Project Completion Report

TECHNOLOGY BUSINESS INCUBATORS IN INDIA: AN EXPLORATORY STUDY ON THEIR CONTRIBUTION TO NATIONAL R&D EFFORTS

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DST PROJECT NO. F. No. DST/NSTMIS/05/194/2016-17

Study Sponsored by

National Science and Technology Management Information System (NSTMIS)

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Disclaimer:

Every care has been taken to provide the authenticated information. However, the onus of authenticity of data rests with the PI of the project.

CONTENTS

List of contents	Page No.
Table of contents	**i**
List of Tables	**iv**
List of Figures	**vi**
List of Acronyms	**vii**
Preface	**viii**
Acknowledgement	**ix**
Executive Summary	**xi**
Chapter 1: Introduction	
1.1 Backdrop	1
1.2 TBIs: Concepts, Characteristics and Importance	3
1.3 Origin and Growth of TBI Movement	8
1.4 TBIs in India: Origin and Current Status	10
1.5 Current Policy for TBI Promotion in India	11
1.6 Research Objectives, Scope and Methodology	16
1.7 Structure of the Report	18
Chapter 2: Typology, Objectives, Function, Processes and Achievements of Technology Business Incubators: A Literature Review	
2.1 Introduction	20
2.2 TBIs: Types and Classifications	21
2.3 TBIs: Goals and Objectives	24
2.4 TBIs: Functions and Services	27
2.5 TBI led Process of Business Incubation	32
2.6 TBIs: Performance Assessment in terms of Outcomes and Achievements	36
Chapter 3: Objectives, Scope and Methodology	

3.1 Introduction 42

3.2 Research Objectives 43

3.3 Scope, Sampling and Data Collection 43

3.4 Methods of Data Analysis 51

Chapter 4: Technology Business Incubation: Typology, Sponsors, Objectives and Facilities

4.1 Introduction 74

4.2 TBIs: Age, Management, Sponsor & Focus Area 74

4.3 TBIs: Objectives, Facilities and Staff Strength 83

4.4 TBIs: Physical Space, Number of Seats & Promotion 90

4.5 Distinguishing Features of Institute promoted TBIs Vs. Industry promoted TBIs 93

4.6 Distinguishing Features of Early Stage TBIs Vs. Stage Agnostic TBIs and Tech Sector focused TBIs Vs. Sector Agnostic TBIs 94

4.7 Summary 95

Chapter 5: Technology Business Incubation: Selection, Incubation and Graduation

5.1 Introduction 97

5.2 TBIs: Applications from Prospective Start-Up Founders (2016/17) and Its Determinants 97

5.3 TBIs: Selection Process of Prospective Incubatees and Occupancy of incubating Ventures 101

5.4 TBIs: Support extended to the Incubatees during the Incubation Process 104

5.5 TBIs: Criteria for Graduation and Determinants of Graduation 108

5.6 Summary 111

Chapter 6: Technology Business Incubators: An Assessment of R&D Contributions

6.1 Introduction 114

6.2 TBIs: R&D Input Contribution 115

6.3 TBIs: R&D Output Contribution 119

6.4 TBIs: Determinants of R&D Contributions 126

6.5 Summary 127

Chapter 7: The R&D Contributions of Start-ups to National R&D efforts: Role of the TBIs and other determinants

7.1 Introduction 130

7.2 TBI based Start-Ups: Characteristics 131

7.3 TBI based Start-Ups: Extent of R&D Contributions 139

7.4 TBI based Start-Ups: Determinants of their R&D Contributions 147

7.5 Summary 148

Chapter 8: Summary and Conclusions

8.1 Backdrop 151

8.2 TBIs: Key Research Gaps derived out of Literature Survey 153

8.3 An Empirical Assessment of TBI Performance: Method of Investigation and Results 156

8.3.1 Method of Research 156

8.3.2 Empirical Analysis Results 158

8.3.3 Key Observations and Findings 163

8.4 Inferences and Policy Recommendations 167

8.5 Major Contributions 170

8.6 Limitations and Scope for Future Work 171

References 173

Appendices 182

List of Tables

No	Title	Page No.
Table 1.1	Incubators: Varieties and Sponsors	4
Table 2.1	Typology of Technology Business Incubators (TBIs)	25
Table 2.2	Goals and Objectives of TBIs	28
Table 2.3	Functions and Services of TBIs	32
Table 2.4	TBI led Incubation Process	35
Table 2.5	TBI Performance Assessment: Outcomes and Achievements	40
Table 3.1	Distribution of Technology/Business Incubators in India: State-wise	44
Table 3.2	Generated Database of TBIs, Accelerators & Co-working spaces	46
Table 3.3	Summary Statistics of the Centralized Database curated for the project	47
Table 3.4	Summary Statistics of the number of Respondents to II Phase Data Collection	48
Table 3.5	TBIs, Accelerators & Co-working spaces: Bangalore, Chennai & Hyderabad	50
Table 3.6	Data Collection Status from Start-ups: Graduated & Under Incubation	50
Table 4.1	TBIs: Typology and Age	75
Table 4.2	TBIs: Sponsors and Locations by Typology	76
Table 4.3	TBIs: Educational Qualifications of CEO	77
Table 4.4	TBIs: Prior Industry/Start-Up experiences of CEO	77
Table 4.5	TBIs: Sector Focus by Typology	79
Table 4.6	TBIs: Stage Focus by Typology	81
Table 4.7	TBIs: Objectives by Typology	83
Table 4.8	TBIs: Infrastructure and Support Offered to Incubatees	86
Table 4.9	TBIs: Staff, In-house Experts & External Networks	89
Table 4.10	TBIs: Physical Space and Number of Seats for Incubation	90
Table 4.11	TBIs: Forms of Promotional Activities	92
Table 5.1	TBIs: Number of Applications Received (2016/17)	98
Table 5.2	TBIs: Applications to Seats (2016/17) Ratio	99
Table 5.3	TBIs: Key Selection Criteria	102
Table 5.4	TBIs: Number of Occupants (2016/17)	103
Table 5.5	TBIs: Occupancy Ratio (2016/17)	104

Table 5.6	TBIs: Provision of Mentoring Services	105
Table 5.7	TBIs: Offer of Financial Support	106
Table 5.8	TBIs: Market Enablement Activities	107
Table 5.9	TBIs: Criteria for Graduation and Exit	108
Table 5.10	TBIs: Cumulative Graduation of Start-Ups (as of 2016/17)	109
Table 5.11	TBIs: Graduation of Start-Ups per Year	110
Table 5.12	TBIs: Cumulative Graduation to Cumulative Admission Ratio	111
Table 6.1	TBIs: Cumulative R&D Investment Expenditure (as of 2016/17)	116
Table 6.2	TBIs: Average and Total - Cumulative R&D Expenditure (as of 2016/17)	116
Table 6.3	TBIs: R&D Personnel (as of 2016/17)	118
Table 6.4	TBIs: Total R&D Personnel Employed (as of 2016/17)	119
Table 6.5	TBIs: New Products/Services generated through Incubated Start-Ups	120
Table 6.6	TBIs: Total & Average Number of New Products/Services (as of 2016/17)	121
Table 6.7	TBIs: Patent Applications Submitted (as of 2016/17)	122
Table 6.8	TBIs: Number of Patent Applications Submitted (as of 2016/17)	123
Table 6.9	TBIs: Classification in terms of Ranges of Revenue Generation (as of 2016/17)	124
Table 6.10	TBIs: Sales Revenue through New Products/Services (as of 2016/17)	126
Table 7.1	Distribution of Start-Ups: Graduated and Incubating	131
Table 7.2	Age of Start-Ups	132
Table 7.3	Nature of Incorporation of Start-Ups	133
Table 7.4	Size of the Founding Team of Start-Ups	134
Table 7.5	Educational Qualification of Start-Up CEOs	135
Table 7.6	Work Experience of Start-Up CEOs	136
Table 7.7	Age Profile of Start-Up CEOs	137
Table 7.8	Duration of Incubation undergone in the TBIs	138
Table 7.9	Start-Ups in terms of Range of Current Value of R&D Investments (2016/17)	139
Table 7.10	Current Value of R&D Investments by Start-Ups for 2016/17 (Rs. Lakh)	140
Table 7.11	Start-Ups in terms of Range of R&D Personnel employed (2016/17)	141
Table 7.12	Actual R&D Personnel employed by the Start-Ups (2016/17)	142

Table 7.13	Start-Ups in terms of Range of New Products/Services (during 2016/17)	143
Table 7.14	Actual # of new product offerings created by the Start-Ups	143
Table 7.15	Distribution of Start-Ups that have filed Applications for Patents	145
Table 7.16	Start-Ups in terms of Ranges of Revenue Generated in 2016/17	146
Table 7.17	Actual Revenue Generated by the Start-Ups (Rs. Lakh) in 2016/17	146

List of Figures

No	Title	Page No.
Figure 3.1	Research Process undertaken for the Study	42
Figure 3.2	Locations of Cities selected for the Study	45

List of Acronyms used in the Report

Serial #	Acronym	Expansion of the Acronym
1.	ABC	Accelerators, Business Incubators and Co-working spaces
2.	ALEAP	Association of Lady Entrepreneurs of India
3.	CEO	Chief Executive Officer
4.	CFI	Centre For Innovation
5.	CHORD	Centre for Human Organization Resource Development
6.	DST	Department of Science and Technology
7.	GSU	Graduated Start-up Units
8.	IIITH	Indian Institute of Information Technology, Hyderabad
9.	IIT	Indian Institute of Technology
10.	IKP	ICICI Knowledge Park
11.	IOT	Internet of Things
12.	IP	Intellectual Property
13.	ISBA	Indian Science and Technology Entrepreneurs Parks and Business Incubator Association
14.	ISU	Incubating Start-up Units
15.	LLP	Limited Liability Partnership
16.	LPAC	Local Project Advisory Committee
17.	MNC	Multi-National Company
18.	MVP	Minimum Viable Product
19.	NCL	National Chemical Laboratory
20.	NCR	National Capital Region
21.	NIRMAN	Pre-Incubation Cell of IIT Madras
22.	NIS	National Innovation System
23.	NSTEDB	National Science and Technology Entrepreneurship Development Board
24.	NSTMIS	National Science and Technology Management Information System
25.	OECD	Organisation for Economic Co-operation and Development
26.	OPC	One Person Company
27.	PE	Private Equity
28.	PLC	Private Limited Company
29.	POC	Proof of Concept
30.	QSE	Qualified Scientists and Engineers
31.	R&D	Research and Development
32.	RTP	Research Technology Park
33.	S&T	Science and Technology
34.	STEM	Science Technology Engineering and Maths
35.	TBI	Technology Business Incubator
36.	VC	Venture Capital

PREFACE

Technology based start-ups and their ecosystems assume a decisive significance for the economic transformation and progress of nations, particularly emerging economies like India, in the current era. An inseparable component of tech start-up ecosystem is the support system comprising accelerators, incubators and co-working spaces, which nurture tech entrepreneurship for the creation of tech start-ups.

Recently, exclusive policies have started emerging on a fast pace for the promotion of start-ups at the national as well as state levels in India, an important dimension of which being the increasing emphasis on Technology Business Incubators for their setting up in Science and Technology (S&T) Institutions/Universities. At the same time, the increasing entry of MNCs, particularly, fortune 500 companies into India has been resulting in the establishment of more and more corporate accelerators, for the time-bound creation/scaling up of tech start-ups, to exploit the S&T base of the nation. Simultaneously, many local/national private organizations/individuals have been resorting to the setting up of co-working spaces, which are characterized by "low entry barriers" as they provide space and basic infrastructural services on rent for anybody, who has the "ability to pay".

These three kinds of support system are remarkably contributing to the vibrancy and visibility of growing start-up ecosystems in India. While the sponsor, location, objective, structure and infrastructure, support and "rules of the game" may vary widely, all of the three aim at nurturing start-up entrepreneurship, formally or informally, in a time-bound manner or otherwise. Given this, successful emergence of start-ups will result in job creation, introduction of new products/services, and income generation, among others, in the start-up hubs and thereby contribute to regional transformation and development, and national economic growth. What is more significant is that increasing generation of technology entrepreneurship led tech start-ups has the potential to contribute to national R&D efforts in the form of R&D inputs of capital expenditure and personnel, and R&D outputs in the form of new products/services, patents, and income creation.

However, the performance of incubation system comprising accelerators, incubators and co-working spaces has hardly been probed comprehensively, particularly with a focus on its contribution to national R&D efforts. This holds good in the Indian context as well. It is against this background that this study has been undertaken with reference to three of the six start-up hubs of India, namely, Bangalore, Chennai, and Hyderabad, which also account for a major share of the TBIs currently operational in the country. It is to throw light on the various dimensions of TBI contributions to national R&D efforts in India that the present study has been carried out, during February 2017 – June 2018.

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July 2018

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This Research Project is sponsored by the National Science & Technology Management Information System (NSTMIS), Department of Science and Technology (DST), Government of India, New Delhi. The original project idea to probe the contributions of TBIs to national R&D efforts came from the head of NSTMIS, Dr Parveen Arora, Advisor and Head, CHORD, DST, and it was the initial round of interactions with him and Dr AN Rai, Director, CHORD, DST, which gave the right impetus to the project to take-off. Both Dr Arora and Dr Rai have been extremely helpful, constantly encouraging, and always available for consultations and discussions on any issue related to the research project, right from the beginning of the project till its completion. Therefore, I would like to place it on record my deep sense of gratitude and appreciation to both of them, as much as to DST for the sponsorship, without which this research project could not have been carried out.

The role played by the Local Project Advisory Committee (LPAC) from the beginning till the stage of project completion and delivery, has been remarkable. The LPAC was headed by Dr Prahlada, former Vice Chancellor of Defense Institute of Advanced Technology (DIAT), Pune and Formerly Distinguished Scientist and Chief Controller, Research & Development (Aero & Services Interaction), DRDO, Ministry of Defence, Government of India, New Delhi. The LPAC comprised Dr Parveen Arora, Dr A N Rai, and seven eminent personalities who either head or directly/indirectly deal with one form of TBI or another, namely, Prof. Rajagopalan, Dr. Gayatri Saberwal, Dr. Ravi Kumar, Dr. Lakshmi Jagannathan, Dr. Taslimarif Saiyyed, Dr. Tej Pochiraju and Dr. Balasubramanian (their details are given in Appendix 1). The inputs provided by them at every stage of the research project were extremely useful and timely. The LPAC played a helpful role by monitoring the project progress and advising the project team from time to time. I am greatly indebted to each one of them.

The respondents of the study comprising the CEOs of 65 TBIs as well as the CEOs of 65 incubating start-ups and 42 incubated start-ups were very cooperative and forthcoming to share their ideas, and provide the valuable primary data for the project. The data and related information provided by them formed the basis for the analysis of our research objectives. But for their cooperation and support, this project could not have been completed satisfactorily. I am thankful to each one of them individually as well as collectively. I also thank all the delegates of the workshop who provided feedback and inputs and enabled us to finalize the report in much better fashion. (The summary of the proceedings of the workshop is provided in Appendix 6)

The research project has been implemented through the Centre for Sponsored Schemes and Projects (CSSP), Indian Institute of Science, Bangalore. Dr M Krishnamurthy, Deputy Financial Controller, CSSP, IISc and his team have been extremely cordial and always willing to render a helping hand in any administrative matter during the implementation of the project. Therefore, I would like to extend my heart-felt appreciation to Dr Krishnamurthy and his team.

The research project has been carried out in the Department of Management Studies, IISc. All through the process of project implementation, we got all-round support from the Chairman and the department staff members adequately. We are grateful to all of them.

In the process of project implementation, I have got due support from Prof. Parthasarathy Ramachandran, Co-Principal Investigator, Prof. K N Krishnaswamy, Project Consultant, Dr H S Krishna, Research associate, and Ms. Geetha, Project Assistant. Prof. Parthasarathy Ramachandran and Prof. K N Krishnaswamy helped us by giving valuable inputs in all the brainstorming sessions, feedback on draft questionnaires, on draft chapters, etc. Thus, both of them played a very effective supportive role in the implementation of the research project and I am extremely grateful to both of them.

Dr. Krishna and Ms. Geetha played a major role in questionnaire preparation and finalization, primary data collection by visiting the TBIs, interacting with their management and the CEOs of incubating start-ups, and tracing out and interacting with the CEOs of incubated start-ups. While Dr. Krishna was instrumental in gathering primary data from the TBIs and start-ups located in Chennai and Hyderabad, Ms. Geetha did the primary data collection from Bangalore based TBIs and start-ups. In addition, Dr. Krishna tabulated the data, went through all the draft chapters in the earlier stages, and provided valuable inputs for the analysis. Thus, both of them contributed significantly to the completion of research project. Therefore, I would like to explicitly acknowledge their valuable contributions and thank them immensely.

