set of metrics that can be used to monitor the efficient and effective functioning of the system. The metrics and indicators have been formulated considering the data collected via literature, studies, and direct observation along with the theoretical recommendation coming from the ten principles of Cabral, the best practices reported in literature and the outcomes of the interviews conducted with a dozen of institutions.

This area is rapidly evolving, see the appearance of the *"Virtual Business Incubators and Accelerators"* as well as with the growing adoption of business incubation/acceleration in the low/middle-income counties such as Kazakhstan, Belarus, and Egypt. Countries such as China have completed in 2017 an analysis of the outcomes from business incubators, while INBIA conducts a yearly assessment of the performances of the incubation/acceleration practices to inform their members and help them adapt their strategies to the constantly changing operation environment. NESTA has conducted several studies on this phenomenon and overall, there is a continuous production of new data. This implies that there is a need for a constant update and monitoring of the domain to look for new developments/approaches that should be included in the model and (potentially) reflected in the metrics & indicators. However, the presented metrics are also of general value and independent from external changes thus ensuring the possibility to extract meaningful information to support the decision process.

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Appendix 1 – Metrics & Key Performance Indicators

Table 2: Incubator/Accelerator demographic data metrics

Metric	Symbol	Description and use	BI perspective	Resident perspective
# sector covered	**MV_c**	The number of sectors (Market verticals) covered. It should be used in conjunction with other metrics for strategic decisions during program and performance evaluations	Should be used in the resources and recruitment planning as it will help better understand the needs in terms of infrastructure, services, trainings and, overall, resources needed as well as the potential number of applicants to be acquired per cohort (and how they should be split). The higher the number of sectors covered, the broader the scope and therefore the need for resources and variety of mentors and investors.	Provides an understanding of the aim of the incubator and weather it is a vertical or a horizontal one and facilitates the comparison between incubators The higher the number, the broader the scope and therefore the less specific the program and (potentially) also the support available
# years in operation	**Y_o**	The number of years in operation. It should be used in conjunction with the program duration to assess the knowledge that can be extracted by other metrics and indicators	It sets the analysis perspective: - if < the program duration performance results cannot be generalized or compared with other - if > allows retrospective performance analysis and benchmarking	The longer the period, the higher the confidence in the validity of the program
Program Duration	**PD**	It varies quite substantially and one of the main characteristics differentiating programs and systems	The program duration is designed at the very beginning and is an integral part of the program itself, it needs to be long enough to provide the required skills/knowledge as well as not too long. It depends also on the adopted business model and is a major differentiator among incubators, accelerators, co-working spaces and science/technology parks	A short but very intense program is very different from a long and diluted program; however, the comparison should be done more in terms of the content and its distribution in time than on the duration itself
# services offered	**S_o**	The number of services offered to the Resident is an indicator of the level of support provided to the residents	It forms part of the cost/effectiveness analysis once combined with the services-cost information and services usage information.	Understanding of how much operation support will be available
# services used	**S_u**	The number of services used by the residents is an indication of the appreciation/usefulness as well as part of the cost analysis	The lower, the less targeted and supportive the portfolio of offered services, therefore a strategy and program revision is required	Not relevant unless some needs are not covered
# facilities offered	**F_o**	The number of facilities offered to the Resident is an indicator of the level of support provided to the residents	It forms part of the cost/effectiveness analysis once combined with the facilities-cost information and facilities usage information.	Understanding of how much structural support will be available
# facilities used	**F_u**	The number of facilities used by the residents is an indication of the appreciation/usefulness as well as part of the cost analysis	The lower, the less targeted and supportive the portfolio of offered facilities, therefore a strategy and program revision is required	Not relevant unless some needs are not covered
# training offered	**T_o**	The number of training offered to the Resident is an indicator of the level of support provided to the residents	It forms part of the cost/effectiveness analysis once combined with the trainings-cost information and trainings usage information.	Understanding of how much training support will be available
# training used	**T_u**	The number of training used by the residents is an indication of the appreciation/usefulness as well as part of the cost analysis	The lower, the less targeted and supportive the portfolio of offered training, therefore a strategy and program revision is required	Understanding of how much training support will be available
# free services/training /facilities offered	**FSO FTO FFO**	Simply the count of the services, training and facilities respectively offered to the residents for free	It should be used in the resource planning and budgeting efforts in combination with the analysis of the number of services/training and facilities use by the previous residents. If resources are not sufficiently used their cost is not justified and thus either they are reduced/revised or the cost is partially/totally passed on to the resident.	The higher the number of services/training /facilities offered, the more supportive the program should be. In any case this information needs to be combined with the ones related to the nature of the services, training and facilities provided

Metric	Symbol	Description and use	BI perspective	Resident perspective
# of paid services/training /facilities offered	**PSO** **PTO** **PFO**	Simply the count of the services, training and facilities respectively offered to the residents in exchange for a fee	It should be used in the resource planning and budgeting efforts in combination with the analysis of the number of services/training and facilities use by the previous residents. If the financial resources are not sufficient to cover the needs of the residents or if they are not affordable, their costs and provision needs revision and so (possibly) their cost.	Supports in the selection of the program as it allows comparing the offerings of incubators, yet should be secondary to the metric providing info on the success ratio of the incubator
# free services/training /facilities used	**FSU** **FTU** **FFU**	Simply the count of the services, training and facilities respectively used by the residents for free	It should be used in the resource planning and budgeting efforts in combination with the analysis of the number of services/training and facilities use by the previous residents. If resources are not sufficiently used their cost is not justified and thus either they are reduced/revised or the cost is partially/totally passed on to the resident.	The higher the number of services/training /facilities offered, the more supportive the program should be. In any case this information needs to be combined with the ones related to the nature of the services, training and facilities provided
# of paid services/training /facilities used	**PSU** **PTU** **PFU**	Simply the count of the services, training and facilities respectively used by the residents in exchange for a fee	It should be used in the resource planning and budgeting efforts in combination with the analysis of the number of services/training and facilities use by the previous residents. If the financial resources are not sufficient to cover the needs of the residents or if they are not affordable, their costs and provision needs revision and so (possibly) their cost.	Supports in the selection of the program as it allows comparing the offerings of incubators, yet should be secondary to the metric providing info on the success ratio of the incubator
Dimension of space available (per resident)	**ASD**	The standard size of the space provided to a resident as available office (this does not include the communal, shared facilities)	These metrics are partially fixed in the initial design of the system and should be used in the planning of the system layout and structure. Additionally, they are also needed to assess the potential requirements for expansion based on the percentage of usage and the ratio of usage of communal space by residents	Provides an understanding of the quality of provided infrastructure
Dimension of communal space	**CSD**	The overall size of the space available for shared use by residents		Provides an understanding of the quality of provided infrastructure
Administration specific Space	**ASP**	The overall size of the space allocated to the management of the system inclusive of offices and service-related space (server room…)		Provides an understanding of the quality of provided infrastructure
Overall dimension of available space	**OASD**	The overall dimension of the space available to the system to provide services, facilities and working space to residents		Provides an understanding of the quality of provided infrastructure
Communal space use ratio	**CSUR%**	The overall percentage of occupation time of communal resources in general and in the period	As communal resources are shared, their usage is subject to booking. The ratio of booking to the available availability/use during the period is an important indicator of usage and availability. If shared resources are not available due to use by other residents, certain activities may be hampered and therefore when the index is >80% it is necessary to plan for reorganization/expansion of the communal resources.	Usually not provided to applicants