Finally, I would like to thank all the others who have helped us directly or indirectly (whom I have not named here explicitly) in carrying out this research project. However, I am alone responsible for any errors or deficiencies, if inadvertently remain in the report.

M H Bala Subrahmanya July 2018
Principal Investigator & Professor

Executive Summary

Context and Background

- Technology Business Incubators (TBIs) form one of the indispensable components of an entrepreneurial ecosystem for technology based start-ups in modern economies. The objective of TBIs is promoting technology transfer and diffusion of products, thereby developing local innovative firms. TBIs play a unique role, particularly with respect to promotion of innovation, technology commercialization and facilitating the emergence of technology based start-ups. Given this, their performance and contribution to national R&D efforts in the form of creating R&D personnel, R&D infrastructure and R&D outputs including patent grants and new products/services - at the TBI level as well as at the start-up level – can indicate the degree and direction of the contributions made by these TBIs to the national economy.
- This study is a preliminary and exploratory assessment of R&D contributions of TBIs in the Indian context comprising accelerators, incubators and co-working spaces located in three of the leading start-up hubs in India, namely, Bangalore, Chennai, and Hyderabad. All the TBIs in the public sector, and all the incubators, accelerators and co-working spaces in the private sector in all the three cities fell within the scope of the study. In addition, graduated as well as incubating start-ups from these TBIs were covered to ascertain the incubation process as well as incubation outcomes of these incubators.
- The primary data collection exercise comprised three stages. As part of stage I, an exhaustive database of TBIs operating in Bangalore, Chennai and Hyderabad was developed in April 2017. The database comprised 239 entities. To ensure quality of data, TBIs who were at least two years of age were considered for data collection. Post the application of the age criteria, the database of TBIs comprised 189 entities. The final and in-depth data collection exercise with the help of the semi-structured schedules was carried out from July 2017 till the end of December 2017. The project team could obtain complete responses from 65 of the TBIs. Further, the team was able to collect primary data from a total of 107 start-ups (65 incubating and 42 incubated). Thirty-one TBIs from a total of 48 incubators across the three locations (constituting to about 65% of the Incubators under the scope of our study) provided complete data for the Questionnaire. Nine accelerators from a total of 21 accelerators across the three locations (41% of the Accelerators that met the criteria for our study) provided inputs to our Questionnaire. Further, the project team was able to collect complete data from 25 co-working spaces out of a total of 44 co-working spaces, across the three locations (constituting about 57% of the total addressable population of the Co-working spaces).
- As regards to the primary data collected from start-ups, a total of 58 start-ups have provided complete data in Bangalore, across the three entities (incubators, accelerators and co-working spaces), with 31 among them being under incubation, and 27 that are alumni (graduates) from the entities that they earlier incubated from. From Chennai, primary data were collected from a total of 20 start-ups, of which 15 were under incubation and five start-ups had graduated from the entities that they were earlier incubated from. In Hyderabad, a total of 29 start-ups provided complete data for the study, of which 19 start-ups were under incubation and the reminder 10 were start-ups that had graduated.

Salient Findings

- The results of data analysis revealed that institute promoted TBIs were found out to be younger with more STEM qualified CEOs, and focused on early stage start-ups. Further analysis revealed that the objectives of early stage TBIs are non-revenue oriented and thus differed from stage agnostic TBIs, which are primarily revenue generation oriented, the former had CEOs with less work experience and are tech sector focused. Finally, tech sector focused TBIs are found to have better infrastructure but engaged in less promotional activities, and their CEOs had more work experience.

- The results for R&D input contribution evaluation indicated that the TBIs with CEOs having no previous experience but have external networks and provide need based mentoring for a larger number of incubatees, accounted for larger R&D investments. But only infrastructure and number of administrative personnel mattered for the employment of R&D personnel. From the collected data, it was revealed that overall, 20% of the TBIs, mostly located in Bangalore, incurred R&D expenditure for infrastructure up to Rs.10 lakh, another 35% of them, again majority located in Bangalore, incurred expenditure for infrastructure in the range of Rs.10 lakh to Rs.100 lakh, whereas the remaining 45% of them, spread more or less equally between the three hubs, incurred expenditure more than Rs.100 lakh up to Rs.2500 lakh. Among the ABCs, incubators accounted for a majority (nearly 80% of the TBIs) in the highest slab of >Rs.100 lakh to Rs.2500 lakh expenditure incurred for R&D infrastructure. The aggregate cumulative R&D expenditure incurred by the TBIs as of 2016/17 amounted to almost Rs.2050 million, the average expenditure being about Rs.31.5 million since inception.
- The 44 TBIs which employed at least one R&D personnel, together employed 150 persons, majority (almost 81%) of which are employed in the incubators, the highest being in Hyderabad, followed by Bangalore and then Chennai. Of all, co-working spaces accounted for the least share (about 5%) of the R&D personnel, in all the three hubs. Almost 50% of these 44 TBIs, largely comprising incubators followed by accelerators, employed at least one but not more than three personnel. About 12% of them, mostly incubators, employed in the range of four to six personnel and about 6% (all of them incubators) employed in the range of seven to 14 personnel. This further confirms that among the ABCs, incubators account for a larger share of TBIs having exclusive R&D personnel.
- The results of R&D output contribution of the TBIs showed that higher number of new products/services emerged from older TBIs, which have exclusive external networks and have a larger number of incubatees. But corporate sponsorship, infrastructure and higher successful exits influenced patent application submissions. Further, corporate sponsorship and successful exits mattered for total revenue generation as well.
- Overall, the 65 TBIs have produced 8110 new products/services from their inception up to 2016/17, with an average of 125 new products/services per TBI. Of these, more than half (about 52%) of the new products/services were produced by the mid-range TBIs (which produced new products in the range of 51-500), followed by the upper range (where just two TBIs accounted for 3050 (about 37%) of the new products/services), followed by the lower range of TBIs (about 11%). Between the ABCs, incubators accounted for a majority (59%) share of the new products/services generated, followed by co-working spaces (about 34%), and accelerators (about 7%). Among the three hubs, Hyderabad accounted for the highest share of 47%, followed by Bangalore (>45%) and then Chennai (<8%).
- While all of the TBIs have claimed to have produced new products/services through their start-ups, 25 (about 38%) of the TBIs (majority located in Bangalore) did not have any patent application submissions. Overall, the 65 TBIs claimed to have made 481 patent submissions. Of the total, about 46% submitted applications emerged from Bangalore, about 38% from Hyderabad followed by Chennai (remaining 16%). Among the ABCs, incubators of the three start-up hubs accounted for more than 71% of the total patent application submissions, followed by accelerators (about 25%), and co-working spaces (hardly 4%).
- The TBIs together generated a cumulative sales revenue of Rs.187985 lakh from the sales of new products/services through their incubated start-ups. Between the ABCs, accelerators accounted for the highest share of 59% of the total revenue, followed by incubators (37%) and co-working spaces (4%). Among the three hubs, Bangalore accounted for the highest share of 68% of the total revenue, followed by Hyderabad (29%) and Chennai (3%). Barring the four entities that together constitute 68.5% of the revenues generated and therefore can be considered as outliers (Microsoft and SAP Accelerators in Bangalore, IKP Knowledge Park and ALEAP in Hyderabad), the total revenues generated from the remaining 61 entities is Rs. 59,485 lakh, which indicates that on an average, each TBI has been able to make an average revenue contribution of about Rs.975 lakh since inception.

- A gender based assessment of TBIs in our sample revealed that overall 13 out of 65 (20%) of the TBIs across the three cities had female CEOs. In Bangalore, 3 out of 11 incubators, 1 out of 7 accelerators and none among the co-working spaces had women leaders managing the TBIs. In Chennai, 3 out of 8 incubators had women leaders. In Hyderabad, 4 out of 10 incubators, 1 out of 2 accelerators and 1 out of 7 co-working spaces had women leadership.
- In terms of R&D contributions, the TBIs with women leadership contributed to about 13290 lakh INR of R&D expenditure in equipment (65% of total R&D expenditure) and was responsible for generation of 138 patents (29% of the total patent applications submitted), 3295 new products & services (41% of the total new products and services), and contributed to 43,705 lakh INR (23% of the total sales) in sales revenue from new products/services.
- The Private / Corporate sector has been the dominant player when it comes to R&D investments and R&D outputs in the TBIs. The private sector accounted for R&D expenditure of INR 17991 lakh (88% of the total R&D investment). In terms of R&D outputs, the corporate and private sector claimed to create 6214 new products and services at their TBIs (77% of the total new P&S), 243 patent applications (51% of the total) and sales revenue of INR 161570 lakh (85% of total revenue).
- Finally, when the R&D inputs along with new products/services and patent applications were analyzed statistically to examine their influence on total revenue, it was found that only new products/services and patent applications together influenced total revenue generation of the TBIs. Overall, it may be appropriate to conclude that there is scope and potential for an increasing R&D contribution to emerge from the TBIs through their incubated start-ups, in the future.
- Based on the analysis of the 65 TBIs across the three cities, an extrapolation at the national level assuming presence of 500 TBIs (190+ incubators and accelerators, 300 co-working spaces), and assuming that the same trends hold true across the country indicates that the total R&D expenditure from TBIs at national level can be about Rs. 1600 crores since inception, providing employment to about 1000 R&D personnel. Further, the revenue contribution from all the TBIs in the country can be estimated to be about Rs. 4875 crores since inception, an aggregate of 62,500 new products/services across all TBIs since inception and about 3500 to 6000 patents submitted by the TBIs at an aggregated level since inception.
- Primary data from one each incubating start-up located in each of the 65 TBIs, and one each graduated/exited start-up from the 42 TBIs which have experienced graduation and successful exit of start-ups since their establishment was analyzed. The results showed that both start-up specific characteristics such as educational qualification of CEO, age of the start-up and TBI specific characteristics such as TBI infrastructure and its external networks access positively influenced the R&D contributions of both incubating and incubated start-ups in the three hubs of India.
- In summary, it can be opined that R&D investment expenditure is common among the TBIs but not exclusive R&D personnel. Similarly, they do generate new products/services thereby enabling generation of revenue, but do not go for patent application submissions. The graduation of start-ups is an important determinant of revenue generation of TBIs. The strength of TBIs as well as resourcefulness of start-ups importantly determine the R&D contributions of start-ups. Overall, the R&D contributions that emerge from the TBIs as well as from the incubated start-ups are still at a moderate level.
- This research work has made three important research contributions to literature. Firstly, it has unraveled the structure and composition of TBIs along with their key characteristics in the context of Bangalore, Chennai and Hyderabad. Particularly, it has differentiated the TBIs in terms of sponsorship, stage focus and sector focus, and thereby provided an understanding of the typology of TBIs with respect to three leading start-up hubs of India.
- Secondly, it has examined the role and performance of TBIs in terms of applications received, admission made, occupancy of incubatees, and graduation of start-ups and thereby revealed the pre-incubation, incubation and post-incubation phases of start-up formation in the context of three start-up

hubs. As a result, it has thrown light on the extent of physical infrastructure and human expertise employed, apart from the prevalence of external networks, in these TBIs and its adequacy/inadequacy.

- Thirdly, it has analyzed the determinants of R&D contributions in terms of inputs (of capital and employment) as well as outputs (in terms of new products/services, patent applications and revenue generated) at the TBI level as well as at the incubating/incubated start-up level.
- The study has thus clearly revealed/answered that the TBIs and tech start-ups contribute to the national R&D efforts emphasizing the need to institutionalize measuring of the national efforts through systematic mechanism for an improved understanding of their structure and orientation in terms of R&D and innovation leading to suitable policy action.

CHAPTER 1
INTRODUCTION

1.1 Backdrop

Incubating new ventures is a part of a wide range of initiatives aimed at stimulating and promoting innovative entrepreneurship and economic growth (Grimaldi and Grandi, 2005; Corsi and Berardino, 2014). Technology Business Incubators (TBIs) form one of the indispensable components of an entrepreneurial ecosystem for technology based start-ups in modern economies (Bala Subrahmanya, 2017). The objective of TBIs is promoting technology transfer and diffusion of products, thereby developing local innovative firms (EU, 2010). TBIs are seen as a mechanism that could create supportive and entrepreneurial environments for technology based start-ups, helping them to increase their survival rates (Aerts, et al, 2007).

TBIs can be viewed as a mechanism (i) to support regional development through job creation (Thierstein and Wilhelm 2001), (ii) for new high tech venture creation, technological entrepreneurship, commercialization, and transfer of technology (Mian, 1997; Phillips 2002), (iii) an initiative to deal with market failures relating to knowledge and other inputs of innovative process (Colombo and Delmastro 2002). Some empirical studies have revealed that one third of new firms do not survive the third year and about 60 per cent do not survive the seventh year (OECD 2002). This number considerably falls to 15–20 per cent among TBI based tenants (Adegbite 2001; Lalkaka 2002). According to some estimates, incubated start-ups grow much faster than their non-incubated counterparts and their survival rate is also 40% higher, at 80% (Startupindia, 2017). For these reasons many countries have increasingly been engaged in establishing TBIs in various forms (Akcomak, 2009).

TBIs are designed to offer start-ups the technological support and services, and a solution in bridging the knowledge gap to help them to develop their own viable businesses, by providing a resource base necessary for supporting their development in early and critical stages (Somsuk et. al., 2012). TBIs support start-ups during their vulnerable early years and enable them to graduate from the programme as viable companies capable of operating independently. TBIs are known by different names such as technology/business incubators, innovation/technology centres, science/research/ technology parks, and business/seed accelerators. The terminology reflects scope of function as well as location (Mian et al, 2016). In emerging economies like India, they include co-working spaces as well which provide common space, facilities and support for nurturing start-ups (Bala Subrahmanya, 2017).

Thus, TBIs play a unique role, particularly with respect to promotion of innovation, technology commercialization and facilitating the emergence of technology based start-ups. Given this, their performance and contribution to national R&D efforts in the form of creating R&D personnel, R&D infrastructure and R&D outputs including patent grants and new products/services - at the TBI level as well as at the start-up level - are hardly investigated, nationally or internationally. These are important as they play a major role in creating/strengthening the National Innovation System (NIS) through the formation of innovative firms and therefore decisive for accelerating the rate of economic growth of nations. The proposed study aims at filling up this research gap by resorting to such an assessment of TBIs in the Indian context comprising accelerators, incubators and co-working spaces located in three of the leading start-up hubs, namely, Bangalore, Chennai, and Hyderabad.

1.2 TBIs: Concepts, Characteristics and Importance

In its generic sense, the term "incubator" is often used to describe a wide range of organizations that, in one way or another, help entrepreneurs develop their ideas from inception through to commercialization and the launching of a new enterprise (Caiazza, 2014). The concept of ''incubator'' is often used as an overall denomination for organizations that constitute or create a supportive environment that is conducive to the ''hatching'' and development of new firms (Chan and Lau, 2005; Lindholm-Dahlstrand and Klofsten, 2002).

Generally, an incubator can be viewed as a support environment for start-up and fledgling companies (Peters et al., 2004). In its generic sense, the term "incubator" is often used to describe a wide range of organizations that, in one way or another, help entrepreneurs develop their ideas from inception through to commercialization and the launching of a new venture (Caiazza, 2014). In summary, TBIs are property based initiatives (Phan et al, 2005) providing their tenants with a mix of services encompassing infrastructure, business support services and networking (Bergek and Norrman, 2008; Hansen, et al, 2000; Lalkaka and Bishop, 1996; Peters et al, 2004).

A broad definition of the term "incubator" embraces science and technology parks, as well as organizations which have no single physical location and concentrate instead on managing a network of enterprise support services (Lindelof and Loftsen, 2004). They can also be found in institutions that do not perform basic research, but which have strong links with the infrastructure of science and technology and the commercialization of technologies (Breschi and Lissoni, 2001). Business incubators are popular tools to accelerate the creation of successful entrepreneurial companies. TBIs typically support new ventures in the hope they will later develop into self-sustaining, thriving companies. This support encompasses several dimensions such as office space, shared resources, business support, and access to networks (Bruneel, et.al., 2012).

They include a diverse set of sponsors and stakeholders such as governments, local development agencies, universities, science parks and non-profit organizations (Westhead, 1997; Westhead and Batstone, 1999). Incubators are promoted in a variety of ways with different sponsors resulting in different programs, as given in Table 1.1. Though incubators might be of different types with different kinds of sponsors, they all have the same objective – find viable companies and get them to early-stage financing by offering specific services and/or initial funding.

Table 1.1: Incubators: Varieties and Sponsors

Incubator Types		**Incubator Sponsors**	
Non-profits	94%	Economic Development agencies	31%
Mix use	54%	Government	21%
Technology	39%	Academic Institutions	20%
Service/Specialty	4%	For Profit	4%
Manufacturing	3%	No Sponsors	8%
		Combination	8%
		Others	8%

Source: State of the Business Incubation Industry (2006)

According to Bollingtoft and Ulhoi (2005), TBI is an umbrella term for any organization that provides access to affordable office space and shared administrative services. The key characteristics of incubators are low rent, shared services, the existence of entry/exit policies and the university networking and support (Al-Mubaraki and Busler, 2010). A business incubator is a shared office space facility that seeks to provide its incubatees (i.e. ''portfolio-'' or ''client-'' or ''tenant-companies'') with a strategic, value-adding intervention system (i.e. business incubation) of monitoring and business assistance. This system controls and links resources with the objective of facilitating the successful new venture development of the incubatees while simultaneously containing the cost of their potential failure (Hackett and Dilts, 2004).

TBIs provide a mechanism for technology transfer and commercialization. The incubation programmes help start-ups to emerge, survive and grow through the provision of supportive environments (Wonglimpiyarat, 2014). TBIs are a venture of universities, public research institutes, local government and private players to promote and bolster a new technology intensive enterprise. In this type of incubation, the targeted talent consists of innovative, mostly technology oriented or knowledge-intensive enterprises. Interactions with academic institutions and public research are almost always a substantive element of the incubation process in such TBIs (The Centre for Internet Society, 2015).

Thus, TBI role is of two kinds, which are as follows:

- They foster innovative start-ups, thus the process of incubation is strongly intertwined with the innovation process that occurs in the supported enterprises, bolstering research, and
- They help develop certain local economic development goals in their region by stressing on a knowledge driven economy where risk taking is encouraged.

Therefore, such incubators have become a ubiquitous phenomenon in many parts of the world. Policy makers on national and local levels have come to view them as a tool for promoting economic development, innovativeness through the promotion of new technology-based growth firms. TBIs are an effective and innovative tool in nurturing and supporting technology start-ups (Al-Mubaraki and Busler (2011).

Smilor and Gill (1986) first articulated the concept of TBIs as offering a link between: technology, know-how, entrepreneurial talent, and capital. TBIs are property-based initiatives providing tenant firms with a portfolio of new venture support infrastructure, including business services, networking (Bergek and Norrman, 2008), access to professional services (Sherman and Chappell, 1998), university resources (Mian, 1996) and capital (Aernoudt, 2004). The intent is to help start-ups by providing enabling linkages to help the new businesses survive, scale up, and grow.

Over the years, TBIs have been marketed under a variety of more or less synonymous labels, including Business Accelerators; Research Parks; Knowledge Parks; Seedbeds; Industrial Parks; Technopoles and Networked Incubators (Bollingtoft and Ulhoi, 2005). In the Indian context, TBIs form a part of the ecosystem for the promotion of tech start-ups comprising not only incubators but also accelerators and coworking spaces (Bala Subrahmanya and Balachandra, 2017).

In fact, at a broader level, TBIs would include incubators, accelerators and co-working spaces (IACs), all of which play an important role in the provision of work space and support to start-up and small businesses and encompasses a wide range of models. Support offered includes services such as training and assistance in areas such as business management (including cash flow, marketing), business mentoring and help with access to funding (Ramidus Consulting, 2015). Although there is no universally accepted definition of IACs, there are certain characteristics which are common to all the three which can be identified. All these three types of spaces – incubators, accelerators and co-working spaces – offer environments designed to suit small and micro businesses with varying levels of business development support offered (Ramidus Consulting, 2015).

Incubators provide space designed to actively promote the growth of start-ups or a new business in its early stage of development with the provision of business support. Accelerators typically provide space to start-up businesses or already existing and operating businesses with the potential for fast growth and good financial returns. Thus support of time-bound fast emergence and/or scaling up of a start-up is provided by accelerators. Whereas Co-working spaces provide a combination of workplace and supporting facilities at affordable rates with easy in-out contractual conditions. The space is rented to attract users who require ad-hoc and short term access to work stations and supporting facilities such as meeting rooms (Ramidus Consulting, 2015).

Quite often, incubators are promoted by government agencies and are located within or near academic institutions of higher learning, accelerators are promoted by corporate sector enterprises located within the enterprise premises, whereas co-working spaces are locally owned, independent, relatively economical to hire, and are usually concentrated in large cities. Startup accelerators and incubators can get involved at all stages of a startup's development, from idea stage to revenue-generating, late stage. However, most tend to focus on relatively early stage startups, as this is when companies can typically most benefit from outside help. Startups enter accelerators for a fixed-period of time, and as part of a cohort of companies. The accelerator experience is a process of intense, rapid, and immersive education aimed at accelerating the life cycle of young innovative companies, compressing years' worth of learning-by-doing into just a few months (Hathway, 2016). Co-working spaces are particularly designed to encourage collaboration, creativity, idea sharing, networking, socializing, and generating new business opportunities for small firms, start-ups and freelancers (Fuzi, 2015). The present study would cover all of these three start-up supporting entities.

1.3 Origin and Growth of TBI Movement

The business incubator is an innovative organizational entity, with origins in the United States, designed to provide a supportive environment for new ventures (Chandra and Chao, 2011). The modern business incubation movement began with the establishment of Stanford Research Park, California in 1951 and the Batavia Industrial Centre in 1959 in Batavia, New York (Lewis, 2002). Thus the movement of TBIs originated in the USA but it has grown substantially since then. Mian, et al, (2016) have identified three broad waves in the evolution of TBI models in the context of USA: (i) the first wave models emerged and grew in the pre-1980s. By 1980, there were 20 research parks and 11 business incubators in the USA., (ii) The second wave models flourished from the 1980s till the late 1990s. By 2000, an estimated 600 incubators and 160 research parks were in the USA. (iii) The third wave models have been emerging and flourishing since 2000. According to the US-based National Business Incubation Association (NBIA), the number of business incubators in the U.S. grew from only 12 in 1980 to over 1,250 by 2012 (Chen and Sisk, 2016).

The early incubators in the US evolved from three concurrent forces, as illustrated by Wiggins and Gibson (2003). The first was an attempt to put to use old, unoccupied manufacturing buildings in distressed Midwest and Northeast communities by subdividing them for small businesses. The second force came from the National Science Foundation that funded emerging university programs in innovation and entrepreneurship. The third driver consisted of individual or groups of successful entrepreneurs who sought to utilize their industry rich experience to, and invest their resources in, new technology ventures.

The major factors which contributed to the growth of incubation movement in the USA, among others, are the recognition of the apparent failure of state policies for attracting investment by large MNCs and the research findings of Birch (1979) and Kirchhoff (1994) which brought out the importance of start-ups and small firms in terms of job growth and contribution to growth of the national economy. The TBI movement for the promotion of start-ups has simultaneously spread to other major economies such as the UK, Sweden, Australia, Canada, China, France, Germany, Belgium, Japan, Russia, Korea, Taiwan, Brazil, Mexico, Singapore, Malaysia and India (Mian, et al, 2016). Currently, there exist about 7000 incubators worldwide, among those, about 1800 are in the USA, 900 in Europe, and many more have emerged globally (Al-Mubaraki and Busler, 2014). Thus, the TBI mechanisms have primarily developed during the past half century and are gaining more and more importance as a mechanism to promote technology based start-ups globally since then (Mian, et al, 2016).

More recently, the digital economy has given rise to a new form of TBI mechanism, the accelerator, the first one being Y Combinator of Massachusetts established in 2005. By 2013, there were over 213 accelerators operating worldwide (Mian, et.al., 2016). Further, while business incubators have been flourishing as one of the most recognized tools of enterprise creation and development, many different forms of private sector managed workspaces are emerging to support the soft and hard elements of entrepreneurship across the world (Fuzi, 2015). The most notable of them all are Co-working spaces, which originated in San Francisco in 2005 and have grown rapidly in the last five years (Leclercq-Vandelannoitte and Isaac (2016). By 2015, about 7800 Co-working spaces existed worldwide (Gerdenitsch, et.al., 2016). Given the origin and growth of TBI movement globally, it is appropriate to understand the Indian perspective of TBIs.

1.4 TBIs in India: Origin and Current Status

In India, TBIs first emerged due to the initiatives taken by the National Science & Technology Entrepreneurship Development Board (NSTEDB), established in 1982 by the Government of India under the aegis of Department of Science & Technology, as an institutional mechanism for promoting knowledge-driven and technology-intensive enterprises. The primary objective of NSTEDB, among others, is to promote Science & Technology (S&T) entrepreneurship. To achieve this objective, NSTEDB operationalized and introduced two schemes, namely, (i) Science & Technology Entrepreneurship Parks (STEP), which was started in the early 1980s, and (ii) the TBI Programme launched in early 2000 (NSTEDB, 2016).

According to National Science and Technology Entrepreneurship Development Board (NSTEDB), Government of India, TBIs are promoted to achieve the following objectives (NSTEDB, 2016):

1. Creation of technology based new enterprises
2. Creating value added jobs & services
3. Facilitating transfer of technology
4. Fostering the entrepreneurial spirit
5. Speedy commercialization of R&D output
6. Specialized services to existing SMEs

India's first incubator, STEP (Science and Technology Entrepreneurship Park) at Tiruchirappalli Regional Engineering College was set up in 1986. As of 2016, there were 68 approved incubators supported by the Department of Science and Technology (DST), 14 approved incubators supported by the Department of Bio-Technology (DBT), 30 approved incubators supported by the Department of Electronics and Information Technology (DeitY), and 47 approved incubators supported by the Ministry of Micro, Small and Medium Enterprises (MSMEs) as well as several incubators in the private sector (Startupindia, 2017).

Thereafter, several engineering institutions (both in the public and private sectors) across the country have established their own TBIs. Over a period of time, the number of TBIs promoted by the government as well as the private sector, has registered a considerable increase amounting to more than 300 registered incubators operating in the country as of early 2014 (Centre for Internet & Society, 2016). These approved incubators are engaged in assisting entrepreneurs with executing their ideas and providing them with a platform to showcase the same, for the creation of new ventures.

While not-for-profit TBIs are eligible for government support, for-profit TBIs are promoted and supported by private organizations including the Corporate sector. In addition, accelerators and co-working spaces have come up in different parts of India, promoted by the private and corporate sector which include MNCs such as Microsoft, SAP, Oracle, Google, Facebook, TechHub, Regus, WeWork and other private organizations and individuals. However, as of now, there is no exhaustive database of incubators operating in different parts of the country, leave alone accelerators and co-working spaces. Given this, it is important to examine the policy support that is currently prevailing for the setting up and operations of incubators, accelerators and co-working spaces in India.

1.5 Current Policy for TBI Promotion in India

As of now, at the national level, TBIs (in the form of incubators) are promoted by the (i) Department of Science and Technology, Ministry of Science and Technology, (ii) Ministry of Electronics and Information Technology (MeitY), (iii) Ministry of Micro, Small and Medium Enterprises, and (iv) NITI Aayog. While the initiative to promote TBIs in the form of Science and

Technology Entrepreneurship Park (STEP) was the earliest one (as far back as in 1986), MeitY launched a scheme titled Technology Incubation and Development of Entrepreneurs (TIDE) in 2008 but the scheme was subsequently revised and extended till March 2017 (AICTE, 2016).

An important step taken for the promotion of incubators and entrepreneurship is in the context of rural India. A Scheme for Promoting Innovation and Rural Entrepreneurship (ASPIRE) was launched on March 18, 2015 to set up a network of technology and incubation centers to accelerate entrepreneurship and promote innovative start-ups in the agro-industry. As part of this scheme the concept of Livelihood Business Incubators (LBI) has been introduced under National Small Industries Corporation (NSIC), Khadi and Village Industries Commission (KVIC), Coir Board or any other Institution/agency of GOI/State Governments or under Public-Private Partnership (PPP) mode with these institutions (Ministry of MSMEs, 2015).

The main objective of this component of the Scheme is to set up business incubators to incubate, impart entrepreneurship, skill development training to youth, mentoring and hand holding with facilitation for funding with a view to empower them to set up own business enterprises. The prime focus of these incubators is to create jobs at local level and reduce un-employment by creating a favourable ecosystem for entrepreneurial development in the country. The financial support under LBI is up to Rs.1 Crore for NSIC and others, and Rs.50 Lakh for PPP incubators. For setting up of Technology Business Innovation Model (TBI), the assistance is for Rs.30 Lakh for existing incubators and Rs.1 Crore for new incubators. The proposed period of incubation to be 12 months to 24 months (Ministry of MSMEs, 2015).

In addition, Ministry of MSMEs supports existing incubators as well as setting up of new incubators in eligible private institutions including Industry Associations, along with the Academic Institutions, R&D laboratories, Universities, Government entities and Technology Parks, Technical institutions with a proven track record in promotion of innovative/technology based entrepreneurship in the agro-rural landscape (Ministry of MSMEs, 2015).

The Indian Council of Agricultural Research (ICAR) has proposed to set up about 30 Agro-Business Incubators (ABIs) in ICAR Institutes across the country on a competitive basis under the XII Plan Scheme. The main objective of ABIs is to encourage, nurture and support technologies, scientists and innovative agribusiness ideas to turn their innovations into sound commercial ventures (ICAR, 2015).

An overall focus on the promotion of TBIs was laid in the Startup India Policy launched in 2016. The policy proposed the launching of Atal Innovation Mission (AIM), which in turn proposed to set up sector specific incubators including in the Public-Private Partnership (PPP) model, 500 Tinkering Labs, and strengthening of incubation facilities in existing incubators and mentoring start-ups. It also proposed to harness private sector expertise for setting up incubators, establish 7 new Research Parks modeled on the Research Park set up at IIT Madras, and support the creation of successful world class incubators in India (Startupindia, 2016a)

Recently, NITI Aayog has launched Atal Incubators scheme under Atal Innovation Mission (AIM) to promote entrepreneurship in universities and industry. At the university, NGO, SME and Corporate industry levels, AIM is setting up world-class Atal Incubators (AICs) that would trigger and enable successful growth of sustainable startups in every sector /state of the country, thereby promoting entrepreneurs and job creators in the country addressing both commercial and social entrepreneurship opportunities in India, applicable globally. AIM is also providing scale up support to existing incubators for scaling up their operations. AIM is providing a grant of up to Rs.10 Crore to successful applicants for setting up green-field incubators or scaling up the existing ones. The objective is every one of the 110 named smart cities and the top 5-10 educational/industrial institutions of every state should aspire to have a world class incubator that will provide the youth/startup communities in the universities/industries opportunity to create new start-ups. To date 19 Atal Incubators have been selected. Before the end of 2018-19 there would be more than 50 Atal Incubators operational (AIM, 2018).

In 2016, DST introduced a new TBI scheme under National Initiative for Developing and Harnessing Innovation (NIDHI). NIDHI is an umbrella programme conceived and developed by the Innovation and Entrepreneurship Division (National Science and Technology Entrepreneurship Development Board) of DST, Government of India, for nurturing ideas and innovations (knowledge-based and technology-driven) into successful startups. NIDHI aims to nurture start-ups through NIDHI TBIs for scouting, supporting and scaling of innovations. NIDHI is open for academic/technical/R&D institutions and other institutions with a proven track record in the promotion of technology based entrepreneurship in India. One of the key objectives of NIDHI-TBI is to facilitate speedy commercialization of technologies developed by the host institution or by any academic/technical/R&D institution or by an individual, apart from providing a vibrant start-up ecosystem with all the necessary support and services (DST, 2016).

The Government of India has now facilitated the setting up of incubators by Corporate Sector companies through Schedule VII of the Companies Act, 2013 which treats contributions or funds provided to TBIs within academic institutions which are approved by the central government as that would qualify as Corporate Social Responsibility (CSR). They can also dedicate the CSR expenditure on building new incubators, under the same schedule of Companies Act, 2013 (Startupindia, 2016).

Thus, though the origin of India's policy for the promotion of incubators can be traced back to the setting up of Science and Technology Entrepreneurship Parks (STEPs) in the 1980s through NSTEDB by the DST, more comprehensive efforts through diverse schemes by various departments and ministries of Government of India have emerged only recently, particularly subsequent to the announcement of Startup India Policy in 2016. The policy developments for the promotion of incubators have two important implications, which are as follows:

1. It is quite possible that the incubators that have emerged due to policy support would have, at the most, initiated their operations and would be working towards its sustainability currently, and therefore, not many of them would have experienced start-up graduation.
2. It is important to note that the policy initiatives are overwhelmingly meant for the promotion of incubators rather than accelerators and co-working spaces, implying thereby that government support is extended only for incubators, whereas accelerators and co-working spaces are emerging exclusively due to private sector initiatives.

Perhaps due to the above, no empirical study has yet been carried out to analyze and understand the operations, extent of support provided for incubation and its effectiveness as well as performance of TBIs (comprising incubators, accelerators and co-working spaces together) with reference to its R&D contributions, in the context of India's start-up hubs. NASSCOM (2017) identifies six major start-up hubs in our country – Bangalore, Hyderabad, Chennai, Mumbai-Pune, National Capital Region (NCR) and Kolkata. It is against this backdrop that the present study is proposed.