Table 3: Incubator/Accelerator demographic data KPI

KPI	Formulation	Description and use	BI perspective	Resident perspective
Average Service Cost	$SC_{av} = \frac{\sum_{j=1}^{S_o} SC_j}{S_o}$	Computed as the standard average of the cost of all services available to the residents	To estimate the Service Cost Index will be useful in estimating the impact of increasing/reducing the services available to the residents	Not relevant
Service Cost Variance	$SC_{\sigma} = \sqrt{\frac{\sum_{j=1}^{S_o}(SC_j - SC_{av})^2}{S_o}}$	Computed as the standard variance of the services costs	Allows understanding how accurate will be a cost estimate for expanding available services based on the average service cost	Not relevant
Service Adoption Index	$SAI = \frac{S_u}{S_o}$ %	Is computed as the ratio between used and available services and expressed as percentage	Provides an understanding of the level of use of available resources, when above 80% should trigger an analysis of opportunities/needs for expansion	Not relevant unless some needs are not covered
Service Cost Index	$SCI = SC_{av}\frac{S_u}{S_o}$	Is computed as the product between the average service cost and the Service Use Index	Provides an indication of the level of resources potentially wasted by providing services that are not used by the resident and should never exceed 5% of the service cost budget	Not relevant unless some needs are not covered
Average Facility Cost	$FC_{av} = \frac{\sum_{j=1}^{F_o} FC_j}{F_o}$	Computed as the standard average of the cost of all facilities available to the residents	To estimate the Facility Cost Index and will be useful in estimating the impact of expanding/reducing the facilities available to the residents	Not relevant
Facility Cost Variance	$FC_{\sigma} = \sqrt{\frac{\sum_{j=1}^{F_o}(FC_j - FC_{av})^2}{F_o}}$	Computed as the standard variance of the facilities costs	Allows understanding how accurate will be a cost estimate for expanding available facilities based on the average facility cost	Not relevant
Facility Use Index	$FUI = \frac{F_u}{F_o}$ %	Is computed as the ratio between used and available facilities and expressed as percentage	Provides an understanding of the level of use of available resources, when above 80% should trigger an analysis of opportunities/needs for expansion	Not relevant unless some needs are not covered
Facility Cost Index	$FCI = FC_{av}\frac{F_u}{F_o}$	Is computed as the product between the average facility cost and the Facility Use Index	Provides an indication of the level of resources potentially wasted by providing facilities that are not used by the resident and should never exceed 5% of the service cost budget	Not relevant unless some needs are not covered
Average Training Cost	$TC_{av} = \frac{\sum_{j=1}^{T_o} TC_j}{T_o}$	Computed as the standard average of the cost of all trainings available to the residents	To estimate the Average Training Cost will be useful in estimating the impact of increasing/reducing the training offering available to the residents	Not relevant
Training Cost Variance	$TC_{\sigma} = \sqrt{\frac{\sum_{j=1}^{T_o}(TC_j - TC_{av})^2}{T_o}}$	Computed as the standard variance of the trainings costs	Allows understanding how accurate will be a cost estimate for expanding available training offerings based on the average training cost	Not relevant

KPI	Formulation	Description and use	BI perspective	Resident perspective
Training Use Index	$\mathbf{TUI} = (\mathbf{T}_u / \mathbf{T}_o)\ \%$	Is computed as the ratio between used and available training and expressed as percentage	Provides an understanding of the level of use of available training, when below 80% should trigger an analysis of opportunities/needs for revision of the program as resources are potentially wasted	Not relevant unless some needs are not covered
Training Cost Index	$\mathbf{TCI} = \mathbf{TC}_{av} (\mathbf{T}_u / \mathbf{T}_o)$	Is computed as the product between the average service cost and the Training Use Index	Provides an indication of the level of resources potentially wasted by providing trainings that are not used by the resident and should never exceed 5% of the training cost budget	Not relevant unless some needs are not covered
Free to Paid services / training / facilities offered Ratio	$\boldsymbol{F2PR} = \frac{\sum \boldsymbol{FxO}}{\sum \boldsymbol{PxO}}\ \%$ $\forall\, \boldsymbol{x} \in \{\boldsymbol{S}, \boldsymbol{T}, \boldsymbol{F}\}$ $\boldsymbol{F2PS} = \frac{\boldsymbol{FSO}}{\boldsymbol{PSO}}\ \%$ $\boldsymbol{F2PT} = \frac{\boldsymbol{FTO}}{\boldsymbol{PTO}}\ \%$ $\boldsymbol{F2PF} = \frac{\boldsymbol{FFO}}{\boldsymbol{PFO}}\ \%$	Computed as the percent ration of Free to Paid services / training / facilities offered respectively	Is particularly important in the planning and dimensioning of the system as the more "free resources" are provided, the higher is the management cost. At the same time, the less the resident will feel stimulated to make good use of the available resources as they are provided for free. Finally, it is important to strike a balance in terms of the cost passed to the resident as this has to be kept affordable if the system wants to really facilitate the successful development of the residents.	The more the free services the more the BI is acting as source of funding, the more the paid services, the more the incubator is trying to push the participant to understand and face the challenges of the market albeit in a controlled and safe environment where usually coaching and consultancy are offered
Overall Space Saturation Index	$\boldsymbol{OSSI} = \frac{\left(\sum_{j=1}^{m} \boldsymbol{ASD}_j\right) + \boldsymbol{CSD} + \boldsymbol{ASP}}{\boldsymbol{OASD}}\ \%$	Computed as the percent ratio between the sum of all spaces used by residents for work plus the communal and administration to the overall space available is particularly important to assess the growth capacity of the system	Used to understand the level of saturation of the available working space, when above 80% should trigger an analysis of opportunities/needs for expansion.	Usually not provided to applicants