1.6 Research Objectives, Scope and Methodology

The research objectives of the study are as follows:

1. To ascertain and understand the focus and objectives, and the nature of services offered for technology based start-ups by Institute promoted TBIs as compared to Industry promoted TBIs,
2. To explore and classify the technology based start-ups of TBIs (Institute as well as Industry promoted) based on sector, ownership, size, and objectives,
3. To probe the proportion of personnel devoted to R&D, proportion of investments made on R&D infrastructure, and number of patent applications submitted, new venture-wise for each of the TBIs, Institute as well as Industry promoted,
4. To examine the R&D outcomes in the form of new products/services developed for venture launching, patents obtained, and initial sales revenue generated, if any for each venture of the TBIs (of Institutes and Industries),
5. To ascertain whether the facilities provided by a TBI and the duration of time spent by an incubating venture have any impact on the R&D outcomes of incubating ventures,
6. To assess the overall contributions of TBIs (Institute as well as Industry promoted) through new ventures in the form of R&D personnel, R&D investments and R&D outcomes, to the national R&D efforts of our country.

These research objectives are proposed to study covering all the functioning accelerators, incubators and co-working spaces in three of the leading start-ups hubs of India, namely, Bangalore, Chennai and Hyderabad, which also account for a majority of the incubators currently operating in the country. At the outset, in the first phase of data collection, we propose to develop an exhaustive database of all the operational incubators, accelerators and co-working spaces in the three start-up hubs, by means of accessing all possible – official as well as private - secondary data sources and social network sites.

Thereafter, in the second phase of data collection, we intend to approach each of them personally and/or virtually to ascertain and ensure that they promote technology start-ups. In the third phase of data collection, we propose to personally interview a senior management representative, preferably the CEO of each short-listed TBI in all the three cities, with a semi-structured questionnaire. In addition, we propose to gather data from one each incubated and graduated start-up from the TBIs which have experienced start-up graduation, and one each incubating start-up from all the TBIs covered for the study. The primary data thus gathered would form the basis for the analysis of research objectives proposed.

The first research objective will be initially analyzed descriptively with the help of tables, figures and charts. The purpose here is to develop a profile of TBIs based on their year of incorporation, title, sponsor, location, objectives, sector focus, key resources/facilities provided for incubation, etc. This will enable us to develop a typology of these incubators located in three different cities, and the variations if any between them. Thereafter, by means of logistic regression analysis, the key differentiating factors between the institute promoted TBIs and the industry promoted TBIs will be ascertained. Similarly, the second research objective of differentiating technology sector focused TBIs from sector agnostic TBIs will be analyzed by means of logistic regression analysis. In addition, attempt will be made to differentiate the TBIs which focused only on early stage start-up incubation from the TBIs which are stage agnostic in their focus.

The third and fourth research objectives will be explored with respect to (i) R&D investment expenditure, (ii) R&D personnel employed, (iii) number of new products/services generated, (iv) number of patent applications submitted, and (v) total revenue generated out of the sales of new products/services generated. This will be done based on multiple regression analysis for each of the five R&D parameters.

The fifth and the sixth research objectives will be examined based on the primary data gathered from the incubated and incubate start-ups of the TBIs. The analyses will be with respect to R&D investment, R&D personnel, new products/services, patent application submission, and revenue generated through the sale of new products/services. Both multiple regression and logistic regression analyses techniques will be employed, wherever appropriate.

1.7 Structure of the Report

The research report is structured to comprise eight chapters. The second chapter presents an exhaustive literature survey focusing on the types and classifications of TBIs, their goals and objectives, functions and services, the process of venture incubation, performance assessment in terms of outcomes and achievements, and dealt with the key theoretical issues pertaining to venture incubation and finally derived a conceptual framework linking the key variables of the study.

The third chapter contains a description on the research process undertaken for the study, research objectives, scope, sampling and data collection process adopted for the study. Further, it narrates the methods of analysis used for examining the research objectives. The nature of support extended to incubatees by the TBIs is revealed descriptively

In the fourth chapter, at the outset, the key characteristics of the TBIs are described, and (i) institute based TBIs from industry promoted TBIs, (ii) early stage focused TBIs from stage agnostic TBIs, and (iii) tech sector focused TBIs from sector agnostic TBIs, are differentiated by means of logistic regression analysis. The fifth chapter comprises an elaborate analysis of selection, incubation and graduation of start-ups adopted in the TBIs. In the process, the factors determining the selection of incubatees, number of incubatees and graduation to admission ratios are explored.

The sixth chapter consists of analysis pertaining to the factors influencing the R&D contributions of TBIs in terms of R&D investment, R&D personnel, new products/services, patent applications submitted, and revenue generated from the sale of new products/services. The seventh chapter includes analysis of R&D contributions emanated from incubated and incubatee start-ups of the TBIs. The eighth and the final chapter summarizes the study, derives inferences, refers to major conclusions and thereby brings out policy implications and recommendations. The Directory of TBIs created based on the data collected for this project is provided in Appendix 5.

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CHAPTER 2

TYPOLOGY, OBJECTIVES, FUNCTIONS, PROCESSES AND ACHIEVEMENTS OF TECHNOLOGY BUSINESS INCUBATORS: A LITERATURE REVIEW

2.1 Introduction:

Technology based start-ups are identified with the potential for employment generation, introduction of innovative products and services, income creation, and thereby contribute to regional economic development (Song, et al, 2008; OECD, 2013). However, these start-ups face innumerable challenges due to internal resource constraints and external threats, even prior to its emergence as much as after its emergence. Despite a positive impact on an economy, tech start-ups are very fragile and vulnerable especially during their first years, as a result of which, majority of them fails after being started and only a small fraction survives and succeeds to grow (Stokes and Wilson, 2010).

This can produce two undesirable outcomes: (i) under-utilized potential of a region to generate tech start-ups, and (ii) limited survival/success rate of emerged tech start-ups. In fact, tech start-ups have been observed to have a limited survival rate and a miniscule success rate in the USA (Song, et al, 2008; Barringer, et. al., 2005). These figures are likely to be much more pronounced in the larger global context, particularly in the context of emerging economies.

A healthy generation and growth (in terms of quality as well as quantity) of tech start-ups would call for support from the stage of ideation (through proof of concept, prototype development, early stage financing, talent acquisition, production, and market identification) leading to start-up creation, and further to start-up sustenance and growth. It is to derive the diverse merits of tech start-ups (through their "accelerated and healthy - emergence and growth") by providing them wide ranging support in an integrated manner 'under a single umbrella' that TBIs are increasingly introduced and promoted the world over. Though TBIs form a part of the support system as one of the indispensable components of an entrepreneurial ecosystem for tech start-ups (Bala Subrahmanya, 2017), they in fact provide access to various components of an ecosystem in a structured manner for the incubating ventures within, by themselves. Thus, they are an "ecosystem within an ecosystem" (Charry, et al, 2014).

Given this, TBIs may vary in typology and sponsors, goals and objectives, functions and services, incubation processes, outcomes and achievements. An adequate understanding of these issues is warranted to identify the research gaps, to propose a conceptual framework, to formulate the research objectives, scope and methodology of the current study.

2.2 TBIs: Types and Classifications

TBIs encompass independent organizations, and they can be examined from different perspectives and at different levels and subjects of analysis (Charry, et al, 2014). TBIs can be classified in terms of terminologies/titles used, revenue orientation/strategic objective, location, origin, sponsor, etc. TBIs are recognized by different names such as technology/business incubators, innovation/technology centres, science/research/technology parks, and business/seed accelerators. The terminology reflects scope of function as well as location (Mian, et al, 2016).

At the broadest level, TBIs can be classified in terms of their revenue orientation or strategic objective: (i) Not for profit and (ii) For profit. Not-for-profit TBIs are usually promoted by governments, local development agencies, universities, non-profit organizations, etc. whereas for-profit TBIs are generally promoted by private sector entities including corporate sector enterprises and private individuals (Von Zedtwidtz and Grimaldi, 2006).

The location of a TBI would determine its type and sponsor, apart from nature of services offered, objectives and achievements. Business accelerators located in the premises of corporate sector enterprises are promoted by companies; whereas Research Parks or Science Parks or Technology Parks or Knowledge Parks are promoted and therefore located in and around Universities or public research institutions (Caiazza, 2014). Industrial Parks or Business Innovation Centres are located in industrial clusters and sponsored by local development agencies.

Bergek and Norrman (2008) classified incubators based on three variables, namely, selection (according to the strategy selected), business support (scaled from strong intervention to laissez-faire) and mediation of regional or national systems; technological or sectoral innovation systems. But Barbero, et al, (2012) classified incubators under four archetype groups, namely, (i) research incubators, (ii) economic development incubators, (iii) university incubators, and (iv) private incubators. Private incubators include co-working spaces as well, which generally do not make any distinction in terms of sector or stage of lifecycle of start-ups, though mostly start-ups in the pre-incubation stage prefer to join them (Bala Subrahmanya, 2017).

Tavoletti (2013) identified four main categories of TBIs: (i) public non-profit incubators, (ii) private independent profit-oriented incubators, (iii) university business incubators, and (iv) private corporate profit-oriented incubators. Most of the TBIs across the world are non-profit organizations focused on regional economic development.

However, the most appealing classification of TBIs is made by tracing their evolutions by Bruneel, et al, (2012). The first generation of TBIs, which originated in the 1950s but became widespread in the 1980s across the world, offered affordable office space and shared resources. Infrastructure is the basic function common to all kinds of TBIs and core of their value proposition (Bruneel, et al, 2012). Infrastructure also included laboratories and research equipment.

The second phase of TBI evolution started emerging in the 1980s in response to accelerating unemployment in mainstream sectors such as automobiles and heavy engineering in the USA and Europe. TBIs became a tool for promoting new technology based ventures. These new ventures were typically found to be lacking business experience and marketing skills, which hampered their chances of survival. TBIs responded to these needs of tech based new ventures by including knowledge based services in their value proposition. Thus, the second generation TBIs represented much more than just a physical infrastructure provision to start-ups.

The third generation TBIs emerged in the 1990s, with a focus on external networking for resources comprising potential customers, suppliers, technology partners and investors. This resulted in the provision of institutionalized networks through TBIs to the incubating ventures, and that networking no longer depended on individuals' personal networks and contacts. The institutionalized networks enabled start-ups to overcome their inherent resource scarcity of various kinds and develop legitimacy faster than otherwise (Bruneel, et al, 2012).

Mian, et al, (2016) followed rather a similar pattern as that of Bruneel, et al, (2012), while exploring the types of TBIs. The first wave of TBIs, which originated in the 1950s in the USA, and went on till 1980, aimed at economic restructuring and job creation. During this period, TBIs primarily provided affordable space and shared services. The second wave of TBIs emerged in response to the concern of loss of industrial competitiveness in the 1980s in the USA, which prompted initiatives to encourage technology commercialization through new venture creation. Towards achieving this objective, TBIs offered a more complete menu of value-adding services including counselling, skill enhancement and networking. In the 1990s, the internet based virtual incubator model emerged to support new venture growth, particularly in the ICT sector. The digital economy gave rise to a new form of TBI mechanism, the accelerator (Mian, et al, 2016).

Thus, TBIs can be differentiated in terms of strategic objective for revenue generation, sponsors, location, method of selection and focus of support extended over the phase of a start-up lifecycle, period of evolution, etc. Such a classification is presented in Table 2.1. Given the different types of TBIs, with different strategic objectives, different kinds of promoters, with different kinds of support offering in different phases of start-up life cycle, it is appropriate to examine their overall goals and via media objectives.

2.3 TBIs: Goals and Objectives

Tavoletti (2013) contended that in general, the goals of TBIs would depend on its promoters or stakeholders, who could be different such as a university, a public institution or a private research lab, a private enterprise or an individual, etc. Even if the stakeholders are similar, their goals can be different. At the same time, Tavoletti (2013) assumed that the main stakeholder of TBIs is a regional policy maker whose main goal is to promote sustainability and qualified employment in a region, through the creation of innovative and technology based ventures. To that extent, TBIs can be considered an element of the regional innovation infrastructure whose special mission is to promote the development of innovation based start-ups (Rogova, 2014).

Table 2.1: Typology of Technology Business Incubators (TBIs)

Typology	Classifications				
Revenue objective	Not-For-Profit			For-Profit	
Sponsors	Government	University		Companies	Private individuals
Location	Industrial centres	University	R&D Centre	Company	Commercial centres
Method of selection	No sector focus	Sector focus	Technology focus	Stage focus	No sector focus
Focus of support	Pre-emergence to emergence stage	Emergence to stability stage	Emergence to stability to growth stage	Post-emergence stage	Pre-emergence to emergence & Post-emergence to growth stage
Period of evolution	I phase: basic infrastructure	II Phase: Infrastructure + Knowledge based services		III Phase: Infrastructure + Knowledge based services + external networks	
Title	TBIs or Business Innovation Centres	Science Parks, Research Parks, Knowledge Parks,		Accelerators or Virtual Incubators	Co-working spaces, Technopoles

Sources: Empirical literature

TBIs are popular tools as a means of accelerating the creation of successful new ventures so as to enable them to develop later into self-sustaining, thriving companies (Bruneel, et al, 2012). They are the policy tools that support innovation and technology oriented entrepreneurial growth (Mian, et al, 2016). They are created often with the help of public funded economic development agencies to support and accelerate the development and success of affiliated ventures to achieve economic development goals (Scillitoe and Chakrabarti, 2010).

Thus, the major goal of TBIs is nurturing entrepreneurship for successful venture creation and growth for economic development (Thierstein and Wilhelm, 2001). This is done by enabling knowledge transfer and providing services and resources, and correcting for the shortage of resources that start-ups often have to deal with (Porter and Kramer, 2011). The purpose of TBIs is promoting technology transfer and diffusion of new products, leading to the development of local innovative firms (EU, 2010). Thus TBIs ensure business stability through start-up survival and growth, employment generation and economic growth (Schwartz and Hornych, 2008). This holds good for TBIs as far as they are public funded vehicles for job creation, urban economic revitalization, and commercialization of university innovations. However, if they are privately funded organizations, the goal is to generate profitable new ventures with the potential to achieve accelerated growth, as quickly as possible.

But Salvador and Rolfo (2011) contend that TBIs have two primary objectives, namely, (i) to identify ventures that have great potentials for success but are constrained by resources, and (ii) to enable such ventures to overcome what is called the liability of newness and the liability of smallness and thereby create innovative firms that are competitive, profitable and sustainable. Sithole and Rugimbana (2014) define the objective in the context of University TBIs as the commercialization of technology and research by setting up new firms to graduate into fully fledged businesses.

Jordan (2010) is of the view that though TBIs might be of different types and might have different kinds of sponsors, they all have the same objective – find viable ventures and get them to early-stage financing by offering specific services and/or initial funding. A TBI seeks to accelerate the process from initiation towards a growing firm for its new ventures (Aaboen, 2009). This would ultimately lead to contributions to economic development through successful commercialization of innovations, employment generation and income creation.

Thus, TBIs aim at achieving multiple fundamental objectives such as to create new jobs and businesses, foster a climate of entrepreneurship, reduce firm mortality rate, reduce unemployment, commercialize technology, diversify, revitalize and accelerate growth of industry and local economies, increase university-incubation interaction and foster technology development (Bizzotto, 2003; Mutambi, et.al., 2010; Al-Mubaraki and Busler, 2011). The various goals and objectives extracted from empirical literature are given in Table 2. While there is considerable unanimity among empirical researchers about the goal and objectives of TBIs, there are differences in the way TBIs function and the services they provide to promote tech start-up creation and growth. Therefore, it is pertinent to understand the way TBIs function and the services they provide to the incubating ventures.

2.4 TBIs: Functions and Services

The major function of a TBI is to help entrepreneurs develop their ideas from inception through to commercialization and the launching of a new venture (Caiazza (2014). TBIs enable knowledge transfer and provide services and resources towards the creation of new ventures (Albort_Morant and Oghazi, 2016). Despite all the differences in the terminologies used, in terms of location, ownership structure, etc., a function commonly shared by all the kinds of TBIs is that they create a conducive environment to new and small ventures to help them to cope with the difficulties exist in the initial stages, survive and grow and become successful mature businesses (Ozdemir and Sehigotlu, 2013).

Table 2.2: Goals and Objectives of TBIs

1. Goals
Regional economic growth & development
Fertile environment for innovation generation, commercialization & technology development
Fertile environment for technology entrepreneurship
2. Objectives
New venture creation (as healthy and as fast as possible)
Job generation
Promotion of innovation & commercialization
Technology development & transfer
Income and wealth creation
Export promotion
University-industry interaction
Reduction of unemployment rate & firm mortality rate
Firm growth & Industry growth

Source: Empirical literature

TBI is an intermediate organization in an entrepreneurial value chain whose main function is to provide a social environment, technological and organizational resources and managerial expertise for the transformation of a technology-based business idea into an efficient economic organization (Phan, et al, 2005). Thus the primary function of TBIs is to commercialize new technologies through innovative entrepreneurial ventures, as they provide social, technological, managerial and financial resources for the start-up phase of a new venture that transform a technology-based new idea into an innovative firm (Ayawongs, et.al, 2007; Corsi and Berardino, 2014).

Given this, some of the common services rendered by TBIs are provision of physical space at subsidized rates, shared basic services and equipment at little or no cost, business assistance, legal and technical advises and financial supports (Bruneel, et al, 2012: Hackett and Dilts, 2004; Grimaldi and Grandi, 2005). Most TBIs offer managerial and administrative assistance as well as physical infrastructure too their tenants. Thus, TBIs are primarily property based initiatives and their main functions are providing their tenants with a mix of services encompassing infrastructure, business support services and networking (Bergek and Norrman, 2008; Peters, et al, 2004). Alongside the service portfolio, business incubation also requires an appropriate selection criteria and exit policies (Aerts, et al, 2007).

A TBI is an environment for initiation and growth of knowledge and technology-intensive technology based firms (Aabeon, 2009). The TBI concept seeks an effective means to link technology, capital and know-how in order to leverage entrepreneurial talent, accelerate the development of new ventures, and thus speed up the exploitation of technology (Grimaldi and Grandi, 2005). Given this, an important function of a TBI is to enable timely graduation of its tenants (Rothaermal and Thursby, 2005). If this has to happen, TBIs must combine infrastructure with business support and provision of access to networks to its incubating ventures, but not all TBIs would be able to do this because various factors might limit them to confine themselves to a mere provision of infrastructure (Bruneel, et al, 2012).

But Pettersen, et al, (2016) argued that a TBI is an entity with an infrastructure intended to nurture incubated start-ups with critical resources in the pursuit of their survival and growth. Given this, though TBIs can provide incubating firms with resources such as office space, counseling, and other basic services, their more important function should be to stimulate internal networking, and exchange of knowledge between incubating firms (Sa and Lee, 2012; Kitagawa and Robertson, 2012). In addition, TBIs should help start-ups to build networks with external companies, organizations and other individuals (Hansen, et al, 2000). This was reiterated by Bergek and Norrman (2002) when they defined the functions and services of TBIs as to provide:

1. Shared office space, which is rented under more or less favourable conditions to incubates,
2. A pool of shared support services to reduce overhead costs,
3. Professional business support or advice (mentoring), and
4. Network opportunities, internal and/or external.

The potential benefits of TBIs can be assessed by understanding the nature of network resources provided by them to incubating start-ups. This would comprise internal networks among tenants within an incubator and external networks facilitated by the incubator, in addition to the networks developed by the incubating start-ups themselves, independent of TBIs. Thus network resources can be broadly divided into two: (i) TBI provided/facilitated network resources (internal and external), and (ii) start-ups' own external networks.

A network consists of a set of relationships with diverse agents or organizations (Walter, et al, 2006). An incubating venture would benefit from the incubator's extensive network comprising its staff and advisory board, local universities, industry contacts, consultants, and venture and angel investors as well as networking with other incubatees (Hackett and Dilts, 2004a). Network relationships play critical roles as the means of learning to acquire multiple resources such as obtaining customers and understanding their needs, access to finance, contacts to mentors, which will enable an entrepreneur which shorten and accelerate a firm's learning processes (Zahra, 2005).

This is especially valuable for start-ups in their pursuit of firm emergence and growth (Schutjens and Stam, 2003). The diversity of networks is more important than the network size, as network heterogeneity helps tech start-ups to grow and succeed (Baum, et al, 2000). Therefore, one of the core functions of TBIs is to provide networking opportunities for their tenants to establish collaborative relationships with external agents or organizations (Sa and Lee, 2012). Most TBIs provide office space, funding, and basic services, but better ones also offer an extensive network opportunities and thereby enable their incubating ventures to beat their competitors to market (Hansen, et al, 2000).

While TBIs may provide network opportunities to all of their incubating ventures, it would be virtually impossible to fully address each of the tenant's networking needs according to their industry and business plans, even if TBIs are sector-specific (Sa and Lee, 2012). Thus, the networks facilitated by the TBIs are generic in nature whereas the networks acquired by the start-ups themselves are specific in nature. The self-acquired networks are labelled as "idiosyncratic" because they are unique to the respective new ventures which satisfied their specific individual needs. Given this, the success of incubating ventures would depend on the "private" external networks acquired through their own efforts rather than facilitated by a TBI (Petterson, et al, 2016). Therefore, TBI provided networks can complement but cannot substitute the tenants' external networks, which appear to be crucial for their success. A summary of empirical literature based functions and services offered by TBIs is presented in Table 2.3.

Table 2.3: Functions and Services of TBIs

Functions
Help prospective entrepreneurs to develop their ideas from inception through to commercialization and the launching of a new venture
Facilitate transformation of a technology-based business idea into an efficient economic organization
Link technology, capital and know-how in order to leverage entrepreneurial talent, accelerate the development of new ventures, and thus speed up the exploitation of technology
Enable timely graduation of its tenants
Services
Shared physical space at subsidized rates
Shared basic services and equipment at little or no cost
Business assistance, legal & technical advices, and financial support
Promote (internal) networking among incubating ventures
Provide access to TBI's external networks

Source: Empirical literature

2.5 TBI led Process of Business Incubation

There could be various factors such as TBIs' age, size, facilities provided, network opportunities facilitated, local environment, etc., which have an influence on the performance of any incubation programme, but it is the incubation process/practice pursued by TBIs which is perhaps the most important determinant of its success (Ayatse, et.al., 2017). A business incubation programme, as a tool of promoting innovation, job creation and economic development, is designed to add value to new ventures (which have joined for incubation) to increase the survival rates (Ayatse, et.al., 2017).

Campbell, et.al., (1985) are recognized as the first to conceptualize a business incubation process model. They identified four basic services or value-adding activities, which have a bearing on firm formation and success in a TBI. The whole process begins with a diagnosis of needs for the new ventures which have sought admission into an incubator for incubation help with their business proposals. When the diagnosis results in the shortlisting of a new venture for incubation, the monitoring of such new ventures (incubator tenants) starts. The incubator tenants enjoy access to common business and professional services and in addition, value adding activities through access to finance, expert networks for market identification and advise. The tenants then graduate from the incubation programme as successful growth ventures. But the major fallacy in the model is the fundamental assumption that all incubated start-ups would survive.

Broadly, the incubation process comprises three stages (Bizzotto, 2003): (i) pre-incubation, (ii) incubation, and (iii) post-incubation. The way in which TBIs operate can be depicted in terms of a simple input-output model. According to this model, there are three major elements of incubation: (i) inputs: these mainly consist of stakeholder inputs, management resources and projects put forward by entrepreneurs, (ii) processes: the various inputs are brought together in the business incubation process through the provision of incubator space and a variety of value-adding services to start-ups, and (iii) successful start-ups which graduate with positive job and wealth creation impact. However, this model does not throw much light on how does the incubation process really enable venture formation and emergence.

An incubation process primarily deals with its internal dynamism, with a link to its external environment (Hackett and Dilts, 2004). Their model of incubation process begins with the selection of incubatees from a pool of prospective new venture applicants who enter into the 'black-box' of incubation. The incubating ventures undergo value-addition activities in three ways: (i) selection performance (which refers to the selection of incubatees, which are prospective firms which exhibit potential to excel), (ii) monitoring and provision of business assistance, and (iii) resource munificence (providing requisite resources to help the incubating firms to develop and graduate). The incubated ventures then emerge from the 'black-box' of incubation as graduated firms with an outcome, that is either success or failure. Thus, Hackett and Dilts (2004) have considered both the possibilities of success and failure of an incubated venture as an outcome of the incubation process.

According to Azih and Inanga (2014), incubation of businesses can be categorized into 3 stages: (i) Pre-incubation, (ii) Incubation, and (iii) Post-incubation. In the pre-incubation stage, entrepreneurs are provided with free accommodation and free business support to help them with the investigating and defining of how they intend to develop their venture through ideation, POC, finding out early product adopters, with a management team, the operational aspects of the business, and the finances of the business. Pre-incubation helps entrepreneurs as they develop their business ideas through to commercialization of their products. The process is highly subsidized, and venture formation is measured by their ability to sustain the business while weathering the storm associated with starting a business.

In the incubation phase, the business idea is nurtured and developed through a series of problem solving. Incubation program involves daily monitoring and assessment followed by reporting to see that problems that have been identified are resolved with the help of the experts. In the post-incubation phase, the ventures graduate and move out of the incubation centre. This involves monitoring and assessment of the ventures of graduated entrepreneurs to make sure that they still enjoy all the support services in a highly subsidized way for business continuity.

Mian, et.al, (2016) state that the TBI mechanism is associated with the incubation process that a start-up is expected to undergo during its life cycle. Broadly, the incubation process is expected to involve three phases: (i) Pre-Incubation/Idea development, (ii) Incubation and Acceleration, and (iii) Post-Incubation, Consolidation and Growth. While some science parks support the entire incubation continuum – germination, incubation, and consolidation – most facilities do not. This heterogeneity leads to inconsistent definitions, criteria for evaluating effectiveness, determination of how much value TBIs add, and determination of key success factors (Albort-Morant and Ribeiro-Soriano, 2015). These differences in organizational structure and objectives hamper the development of a unified conceptual framework for TBI research. The broad stages of business incubation as derived from empirical literature is given in Table 2.4.

Table 2.4: TBI led Incubation Process

Scrutiny of applications/ideas submitted by prospective start-up founders for match making
Admission of shortlisted prospective start-up founders to the TBI
Provision of space, and access to common infrastructure and services
Provision of legal, & technical advice (internal/external) for facilitating Ideation, POC & Prototype development for a Minimum Viable Product (MVP)
Provision of business advice (internal/external) for market identification
Provision of seed funds and link with (external) angels or early stage venture capital funds
Product generation and linking with early product adopters
New venture graduation

Source: Empirical literature

2.6 TBIs: Performance Assessment in terms of Outcomes and Achievements

Despite the lack of unanimous description and understanding of what contains the 'business incubation process', empirical researchers have attempted to assess the outcomes and achievements of TBIs in diverse ways. It is essential to understand the varied ways of TBI performance assessment made in empirical research.

The performance assessment of TBIs in terms of outcomes and achievements has to be done with respect to its stakeholders, goals and objectives, but incubation process would be its major determinant. Further, while some have assessed the impact of TBIs at the individual firm level, others have estimated the impact at a macroeconomic level (Huasberg and Korreck, 2018). Most of the empirical studies conducted so far is based on case studies, which are largely considered atheoretical and that analysis of perceptual data of a small number of incubators is inappropriate (Barbero, et.al., 2012). Aernoudt (2004) pointed out that TBIs in the world are of uneven quality, and their evaluation must take into account differences in the archetype of TBIs as they have different missions. TBIs with different stakeholders and different incubation models produce different outcomes and performances, and therefore different evaluations of effectiveness is essential.

Even if the stakeholders are similar, their goals can be different. Therefore, measuring outcomes without putting them in relation to different stakeholders and their different goals is meaningless (Tavoletti, 2013). As a result, despite the steady increase in the number of TBIs since the early 1980s, there has been no single framework available to assess the way they are working and thereby improve their effectiveness (OECD, 1997). Though there are several empirical studies on the performance of TBIs, no single standard method which is universally acceptable has emerged to measure the incubation performance and make comparisons (Phan, et.al., 2005; Odemir and Sehitoglu, 2013). This is due to the definitional challenge of what incubators are as much as due to a lack of consensus among researchers on what constitutes an appropriate measure of incubator performance (Ayatse, et.al., 2017).

Therefore, TBI performance measure has become one of the most controversial issues among empirical researchers ((Barbero, et.al., 2012). As a result, in the business incubation literature, different kinds of performance indices are used such as revenues, finance, venture capital funds, graduation from incubation programmes, firm survival, organizational or firm growth, job creation, sales growth, profitability, patents registered, number of patent applications filed, employment growth, technology development, R&D productivity, etc. (Ayatse, et.al., 2017).

A more acceptable way of TBI performance assessment may be done in terms of immediate outcomes in the form of success or failure of incubated ventures after graduation, the number of jobs created and income generated by the successfully emerged new ventures, and its larger impact on the regional economy. In this regard, Hackett and Dilts (2004) are of the view that performance of TBIs is possible by examining five different, mutually exclusive, outcomes at the completion of incubation process, namely:

1. The incubate is surviving and growing profitably,
2. The incubate is surviving and growing and is on a path toward profitability,
3. The incubate is surviving but is not growing and is not profitable or is only marginally profitable,
4. Incubatee operations were terminated while still in the incubator, but losses were minimized,
5. Incubatee operations were terminated while still in the incubator, and the losses were large.

While the first three would indicate incubation success, the last two indicate incubation failure. Of course, the first three represent only a snapshot of the incubatee's performance on "graduation day" and are no guarantee of future success or failure.

Ozdemir and Sehitoglu (2013) have identified eight performance measures used in literature for evaluating TBIs: (i) tenant firms' survivability, (ii) tenant firms' sales growth, (iii) tenant firms' employment growth, (iv) tenant firms' profit growth, (v) tenant firms' raised finance, (vi) tenant firms' taxes growth, (vii) tenant firms' export growth, and (viii) tenant firms' number of copyrights. But these are used primarily in the context of developed countries.

Several studies have used an array of input and output indicators for assessing the performance of TBIs. Westhead's (1997) perspective on TBI performance is one of the most followed. For input R&D, he used the proportion of QSEs employed in a firm, primary research thrust as radical new research, and some financial indicators measuring R&D intensity such as R&D expenditure, or gross R&D investment as a percentage of total sales revenue. For output R&D, he used the number of patents, and the introduction of new products or services, either for existing clients or for new markets. In Westhead's method, there is an implicit assumption that new ventures start generating sales revenue as and when they emerge out of a TBI, which is not necessarily true. But these measures are exclusively confined to incubatees and their performance, and this forms just one of the dimensions of TBI performance. Many studies have used a venture survival rate either as a sole indicator or as part of a set of indicators. But using survival of incubated firms as an indicator has been widely criticized. Phan, et. al. (2005) believe the measure lacks construct validity and creates an endogeneity problem as incubators are designed to maintain incubators alive.

There are a variety of measures of incubation performance or outcomes such as occupancy rate, added value of incubator service, the number or proportion of firms graduated, growth rate of tenant firms, jobs and wealth created (Phan, et al, 2005; Chan & Lau, 2005; Hackett and Dilts, 2008) and number of patent applications per firm (Colombo & Delmastro, 2002). But Mian (1997) had adopted a broader approach for the performance assessment of TBIs. The TBI performance outcomes are assessed using four elements: (a) programme sustainability and growth; (b) tenant firms' survival and growth; (c) contribution to the sponsors' mission; and (d) community-related impacts.

In summary, assessing incubator performance should be done taking into account all the relevant influences. But complex models are valid for case studies. For empirical research involving a larger sample size, it is appropriate to use a set of indicators which would facilitate analysis and drawing conclusions. Accordingly, Barbero, et al, (2012) used a set of indicators, widely used in literature, based on input R&D and output R&D. Output R&D measures used are employment growth, sales growth, patents generated and introduction of new products and services. Input R&D measures included Qualified Science & Engineers as a percent of total employees, gross R&D investment as a percent of sales, contribution to domestic R&D programmes as a percent of sales, contribution to European R&D programmes as a percent of sales, and cost incurred per job.

The above discussion throws light on the typology and sponsors of TBIs, their goals and objectives, functions and services, process of incubation, and outcomes and achievements of the incubation process based on empirical research findings in diverse contexts. While there is wide divergence in the typology and sponsors, services rendered and therefore process of incubation leading to different outcomes and achievements, there is convergence as well with respect to the key objective of a TBI in the form of facilitating or nurturing technology based new ventures, for their successful emergence and growth as "healthily and quickly" as possible, subsequently. A consistent emergence of successful technology start-ups and their growth would invariably result in new products and services, possibly through commercialization of innovations and technology transfer, more employment generation, income creation, sales growth, possibly, patent generation, with an overall positive impact on regional economic growth. The broad indicators of TBI performance in terms of outcomes/achievements are presented in Table 2.5.