Table 4: Incubator/Accelerator Applicant-related data

Metric	Symbol	Description and use	BI *perspective*	Resident perspective
# companies incubated	**IC$_T$** **IC$_C$**	This is a basic metric is divided in two parts, one cumulative and one as a snapshot on the quantity of incubated companies (alumni / ex-resident) and current residents. The subscript ***T*** stands for ***Total*** and ***C*** stands for ***Cohort***.	The count of the companies incubated since inception (or reformulation of the program) as a cumulative value, its trend connected with other metrics is crucial in the assessment of the system success The count of companies enrolled in the current cohort (although being a snapshot) it allows comparing with the previous (and the total) as well as to extract trends useful to assess program and overall system success	Understanding of the overall capacity of operation and (to some extent) its focus (quantity or quality). Large incubators can be less focused on the individual resident and therefore less effective. Large cohorts present a similar problem and, in both cases, (when resident numbers are large) access to certain resources may be more constrained
# applications received	**AR$_T$** **AR$_C$**	This is a basic metric is divided in two parts, one cumulative and one as a snapshot of the application received and examined	The number of total application received accounts for the popularity of the system and associated program (especially if rapidly / exponentially growing). The total per cohort provides an indication of how the program is evolving and can be an early indicator of problems in case of sudden reduction (either with the overall operation context or the program etc.)	It helps understanding the popularity of the system, its program and is a component of the system reputation
# applications accepted	**AA$_T$** **AA$_C$**	This is a basic metric is divided in two parts, one cumulative and one as a snapshot of the application accepted	The number of total applications accepted accounts for the seriousness of the system and associated program. The total per cohort provides an indication of how selective and stringent the selection process is. Combined with the info on the success rate provides also an indication on the validity of the selection criteria	Understand how strict the rules for application acceptance are
# failed incubated companies	**ICF$_T$** **ICF$_C$**	**ICF$_T$** The total number of companies that failed in the incubation process since the opening of the Incubator / Accelerator **ICF$_C$** The number of companies failed in the current cohort	A potential indicator of underlying issues in the program or resident selection It needs to be considered in combination with other metrics to ascertain if the origin of the failures The number of failures per cohort should be fairly stable across cohorts, if decreases is positive but if increases it highlights issues in recruitment or execution The total number of failures should be limited and exhibit an almost flat trend a pronounced or steep increase is a signal of issues either in the recruitment, the program or the management of the entity.	If available, could be an indication of the difficulty/quality of the program
# incubated companies graduated	**ICG$_T$** **ICG$_C$**	**ICG$_T$** The total number of companies that graduated in the incubation process since the opening of the Incubator / Accelerator **ICG$_C$** The number of companies graduated in the current cohort.	Provides a measure of how efficient the conversion of application to actual established companies is, however, it cannot be considered in isolation as only the survival rate in time is clear evidence of incubation success	Usually provided as a measure of the success of a program, it is not a sufficient indicator unless the failure indexes are also known