Table 2.5: TBI Performance Assessment: Outcomes and Achievements

Outcomes/Achievements
Success or failure of incubated start-ups to emerge
Success or failure to develop/exploit internal and/or external networking
Success or failure to generate jobs
Success or failure to generate revenue
Success or failure to introduce new products/services
Success or failure to generate innovations & its commercialization for new venture creation
Success or failure to develop new technologies for transfer
Success or failure to obtain patents
Success or failure to contribute in terms of R&D inputs and R&D output
Success or failure of emerged start-ups to sustain and grow
Success or failure to contribute to exports
Success or failure to reduce firm failure rate & unemployment rate
Success or failure to contribute to regional economic growth

Source: Empirical literature

Based on the above literature discussion, we have identified some key research gaps, which are as follows:

- There is no comprehensive empirical study which has examined the whole process of business incubation covering pre-incubation, incubation, and post-incubation stages of start-up nurturing and emergence.
- Empirical studies are lacking to throw light on the factors which determine the selection of incubatees, and the effectiveness of incubation for the emergence of start-ups.
- Literature is inadequate to throw light on how institute promoted TBIs differ from industry backed TBIs?
- There is no unanimity in measuring the performance of TBIs, particularly with respect to its R&D contributions to a national economy.

It is against the backdrop of these identified research gaps that we have proposed to undertake our study, in the context of Indian economy.

[In the context of the above literature discussion, we have examined key theoretical contributions relevant in the sphere of technology business incubation, to conceptualize TBIs in terms of determinants of the incubation process and its cumulative impact on incubation outcomes resulting in new venture generation and growth. Subsequently, we proposed a conceptual framework linking sponsors, objectives, services, incubation process, and achievements of TBIs to set the research objectives of our study. The same is presented in Appendix 2]

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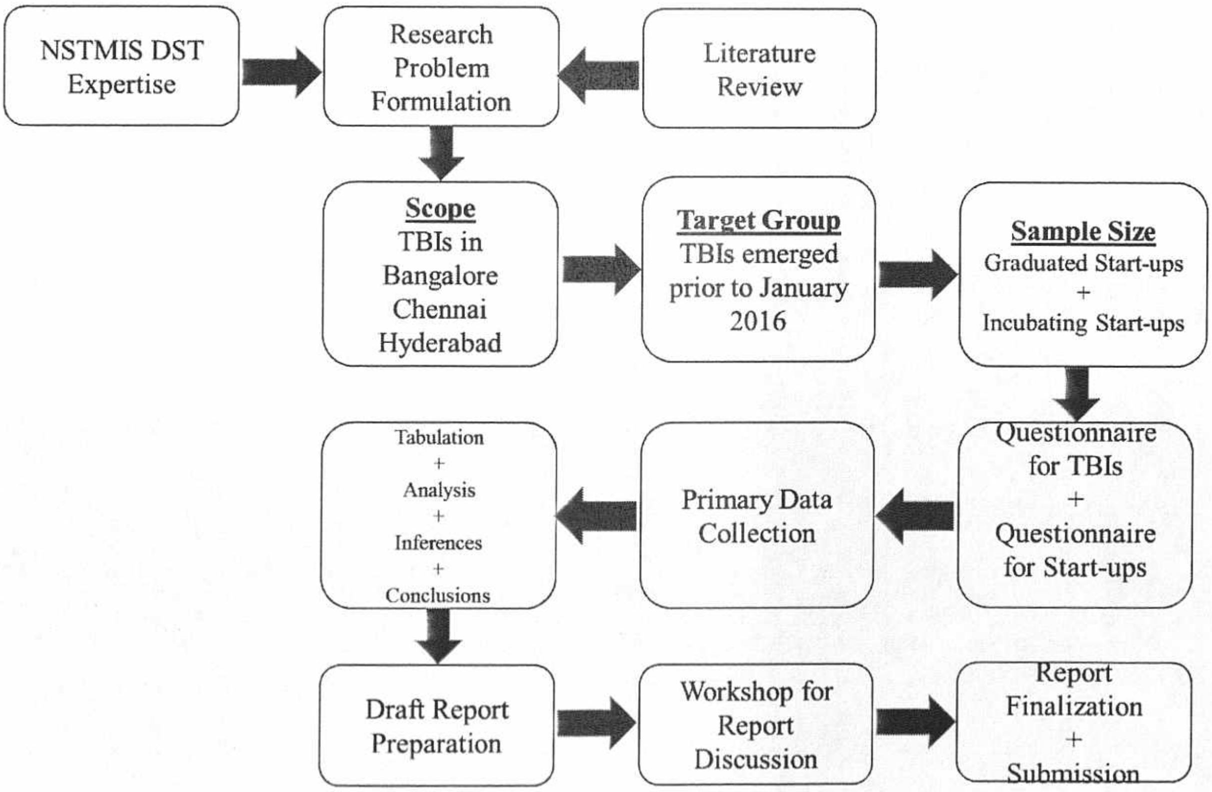
CHAPTER 3
OBJECTIVES, SCOPE AND METHODOLOGY

3.1 Introduction

The research objectives, scope, methodology adopted for data collection and analysis of research objectives are described in this chapter. The research objectives are formulated in the backdrop of research gaps ascertained based on literature review discussed in the previous chapter, supplemented by discussions with experts in the field. Subsequently, the scope of the study is determined followed by the development of an appropriate methodology for the collection of secondary and primary data for analyzing the research objectives of the study. The research process undertaken for the study is presented in Figure 3.1.

Figure 3.1: Research Process undertaken for the Study



3.2 Research objectives

The specific research objectives of the study are as follows:

1. To ascertain and understand the focus and objectives, and the nature of services offered for technology based start-ups by Institute promoted TBIs as compared to Industry promoted TBIs,
2. To explore and classify the technology based start-ups of TBIs (Institute as well as Industry promoted) based on sector, ownership, size, and objectives,
3. To probe the proportion of personnel devoted to R&D, proportion of investments made on R&D infrastructure, and number of patent applications submitted, new venture-wise for each of the TBIs, Institute as well as Industry promoted,
4. To examine the R&D outcomes in the form of new products/services developed for venture launching, patents obtained, and initial sales revenue generated, if any for each venture of the TBIs (of Institutes and Industries),
5. To ascertain whether the facilities provided by a TBI and the duration of time spent by an incubating venture have any impact on the R&D outcomes of incubating ventures,
6. To assess the overall contributions of TBIs (Institute as well as Industry promoted) through new ventures in the form of R&D personnel, R&D investments and R&D outcomes, to the national R&D efforts of our country.

3.3 Scope, Sampling and Data Collection

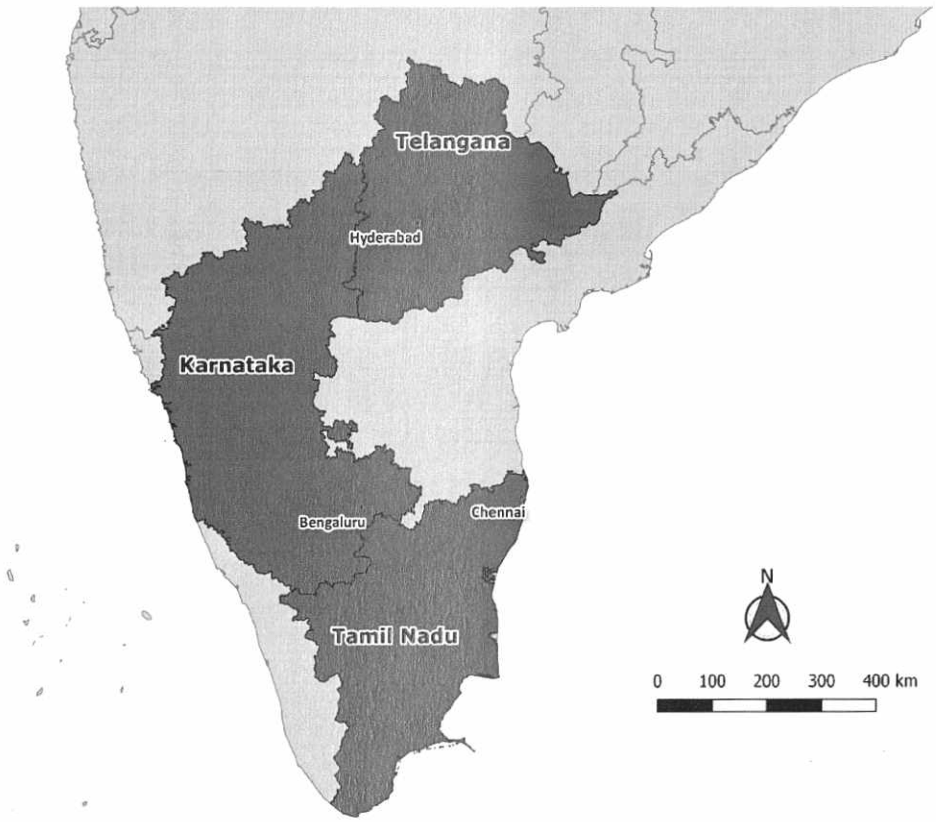
A preliminary state-wise tabulation of TBIs gathered from multiple public and private sources independently reflected that Tamil Nadu, Karnataka, and Telangana are three of the leading states in India which account for a majority of the TBIs currently operating in the country (Table 3.1). A majority of these TBIs functioning in the three states are located in their respective Capital cities, namely, Bangalore in Karnataka, Chennai in Tamil Nadu and Hyderabad in Telangana (Figure 3.2). Bangalore, Chennai and Hyderabad are the three important start-up hubs in South India, and they account for a considerable number of TBIs/Accelerators/Co-working spaces in the country (Joshi and Krishna, 2014).

Table 3.1: Distribution of Technology/Business Incubators in India: State-wise

Source→ **State**	**ISBA**	**NSTEDB**	**Inc42 Media**	**NCL Innovations**
Andhra Pradesh	--	3	--	7
Arunachal Pradesh	--	--	--	1
Assam	--	--	2	2
Bihar	--	--	3	--
Chhattisgarh	--	--	--	--
Delhi	3	3	6	11
Goa	--	2	2	3
Gujarat	4	9	13	18
Haryana	1	1	1	5
Himachal Pradesh	--	1	--	1
J & K	--	2	1	--
Jharkhand	--	1	1	3
Karnataka	**8**	**15**	**16**	**18**
Kerala	5	8	9	7
Madhya Pradesh	--	1	3	4
Maharashtra	7	10	9	19
Mizoram	--	1	--	--
Nagaland	--	--	--	1
Odisha	1	2	3	5
Puducherry	--	--	1	--
Punjab	1	4	3	5
Rajasthan	1	4	3	3
Tamil Nadu	**15**	**21**	**23**	**31**
Telangana	**7**	**8**	**12**	**11**
Uttar Pradesh	6	7	11	16
Uttarakhand	--	2	3	--
West Bengal	2	4	5	6
Total	**61**	**109**	**130**	**181**

Sources: 1. ISBA (2018): http://isba.in/members/directory/
2. NSTEDB (2018): http://www.nstedb.com/institutional/tbi-2016.htm
3. Inc42 Media (2018): https://inc42.com/startup-101/top-startup-incubators-india/
4. NCL Innovations (2018): http://www.venturecenter.co.in/incubatordb/

Figure 3.2: Locations of Cities selected for the Study



Therefore, the scope of the present study is confined to all the TBIs/Accelerators/Co-working spaces located in Bangalore, Chennai and Hyderabad. All the TBIs in the public sector, and all the TBIs, Accelerators and Co-working spaces in the private sector in all the three cities fell within the scope of the study. In addition, graduated as well as incubating start-ups from these would be covered to ascertain the incubation process as well as incubation outcomes of these incubators.

The primary data collection exercise comprised three stages:

Stage 1: At the outset, we developed an exhaustive database of TBIs, Accelerators and Co-working spaces operating in Bangalore, Chennai and Hyderabad. This is done based on secondary data, available from both official and non-official sources, in April 2017. The exhaustive database in terms of the distribution of TBIs, Accelerators and Co-working spaces in the three cities is presented in Table 3.2. Obviously, Bangalore being the leading start-up hub in the country, accounted for the maximum number of TBIs, Accelerators and Co-working spaces (Bala Subrahmanya, 2017). This is followed by (i) Hyderabad and Chennai with respect to TBIs and Accelerators, and (ii) Chennai and Hyderabad with respect to Co-working spaces.

Table 3.2: Generated Database of TBIs, Accelerators & Co-working spaces

	Bangalore	Chennai	Hyderabad	Total
TBIs	38	15	19	72
Accelerators	22	3	12	37
Co-working Spaces	60	40	30	130
Total	120	58	61	239

Among the three major kinds of incubators, Co-working spaces accounted for the majority in all the three cities. As these are milder versions of incubators, which primarily provide shared office environments for freelancers, small firms and start-ups for collaboration, creativity, idea sharing, networking, socializing, and generating new business opportunities, they have been increasing rapidly all over the world (Fuzi, 2015; Gerdenitsch, et.al., 2016). In 2015, 7800 Co-working spaces existed worldwide with a growth rate of 83% between 2012 and 2013, which grew further by 36% between 2014 and 2015 (Foertsch, 2013, 2015). According to one source, there are about 400 Co-working spaces operating out of India now (Coworker, 2018).

We focused on only those TBIs, Accelerators and Co-working spaces, which are at least two years old, that is, only those which have started their operations by allowing new venture incubation by December 2014. The logic behind such a prescription of a minimum age of two years is that, a meaningful study of TBIs, Accelerators and Co-working spaces is possible, only when they have established their operations and set in place a well-defined incubation process for incubating start-ups. Accordingly, we segregated TBIs, Accelerators and Co-working spaces, which have started their operations before January 2015 from the generated database, as given in Table 3.3.

Table 3.3: Summary Statistics of the Centralized Database curated for the project

	Bangalore	Chennai	Hyderabad	Total
TBIs	34	11	14	59
Accelerators	18	1	8	27
Co-working Spaces	45	32	26	103
Total	97	44	48	189

Stage 2: After the completion of I Phase data collection, a one-page initial questionnaire was developed to capture the basic profile information of all the TBIs, Accelerators and Co-working spaces that were identified in the database. This initial questionnaire was designed to capture data on: (i) their functions and objectives, (ii) services offered to their occupants, (iii) number of occupants, and industry sector in which they operate, to segregate tech start-ups from non-tech start-ups, if any and gather data for tech start-ups on the year of occupation, and (iv) number of tech start-ups graduated from these TBIs, Accelerators and Co-working spaces. The contents of the initial questionnaire are given in Annexure 1.

As part of II Phase data collection exercise, the initial questionnaire was administered to each of the entities identified in the database of TBIs, Accelerators and Co-working spaces. These entities were contacted using various modes of in person meetings, telephonic discussions and emails, during May-June 2017. Out of the 189 entities that formed the addressable population for the scope of the study of this project, we received completed responses from 114 entities. The remainder of the entities either provided incomplete information or did not respond to our repeated requests to participate in the study. The list of TBIs, Accelerators and Co-working spaces which responded to our questionnaire in the three cities is given in Table 3.4.

Table 3.4: Summary Statistics of the number of Respondents to II Phase Data Collection

	Bangalore	Chennai	Hyderabad	Total
TBIs	26	11	11	48
Accelerators	16	0	6	22
Co-working Spaces	18	16	10	44
Total	60	27	27	114

The responses to the initial questionnaire enabled us to arrive at the final subset of TBIs, Accelerators and Co-working spaces for which primary data have to be gathered. The review of the responses from the entities revealed that all the entities were incubating and/or engaging tech start-ups. Hence, all these entities formed the addressable population for the final (III Phase) data collection. In order to proceed towards the final phase of primary data collection, two semi-structured schedules were developed. The first semi-structured schedule was developed to collect data from the TBIs, Accelerators and Co-working spaces. The other schedule had questions that were aimed at collecting data from the tech start-ups that were incubated/are currently being incubated in these entities.

The TBI, Accelerator and Co-working space focused schedule contained questions to collect data on (i) selection criteria, key result areas and key performance indicators of the entity, (ii) the hard and soft infrastructure facilities present at the entity, (iii) activities and resources available to promote technology transfer and commercialization of innovation at the entity being studied, and, (iv) facilities provided to the start-ups on various functional areas such as marketing, sales, hiring, funding and mentoring support.

The schedule focused on the currently incubated start-ups/alumni had questions regarding (i) background of promoter/s of start-ups, (ii) objectives of start-ups, (iii) the size of each tech start-up in terms of number of personnel, their background and qualifications, (iv) size of investments made on R&D infrastructure (including software, database, and equipment, etc.), (iv) number of patent applications submitted as well as obtained, if any, (v) R&D outcomes generated in the form of tech products/services, and initial market penetration made by realizing sales revenue.

In addition, there are some qualitative questions about the future technology-cum-product market strategy, size and nature of personnel to be hired and R&D infrastructure to be acquired in the immediate future. Both of these semi-structured schedules are enclosed (Annexures 2 and 3, respectively). With these instruments, the project team started the final stage of primary data collection in July 2017. All the 114 entities that formed the addressable population for the study were contacted for the detailed data collection exercise. The data collection exercise was completed in December 2017. The final status of primary data collected across the three entities (TBIs, Accelerators and Co-working spaces) as well as across the three locations (Bangalore, Hyderabad and Chennai) is presented in Table 3.5. Only 31 of the 48 TBIs, 9 of the 22 Accelerators and 25 of the 44 Co-working spaces provided us complete data based on the questionnaire. Thus primary data provided by a total of 65 out of the total 114 TBIs, Accelerators and Co-working spaces, formed the basis for analyzing our research objectives.