Metric	Symbol	Description and use	BI *perspective*	Resident perspective
# incubated companies active 3 / 6 months after graduation	**GC_{3m}** **GC_{6m}**	The number of companies graduated still in business after respectively 3/6 months from graduation (it could be difficult to collect as the connection with the graduated companies are less frequent, however, this is part of the Alumni management)	Helps detecting the presence of potential issues either in the program or the selection of the candidates as the premature death of companies that were successfully incubated is not part of the expectations. The trend of these metrics is particularly important to understand the effectiveness of the program. (*)	Usually not provided to applicants
# incubated companies failed 3 / 6 months after graduation	**FC_{3m}** **FC_{6m}**	The number of companies graduated failed after respectively 3/6 months from graduation (it could be difficult to collect as the connection with the graduated companies are less frequent, however, this is part of the Alumni management)	Helps detecting the presence of potential issues either in the program or the selection of the candidates as the premature death of companies that were successfully incubated is not part of the expectations. The trend of these metrics is particularly important to understand the effectiveness of the program. (*)	Usually not provided to applicants
# incubated companies active 1 / 3 / 5 year after graduation	**GC_{1y}** **GC_{3y}** **GC_{5y}**	The number of companies graduated still in business after respectively 1/3/5 years from graduation (it could be difficult to collect as the connection with the graduated companies are less frequent, however, this is part of the Alumni management)	Helps understanding the effectiveness of the program. If the first year is passed successfully, this means the company has potential and the entrepreneur resilience as usually the first year is the most difficult and often closes with losses due to the investments. Healthy companies should be profitable after 3 years and therefore still active, if they reach the 5 years mark, this should provide a clear indication of program overall success. (*)	Usually not provided to applicants
# incubated companies failed 1 / 3 / 5 year after graduation	**FC_{1y}** **FC_{3y}** **FC_{5y}**	The number of companies graduated failed after respectively 1/3/5 years from graduation (it could be difficult to collect as the connection with the graduated companies are less frequent, however, this is part of the Alumni management)	Helps understanding the effectiveness of the program. If the first year is passed successfully, this means the company has potential and the entrepreneur resilience as usually the first year is the most difficult and often closes with losses due to the investments. Healthy companies should be profitable after 3 years and therefore still active, if they reach the 5 years mark, this should provide a clear indication of program overall success. (*)	Usually not provided to applicants
# Graduated Companies Active	**GCA**	The total number of graduated companies that are active at the time of measurement	Provides an overall indication of the effectiveness of the program as the main purpose of the program itself is to prepare the incubated companies to face the market and succeed in surviving the difficulties of the early stages.	Is an indicator of the overall success of the program

(*) Company's survival metrics have been defined taking into account (Daepp et al 2015) analysis of company mortality.