Table 3.5: TBIs, Accelerators & Co-working spaces: Bangalore, Chennai & Hyderabad

Entities→	TBIs				Accelerators				Co-working spaces			
Location	TP	CR	PR	NR	TP	CR	PR	NR	TP	CR	PR	NR
Bangalore	26	13	5	8	16	7	0	9	18	11	1	6
Chennai	11	8	0	3	0	0	0	0	16	7	2	7
Hyderabad	11	10	1	0	6	2	0	4	10	7	2	1
Total	48	31	6	11	22	9	0	13	44	25	5	14

Note: TP-Total Population; CR: Complete Response; PR- Partial Response; NR-No Response

Table 3.6 summarizes the final status of primary data collected from the start-ups that were either under incubation, or that had graduated out of these entities. Only those tech start-ups which have been operating for at least one year as on 1st January 2016 and those which have graduated are approached for primary data collection.

Table 3.6: Data Collection Status from Start-ups: Graduated & Under Incubation

	ENTITES											
	TBIs	ISUs	GSUs	Total	Accelerators	ISUs	GSUs	Total	CWS	ISUs	GSUs	Total
Bangalore ISUs+GSUs	10	10	10	**20**	7	7	7	**14**	10	10	10	**20**
Bangalore (ISUs only)	3	3	N.A	**3**	0	0	N.A	**0**	1	1	N.A	**1**
Chennai (ISUs+GSUs)	5	5	5	**10**	0	0	0	**0**	0	0	0	**0**
Chennai (ISUs only)	3	3	N.A.	**3**	0	0	N.A	**0**	7	7	N.A.	**7**
Hyderabad (ISUs+GSUs)	6	6	6	**12**	2	2	2	**4**	2	2	2	**4**
Hyderabad (ISUs only)	4	4	N.A.	**4**	0	0	N.A	**0**	5	5	N.A.	**5**
Total	**31**	**31**	**21**	**52**	**9**	**9**	**9**	**18**	**25**	**25**	**12**	**37**

Note: ISUs = Incubating Start-Ups; GSUs = Graduated Start-Ups; CWS = Co-working spaces

N.A. = Not Applicable; Total = Total number of start-ups (ISUs + GSUs)

In all, we were able to collect complete data from 65 entities out of the addressable population of 114 (57% of the total addressable population). Further, the team was able to collect primary data from a total of 107 start-ups that were either undergoing incubation or had graduated out of these 65 entities. Thirty-one TBIs from a total of 48 Incubators across the three locations (constituting to about 65% of the Incubators under the scope of our study) provided complete data for the

Questionnaire. Nine Accelerators from a total of 21 Accelerators across the three locations (41% of the Accelerators that met the criteria for our study) provided inputs to our Questionnaire. Further, the project team was able to collect complete data from 25 Co-working spaces out of a total of 44 Co-working spaces, across the three locations (constituting about 57% of the total addressable population of the Co-working spaces).

As regards to the primary data collected from start-ups, start-up hub wise, a total of 58 start-ups have provided complete data in Bangalore, across the three entities (TBIs, Accelerators and Co-working spaces), with 31 among them being under incubation, and 27 that are alumni (graduates) from the entities that they earlier incubated from. From Chennai, primary data were collected from a total of 20 start-ups, of which 15 were under incubation and five start-ups had graduated from the entities that they were earlier incubated from. In Hyderabad, a total of 29 start-ups provided complete data for the study, of which 19 start-ups were under incubation and the reminder 10 were start-ups that had graduated.

3.4 Methods of Data Analysis

The first research objective is to understand the focus, objectives and nature of services offered by incubators (TBIs, Accelerators and Co-working spaces) of institutions relative to that of industries. They are analyzed descriptively with the help of tables, figures and charts. The purpose here is to develop a profile of TBIs based on their year of incorporation, title, sponsor, location, objectives, sector focus, stage focus, key resources/facilities provided for incubation, educational qualifications of the CEO, prior industry/startup experience of the CEO, etc. This will enable us to develop a typology of these incubators located in three different cities, and the variations if any between them. Stepwise backward elimination logistic regression would be carried out in order to ascertain the distinguishing features of institute promoted TBIs vis-à-vis industry promoted TBIs.

The second research objective is to explore and classify the technology based start-ups of TBIs (Institute as well as Industry promoted) based on sector, ownership, size, and objectives. The profile of the TBIs developed based on the raw data provides initial descriptive insights on the above aspects of examination of the TBIs. Stepwise backward elimination logistic regression would be carried out on the data set to understand the differences between the stage focus and sector focus among the institute promoted TBIs vis-à-vis industry promoted TBIs.

The information profile of the TBIs developed to address the first two research objectives will enable us to lay out a process map for the overall incubation lifecycle. The data collected for the purposes of the research project also enables us to shed light on the three critical phases of the incubation lifecycle, namely: Selection, Incubation and Graduation. A descriptive and quantitative analysis of the above three lifecycle stages of TBIs will help us further understand the differences between Institute and Industry promoted TBIs. Using stepwise backward elimination multiple regression analysis, data would be examined to understand the selection process at the TBIs better – particularly we will probe what characteristics and facilities of TBIs influence or determine the number of applications received by each of them. Later, we will proceed to ascertain what variables account for the differences in the number of occupants between these TBIs. The above two aspects provide insight into the selection processes followed by the TBIs. Lastly, we will probe and understand what variables have contributed to the higher annual graduation, and higher cumulative graduation to cumulative admission ratio. This analysis will help us understand the dynamics of the graduation related processes of TBIs. We will be using stepwise backward elimination regression in order to ascertain the factors that influence the graduation of startups in the TBIs.

The third and fourth research objectives are to examine the contributions of incubated as well as incubating new ventures to national R&D efforts in terms of R&D inputs as well as R&D outputs. The R&D input contributions would include proportion of personnel devoted to R&D, and proportion of investments made in laboratory equipment and machinery used for carrying out R&D. The R&D outcomes are assessed in terms of introduction of new products/services, patents obtained, and revenue generated. A two-way relationship between R&D inputs and R&D outputs is examined by means of correlation analysis, and further between the three cities as well as between TBIs, Accelerators and Co-working spaces by statistically analyzing the following research questions:

1. What factors influence the R&D investment expenditure and the R&D personnel employed by TBIs?
2. What factors influence the generation of new products/services, new patent applications and revenue from sales of new products/services from the TBIs?

The variables influencing R&D input contributions and R&D output contributions are ascertained by means of stepwise (backward elimination) multiple regression models.

To analyze the fifth research objective, to ascertain the influence of incubation facilities provided and time spent by incubating ventures in an incubator on the R&D outcomes of incubating/incubated ventures, we will examine the factors that influence the R&D investment expenditure and the number of R&D personnel employed by the startups using regression models. The results from the above models will enable us to explain the extent of contribution of the TBIs on the R&D inputs of the startups. Further, we will examine the factors that influence the generation of new products/services from the startups, revenue generated from the startups and the ability of startups to file for patents. These will be examined by using regression models. The results from the above models will enable us to explain how TBIs have contributed to the R&D outputs of the startups.

The sixth and the final research objective is answered by summing up the R&D input and the R&D output contributions of all the TBIs, Accelerators and Co-working spaces in the three cities.

****

Annexure 1: Phase II Questionnaire to collect Preliminary Information from the TBIs

1. Name of the TBI:

2. Address of the TBI (please include City name in the address):

3. Type of the TBI: Incubator / Accelerator / Co-working space / Other (Research Park based)

4. Promoters of the TBI: Government / Academia / Corporate / Privately backed (Tick all options that apply)

5. Focus area / sectors / stage [idea / survival / growth / scale] for promotion of start-ups, if any:

6. Objectives of the TBI:
a. ……………………………… c. ……………………………..
b. ……………………………….. d. ……………………………..

7. Services Offered by the TBI(Please tick the appropriate choice):

	YES	NO
Market Access Support		
Funding Support		
Technology and R&D Support		
Sales Enablement Support		
Marketing & Branding Support		
Hiring Support for startups		
Operations Management Support:		
1. Legal Support Services		
2. Accounting and Finance Support Services		
3. Hardware/Software Infrastructure Support		
(Equipment/Cloud credits etc) 4. Common Office Facilities (Printer/Scanner/Fax/Pantry etc.)		
Mentoring Support on above activities		

8. Year of Incorporation of the TBI:
9. Number of graduated start-ups since the TBI's inception:
10. Number of start-ups currently being incubated in the TBI:
11. Total capacity of the facility (in terms of # of seats):
12. Do you as a TBI provide access to all of these/any of these (Please tick the appropriate choice):

	YES	NO
Proof of Concept (POC) Center		
Prototype Development and Testing Center		
Product Development and Testing Center		

Annexure 2: Questionnaire targeted to the TBIs

Part – I: Basic Profile of the TBI

1. Name of the TBI:
2. Address of the TBI:
3. Type of the TBI: Incubator / Accelerator / Co-working space / Other (Research Park based)
4. Promoters of the TBI: Government / Academia / Corporate / Privately backed (Tick all options that apply)
5. Focus area / sectors: stage [idea / survival / growth / scale] for promotion of start-ups, if any:
6. Objectives of the TBI:
   a. ………………………………… c. ………………………………..
   b. ………………………………….. d. ………………………………..
7. Year of Incorporation of the TBI:
8. Year-wise details of number of graduated start-ups since the TBI's Inception:

Year of Establishment	2017-18	2016-17	2015-16	2014-15	2013-14	2012-13	2011-12	2010-11	2009-10	2008-09
No of Start-ups Joined the Incubation										
No of Start-ups Graduated										
No of Start-ups under Incubation										

9. What are the key challenges faced by the TBI:
   a. ………………………………… c. ………………………………..
   b. ………………………………….. d. ………………………………..

Part – II: Selection Process, KRA and KPIs of the TBI

1. Key Result Areas that are the focus of the TBI:

   a. ……………….. b. ………………………. c. ………………..

2. Selection of Applications:
   a. Number of applications for incubation/acceleration received / quarter:

   b. Proportion of applications accepted/quarter:

   c. What are the criteria for the acceptance/selection of start-ups at your TBI:

      1. ……………….. 2. ………………………. 3. ………………..

      4. ……………….. 5. ………………………. 6. ………………..

   d. Top three reasons for rejection of applications by prospects:
      1. ……………….. 2. ………………………. 3. ………………..

3. Key Performance Indicators of the TBI:

   a. ……………….. b. ………………………. c. ………………..

4. How frequently are the performance indicators of the TBI are assessed? ……………

5. How do you evaluate the influence/contribution of the TBI?

6. What factors determine the average duration of incubation by the Start-up at the TBI?
   1. ……………….. 2. ………………………. 3. ………………..

7. What criteria do you employ to identify the mentoring needs for the incubated start-ups?
   1. …………….. 2. ………………………. 3. ………………..
8. Organizational Structure of the TBI(Please provide the chart):

9. What criteria do you employ to differentiate between high-tech and low-tech start-ups?

   1. …………….. 2. ………………………. 3. ………………..

10. Aggregate information about the founders of start-ups incubated in the TBI:

Sl #	Average Industry Exp(Previous) (YY/MM)	Average Startup Exp(Previous) (YY/MM)	Family Business Background(Y / N)	Average Age (Firm/Entrepreneur Specific)	Average Duration (in months) of employment with the current TBI	Edu. Backgnd (Non-Tech degree / Tech Degree/Masters/PhD/Business Degree etc)

11. Number of high-tech start-ups incubated in the TBI (including current incubates):

12. Why do you think some of your incubated start-ups qualify as high-tech start-ups?

…………………………………………………………………………………………

13. Sources of Funding to the TBI:

Part III: Hard and Soft Infrastructure Facilities of the TBI

c. ***Hard Infrastructure:***
   i. Area / Number of Seats / Capacity/ No of seats occupied / Total Seats / Total Capacity:
   ii. Common Office facilities (Printer/Scanner/Fax/Pantry/Internet Connectivity etc.):

   iii. Hardware / Lab Equipment / Network Infrastructure:
   iv. Approx. Investment on Equipment:

   v. Software (Cloud infrastructure credits, software licenses etc.):

d. ***Soft Infrastructure:***
   i. Mentoring Support/Services:
   ii. Legal Support Services:
   iii. Accounting and Financial Support Services:
   iv. Investment/Fund raising Support:
   v. Access to R&D / Academic Institutions:
   vi. Access to Enterprises (MNCs/Large Enterprises):

   vii. Access to key Start-up Ecosystem partners/Industry Associations:

Part IV: Resources available/activities performed at the TBI for promotion of technology transfer/commercialization of innovation

A. Market Access (Sales Enablement) activities

a. Key programs to enable market access to the incubated start-ups:

i. ………………. ii. ………………….. iii. ………………….

b. Number of prospects connected to the start-ups:

c. Rate of conversion of leads to business / Amount of new business influenced through the Market Access program:

……………………………………………………………………………………..

d. Existing resources (database of contacts, key agreements with industry etc.) within the TBI to enable Market Access to incubated start-ups:

……………………………………………………………………………………..

B. Finance related activities

a. Aggregate funding amount raised by incubated start-ups since inception (year-wise):

Year(Since Inception)	Year 2017-2018	Year 2016-2017	Year 2015-2016	Year 2014-2015	Year 2013-2014	Year 2012-2013	Year 2011-2012	Year 2010-2011	Year 2009-2010	Year 2008-2009
Aggregate funding amount raised by incubated start-ups since inception										

b. Nature of funding (Seed Capital / Angel / Crowd funded / VC / Others) raised:

……………………………………………………………………………………..

c. Average ticket size of deals facilitated by TBI per quarter/year: ………………….

d. Existing resources (database of angels, VCs, Crowd funding platforms and key arrangements with these entities) to enable financial capitalization to the incubated start-ups:

……………………………………………………………………………………..

C. Human Resource and Skills / Capabilities of the TBI

a. Number of personnel to manage the following aspects of the TBI:

i. Market Access
ii. Funding Support
iii. Technology and R&D Support
iv. Sales Enablement
v. Marketing and Branding
vi. Hiring Support for startups
vii. Operations Management support (legal, accounting, hardware/software infrastructure etc.)
viii. Selection of Start-ups

b. Background and Information profile of personnel who manage the above activities at the TBI

Sl #	Name	Previous Industry Exp (YY/MM)	Previous Startup Exp (YY/MM)	Family Business Background(Y / N)	Gender	Age / DOB	Duration (in months) of employment with the current TBI	Edu. Backgnd	Cumulative TBI work experience (in months)	Current Role at the TBI
1										
2										
3										

D. Technology and Innovation enablement activities

a. Number of new technology offerings / services prototyped/enhanced in the TBI since inception(year-wise):

Year(Since Inception)	**Year 2017 - 2018**	**Year 2016 - 2017**	**Year 2015 - 2016**	**Year 2014 - 2015**	**Year 2013 - 2014**	**Year 2012 - 2013**	**Year 2011 - 2012**	**Year 2010 - 2011**	**Year 2009 - 2010**	**Year 2008 - 2009**
Number of new technology offerings / services prototyped/enhanced in the TBI since inception										

i. Was/Were the new technology/ies developed by startup/s, or licensed/initiated external to the startup/s?

ii. If new technology is licensed/sourced from organization/institution external to the startup/s, please provide details:

1. Type of the Licensee (Academic/Govt. Lab/Industry):
2. Name and Department/Division of the Organization/Institution:
3. License Value (INR)/Cost of acquisition:
4. Is there any equity/debt based arrangement with the startup to cover cost of license of new technology?

b. Activities / Programs / Initiatives of the TBI to identify new technologies ripe for commercialization. (For example: Number of agreements with institutions / organizations for sourcing/identifying new technology/innovative ideas)

…………………………………………………………………………………………..

c. Activities / Programs / Initiatives / Mentoring Support from the TBI to the startups to enable them to incorporate / assimilate new technology: (For example: knowledge sharing sessions, workshops, skill development programs, seminars, conferences, certificate courses offered by Industry/Academia to assimilate new technology into the startups' offerings)

…………………………………………………………………………………………..

d. Activities / Resources / Facilities / targeted initiatives if any to facilitate the technology absorption by the Licensee (incubated startups):

…………………………………………………………………………………………..

e. Details of failure of technology transfer from the licensee to the startup, if any. Please specify the stage at which you stopped these activities (Tech Development / Transfer / Commercialization):

…………………………………………………………………………………………..

f. Activities/Programs/Initiatives to enable commercialization (Sales/Marketing/Branding) of the new technology based offerings of the incubated startups: (For example: Prominently showcasing the startups/offerings at the TBI, supporting attending of trade shows, conferences to enable sales, identification of initial prospects to sell/validate the new offering, closed door meetings with MNCs and large enterprises to provide them early access to the new technology based offering, support in patent filing, copyright creation etc.)