Table 5: Incubator/Accelerator Applicant-related KPI

KPI	Formulation	Description and use	BI perspective	Resident perspective
Acceptance Ratio	$ACC_T = \frac{AA_T}{AR_T}$ %	Computed as the percent ratio between total accepted application and total received applications	A too low or too high value indicates a problem in the residents' recruitment process. If the recruitment process is working well, the acceptance ration should remain more or less stable. Sharp or significant variations need to be understood and the related root-cause identified	Understand how strict the rules for application acceptance are
Cohort Acceptance Ratio	$ACC_C = \frac{AA_C}{AR_C}$ %	Computed as the percent ratio between accepted application and received applications for a specific cohort	It provides an understanding of the overall socio-economic, education and innovation context. It needs to be assessed in combination with the overall and historical acceptance ratio. Small variations may be related to the quality of applicant in the specific time, while large variations could be a symptom of problems in the operation context or the recruitment process	Understand how strict the rules for application acceptance are
Cohort Companies Failure Index	$CCFI = \frac{ICF_C}{IC_C}$ %	It is computed as the percent ratio between the number of companies failed in the current cohort and the total number of companies admitted to the cohort	Provides an indication of how successful the current cohort has been, when mapped in time allows comparing the cohorts An increase points to a problem in recruiting or execution of the program as otherwise it should decrease or stay stable depending on the difficulty of the program itself	If available, could be indication of the success of the program
Companies Failure Index	$CFI = \frac{ICF_T}{IC_T}$ %	It is computed as the percent ratio between the number of companies failed and the total number of companies admitted	Provides an indication of how successful the designed system has been so far and should (ideally) stabilize asymptotically until major changes to the system are applied	If available, could be indication of the success of the program
Incremental Companies Failure Index	$ICFI = \frac{CCFI}{CFI}$ %	It is computed as the percent ratio between the Cohort Companies Failure Index and the Companies Failure Index	If it is lower than 1 it means that the cohort failure rate is decreasing (or in other words the success rate in incubation is increasing). If it is greater than 1 it points out a problem with the cohort or the system that need attention and investigation	If available, could be indication of the success of the program
Cohort Companies Graduation Index	$CCGI = \frac{ICG_C}{IC_C}$ %	It is computed as the percent ratio between the number of companies graduated in the current cohort and the total number of companies admitted to the cohort	Provides an indication of how successful the current cohort has been, when mapped in time allows comparing the cohorts A decrease points to a problem in recruiting or execution of the program as otherwise it should increase or stay stable depending on the difficulty of the program itself	If available, could be indication of the success of the program
Companies Graduation Index	$CGI = \frac{ICG_T}{IC_T}$ %	It is computed as the percent ratio between the number of companies graduated and the total number of companies admitted	Provides an indication of how successful the designed system has been so far and should (ideally) stabilize asymptotically until major changes to the system are applied	If available, could be indication of the success of the program

KPI	Formulation	Description and use	BI perspective	Resident perspective
Incremental Companies Graduation Index	$ICGI = \frac{CCGI}{CGI}$ %	It is computed as the percent ratio between the Cohort Companies Graduation Index and the Companies Graduation Index	If it is lower than 1 it means that the cohort success rate is decreasing (or in other words the failure rate in incubation is increasing). If it is greater than 1 it shows a clear positive outcome for the program	If available, could be indication of the success of the program
Graduated Companies Survival Rate	$GCSR = \frac{GCA}{IC_T}$ %	Computed as the percent ratio between the number of graduated companies still active and the total number of graduated companies	These are major indicators of the program success as the main objective of incubation is to facilitate the safe crossing of the chasm existing at the beginning of a business launch and, overall, allow the thriving of the applicant. The survival rate especially is important to be assessed as the more companies survive the better is the program and its execution.	Usually not provided to applicants
Mortality Rate	$MR_n = \frac{FC_n}{(CG_n + FC_n)}$ % $\forall n \in \{Y1, Y3, Y5\}$	Computed as the percent ratio between the number of failed companies and the total of graduated companies (active and failed) in the period examined, that is 1, 3, or 5 years (represented with Y1, Y3, or, Y5 respectively)	These are major indicators of the program success as the main objective of incubation is to facilitate the safe crossing of the chasm existing at the beginning of a business launch and, overall, allow the thriving of the applicant. The mortality rate especially is important to be assessed as the earlier incubated companies fail the more likely is that there are issues in the program and its execution. (*)	Usually not provided to applicants
Global Mortality Rate	$GMR = (1 - GCSR)$ %	Computed on the basis of the global companies' survival rate (is an internal indicator for potential issues)	The closer to zero (0%) the better as it means that the graduated companies manage to overcome the difficulties of the passage from a protected environment to the market. If it increases is crucial to understand the causes and the maturity level of the companies that have ceased operation as the younger they are (in terms of time from graduation) the more it is likely there is a problem in the incubation/acceleration process. (*)	Usually not provided to applicants

(*) Company's survival metrics have been defined taking into account (Daepp et al 2015)