…………………………………………………………………………………………..

Part V: Mentoring Support by the TBI

i. Are the mentoring sessions conducted on individual basis or on group basis?
ii. Number of mentors empaneled by the TBI:

iii. Background and qualification of the mentors (Age, Gender, Educational Qualification, Work experience – industry/startup/family business, # of years of prior work experience, prior mentoring experience, primary origin of mentoring expertise [academic/industry/ecosystem based], areas of expertise etc.)

Sl #	Name	Previous Industry Exp (YY/ MM)	Prior Startup Exp (YY/MM)	Family Business Background(Y / N)	Gender	Age / DOB	Duration (in months) of association with the current TBI	Edu. Backgnd	Cumulative mentoring experience (in months)	Origin of mentoring experience (Academia / Industry/ Ecosystem	Areas of mentoring expertise	Type of Mentor (Academia/Corporate /Business/Technology)
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

iv. Frequency of mentor – mentee interactions (Weekly/Monthly/Quarterly/Need based….)

v. Average number of TBI based startups mentored by the mentors:

vi. What is the criteria for identification of mentors?

1. ……………….. 2. ……………… 3. ……………….. vi. vii.

What is the criteria for approval of mentors?

viii. Is there a pre-defined mentoring policy/process?

1. ……………….. 2. ……………………….. 3. ……………….. xi.

ix. What factors determine the success or failure of mentoring sessions?

1. ……………….. 2. ……………………….. 3. ………………..

x. Do you decide on mentoring effectiveness based on individual sessions or at an aggregate level?

Part VI: Measures of Technology Transfer and Commercialization of Innovation (at the TBI)

1. Total # of tech startups incubated in the TBI:
2. Proportion of personnel involved in R&D across all incubated startups:
3. Percentage of capital spent on R&D activities from the overall budget by startups:
4. Cumulative number of instances where licensing of technology / adaptation of new technologies have materialized:
5. Cumulative valuation (INR) of such licensing deals in the TBI till date:
6. Number of new technology ideas incubated by the startups till date:
7. Total number of customers acquired on account of incorporation of the new technology, across the incubated startups:
8. Total revenue generated on account of incorporation of new technology aggregated across the incubated startups
9. Deciding factors for a Startup to Graduate from the TBI:
10. Number of Patents per technology produced by the startups during incubation at the TBI:
11. Number of patented technologies commercialized by the startups in the TBI:
12. Cumulative Evaluation of number of startups contributing towards R & D outcome of the society and new product development:

Annexure 3: Questionnaire to the startups

Part – I: Basic Profile of the Startups

1. Name of your startup:
2. Registered Address of your startup:
3. Formal incorporation of your startup (MM/YYYY) :
4. Type of firm at time of Incorporation: (Proprietorship / Partnership / Pvt. Ltd / LLP / Other)
5. Number of founders at the time of incorporation:
6. Information Profile of the founder(s):

Sl #	Name	Previous Industry Exp (YY/MM)	Previous Startup Exp (YY/MM)	Family Business Background(Y / N)	Gender	Age at time of creation	Role at time of creation (Dev/ Sales /Finance/ All of above)	Edu. Backgnd	Have the founders known each other prior to this venture
1									
2									
3									

7. Number of employees in your startup, other than the founders/co-founders (with breakup of full time, part-time, consultants, interns):
8. According to you, your startup is currently in which phase of the lifecycle:

   a. Early Stage　　　　b. Mature Stage
   b. Growth Stage　　　　d. Other: …………..

Part – II: Selection Criteria for your startup at the TBI

1. Type of the TBI that the startup was incubated: Incubator / Accelerator / Co-working space / Other (Research Park based)

2. Top three aspects in consideration for incubating in a TBI?

a. ……………….. b. ………………………   c. ………………..

3. Start and End date of the Incubation at the TBI:

4. Did the TBI have a selection criteria?

a. ………………..   b. ………………………   c. ………………..

4. In your opinion what factors/aspects made the TBI accept your proposition for incubation?

1. ………………..   2. ………………………   3. ………………..

5. Top three aspects where you think the TBI helped your startup:
   a. ………..
   b. ………..
   c. ………..

6. Top three aspects where you think the TBI was not able to help your startup:
   a. ………..
   b. ………..
   c. ………..

Part – III: Hard and Soft Infrastructure available at the TBI

On a scale of 1-5 please indicate how satisfied you are with the following resources available to you from the TBI:

a. Hard Infrastructure Facilities:

	Most Effective	**More Effective**	**Moderately Effective**	**Less Effective**	**Least Effective**
	5	4	3	2	1
Area / Number of Seats / Capacity					
Common Office facilities (Printer/Scanner/Fax/Pantry/Internet Connectivity etc.)					

Hardware / Equipment / Network Infrastructure					
Software (Cloud infrastructure credits, software licenses etc.)					

b. Soft Infrastructure Facilities:

	Most Effective	More Effective	Moderately Effective	Less Effective	Least Effective
	5	4	3	2	1
Mentoring Support/Services					
Legal Support Services					
Accounting and Financial Support Services					
Investment/Fund raising Support					
Access to R&D / Academic Institutions					
Access to Enterprises (MNCs/Large Enterprises)					
Access to key Startup Ecosystem partners/Industry Associations					

Part – IV: Resources available at the TBI for promotion of technology transfer / commercialization of innovation

On a scale of 1-5 please indicate how satisfied you are with the following resources available to you from the TBI:

A. **Market Access (Sales Enablement) capabilities of the TBI**

	Most Effective	More Effective	Moderately Effective	Less Effective	Least Effective
Sales Enablement Events	5	4	3	2	1
Number of prospects introduced by the TBI					
Rate of conversion of prospects to customers from sources introduced by the TBI					
Industry Agreements/Databa se of key Contacts who can enable Sales for your startup					
Mentoring support from the TBI on Market Access / Sales Enablement					

a. Can you provide details of the amount of new business (INR) influenced through the Market Access program by the TBI:

B. Finance related capabilities of the TBI

On a scale of 1-5 please indicate how satisfied you are with the following resources available to you from the TBI:

	Most Effective	More Effective	Moderately Effective	Less Effective	Least Effective
	5	4	3	2	1
Support for Fund Raising to your startup					

Provision of leads / connects to Angels / VCs / P Es					
Support and guidance to prepare collateral that aid in discussion with the Angels / VCs / P E s					
Mentoring Support on Fund Raising /					
Financial Management from the TBI					

a. Can you provide the details of funds raised / infused at key milestones of your startup journey (Amount in INR, Valuation at that milestone):

i. ……….. ii. ………… iii. …………… iv. …………….

C. R&D / Technical Enablement support from the TBI

On a scale of 1-5 please indicate how satisfied you are with the following resources available to you from the TBI:

	Most Effective	**More Effective**	**Moderately Effective**	**Less Effective**	**Least Effective**
	5	4	3	2	1
Support from TBI on new Technology identification					
Support from TBI on new technology assimilation into your offerings					
Support from TBI on new product commercialization					

Mentoring support from the TBI on technology creation, assimilation and commercialization aspects					

D. Operational Support from the TBI

On a scale of 1-5 please indicate how satisfied you are with the following resources available to you from the TBI:

	Most Effective	More Effective	Moderately Effective	Less Effective	Least Effective
	5	4	3	2	1
Support and inputs to Marketing / Branding of your startup/offerings					
Support from the TBI on hiring new talent to your startup					
Support from TBI on legal matters dealing with your startup					
Support from TBI on the accounting/book keeping activities of your startup					
Support from TBI on enabling hardware/softwar e infrastructure at discounted rates					

E. Mentoring Support from the TBI

1. Did you as a startup get any Mentoring support from the TBI?

2. Did you actually get mentored by the TBI?

3. How many such mentors did you interact with and further connect with?

4. Average number of discussions with each mentor:

On a scale of 1-5 please indicate how effective is the mentoring support provided by the TBI:

	Most Effective	**More Effective**	**Moderately Effective**	**Less Effective**	**Least Effective**
	5	4	3	2	1
Support enabling insights into Market and providing Access					
Support from the TBI on hiring new talent to your startup					
Support from TBI on business/technology aspects					
Support from TBI enabling the sales of the startup					
Support from TBI on finance related capabilities					
Overall Quality and Effectiveness of Mentoring Support from the TBI					

Part – V: Measures of Technology Transfer and Commercialization of Innovation (at the TBI)

1. Proportion of employees contributing to R&D/Tech efforts in your startup:

2. Average years of technical experience of your R&D/Tech team (including founders):

3. Details of capital expenditure done by the startup for R&D over the last three years (if applicable):

Year	2014-15	2015-16	2016-17
R&D Expenditure (in Rs.)			

4. Details of revenue generated due to sales of innovated (R&D invested) products/offerings:

Year	2014-15	2015-16	2016-17
Sales based on innovated offerings (in Rs.)			

5. Education Background of the R&D team:

Proportion of employees without a technical degree	Proportion of employees with bachelors' degree (technical)	Proportion of employees with masters' degree (technical)	Proportion of employees with PhD (technical)

6. What is the nature of innovation practiced in your startup? Please rank them in the order of priority.

Nature of Innovation	New Product	New Process	Improved Product	Improved Process
Rank				

7. Does your startup have patents or any other forms of Intellectual Property: Yes/No

8. If Yes, please provide the details of IP:

Type of IP (patent / copyright / trademark / industrial design)	Tradable Value (INR)	Date of Acquisition/Grant/ Application	Source of Patent Office	Duration

9. Number of product offerings from your startup:

10. Does your product offerings differ from competitors offerings? If yes, what are the areas of differentiation: Features / Performance (Durability / Reliability) / Style / Design / Mode of Delivery / Others

11. How did you get your first customer? (Mention the Source:) Was TBI helpful in this aspect?

12. Number of customers per offering:

13. During the course of running this company, did you approach Seed / Angel / VC funds in order to capitalize your Organization? Yes / No

14. Did any of the founders receive Seed/Angel/VC funding in previous ventures?
Yes/No

15. Please indicate the proportion of sources of funds at all the stages of your startup lifecycle as applicable:

	Personal Funds	Revenue from Sales	Funding from Seed/Angels/VCs	Bank Loans	Any other sources (Please specify)
Creation of firm					
Breakeven					
Growth / Scaling up					

16. At the following milestones, how were the funds allocated to different functions within the Company? (To add up to 100%)

	Sales	Research and Development	Marketing	HR (includes hiring for all functions)	Any other sources (Please specify)
Creation of firm					
Breakeven					
Growth / Scaling up					

17. In your opinion, how helpful/useful (to your startup) are the startup conferences / meetups and events that happen in your city

Highly Effective	**Very Effective**	**Moderately Effective**	**Little Effective**	**Not Effective**
5	4	3	2	1

18. In your opinion, how helpful/useful (to your startup) are the local/central government policies

Highly Effective	**Very Effective**	**Moderately Effective**	**Little Effective**	**Not Effective**
5	4	3	2	1

19. In your opinion, how helpful/useful (to your startup) are the presence of large MNCs and enterprises in your city

Highly Effective	**Very Effective**	**Moderately Effective**	**Little Effective**	**Not Effective**
5	4	3	2	1

CHAPTER 4

TECHNOLOGY BUSINESS INCUBATION: TYPOLOGY, SPONSORS, OBJECTIVES AND FACILITIES

4.1 Introduction:

Though TBIs are of recent origin in India, a variety of them have come up across the country in academic institutions as well as outside of it, with different kinds of sponsors and locations, diverse objectives, sector and stage focus, and with varied infrastructure and facilities, both hard and soft. However, (as observed in the previous chapter) majority of them is concentrated in the three start-up hubs chosen for the present study, namely, Bangalore, Chennai and Hyderabad.

Given this, it is appropriate to understand the profile of these institutions spread across the three cities, in terms of their age, typology, sponsors, location, sector and stage focus, their objectives, promotional activities, physical space, ability to accommodate a number of incubatees, and the infrastructural facilities offered by them to the selected prospective new venture founders while undergoing incubation. Accordingly, this chapter elucidates the basic profiles of technology business incubation institutions in the three cities.

4.2 TBIs: Age, Management, Sponsor & Focus Area

At the outset, it is appropriate to know how long these technology business incubation institutions have been operating in the three different start-up hubs of India. Accordingly, Table 4.1 presents the distribution of these institutions in terms of age ranging from (i) less than or equal to 5 years (ii) more than 5 years up to 10 years, and (iii) more than 10 years. The age of each institution has been calculated as of January 2018.

It is clear that majority of the accelerators, business incubators and co-working spaces (hereafter ABCs) in all the three cities have emerged in or after January 2011, followed by between January 2006 and December 2010, and the rest emerged prior to January 2006. About 63% (41 out of 65) of the ABCs was less than or equal to five years old, about 23% (15 out of 65) of the ABCs was more than five years but less than or equal to 10 years old, whereas only 14% (9 out of 65) of the ABCs was more than 10 years old. This implies that ABCs, in general, are of recent origin in Bangalore, Chennai and Hyderabad.

Table 4.1: TBIs: Typology and Age

Cities→	Bangalore			Chennai			Hyderabad			Total
Age / Typology	Up to 5	>5 - 10	>10	Up to 5	>5 - 10	>10	Up to 5	>5 - 10	>10	
Accelerator	5	2	0	0	0	0	1	1	0	9
Incubator	8	3	2	4	1	3	4	3	3	31
Co-working space	9	2	0	4	2	1	6	1	0	25
Total	22	7	2	8	3	4	11	5	3	65

A higher proportion of the ABCs which has emerged recently (in the previous five years) could be due to policy support, as government policy for the promotion of start-ups through business incubation promotion is a recent development in India (as discussed in Chapter 1). If that is the case, majority of the ABCs would have emerged due to policy support and would have located themselves within the universities, public or private. Therefore, it is appropriate to examine the sponsors of ABCs and their respective locations. Table 4.2 presents the distribution of ABCs in terms of their sponsors as well as their locations.

Almost one-half of (32 out of 65) ABCs is promoted by private (non-corporate) enterprises and located in commercial areas, whereas about 2/5 (27) of them is promoted by the government and located in Universities, both public and private, and hardly 10% (6 out of 65) is promoted by

Corporate sector enterprises, which are located in the corporate sector premises. Among the three types of incubating institutions, accelerators are primarily a private enterprise phenomenon being promoted by either the corporate sector enterprises or non-corporate enterprises, incubators are predominantly government promoted and located in public/private universities, whereas co-working spaces are exclusively promoted by non-corporate enterprises. 8 out of 65 ABCs (12% of the ABCs) are setup by MNCs, of which 6 accelerators and 1 co-working space are located in Bangalore, with one incubator operating out of Hyderabad.

Table 4.2: TBIs: Sponsors and Locations by Typology

Cities→	Bangalore			Chennai			Hyderabad			Total
Sponsors → Typology	G + U	CE	PR	G + U	CE	PR	G + U	CE	PR	
Accelerator	0	4	3	0	0	0	2	0	0	9
Incubator	10	0	3	8	0	0	7	2	1	31
Co-working space	0	0	11	0	0	7	0	0	7	25
Total	10	4	17	8	0	7	9	2	8	65

Note: G + U = Government + University; CE = Corporate Enterprise; PR = Private (Non-corporate)

The background of CEOs of TBIs is another relevant issue. The background refers to educational background, and previous start-up/industry experience. The educational qualifications are classified under three heads, namely, graduation or post-graduation or doctorate in Science/Technology/Engineering/Mathematics (STEM). The distribution of TBI CEOs in terms of their educational qualifications is given in Table 4.3.

It is important to note that CEOs of all the TBIs are, at least, STEM graduates or more. About 29% of the CEOs are STEM degree holders, about 31% CEOs are STEM post-graduates and the rest (40%) are STEM doctorates. Among the doctorates, larger proportions of the CEOs are from Chennai and Hyderabad relative to Bangalore, whereas larger proportions of STEM graduate and post-graduate CEOs are from Bangalore compared to Chennai and Hyderabad. Among the ABCs, highest proportion of doctorate qualified CEOs are in the incubators, followed by accelerators and co-working spaces.

Table 4.3: TBIs: Educational Qualifications of CEO

Cities→	Bangalore			Chennai			Hyderabad			Total
Typology → Qualifications	A	B	C	A	B	C	A	B	C	
Graduation in STEM	3	3	7	0	0	3	0	0	3	19
PG in STEM	4	4	3	0	0	3	0	2	4	20
Ph.D. in STEM	0	6	1	0	8	1	2	8	0	26
Total	7	13	11	0	8	7	2	10	7	65

Note: A=Accelerators, B=Incubators & C=Coworking spaces.

The previous work experience of TBI CEOs is another important dimension. The relevant experience is of two kinds: (i) previous industry experience and/or (ii) previous start-up experience. Table 4.4 presents the distribution of TBI CEOs in terms of the nature of their prior industry/start-up experience. About 9% of them did not have either industry or start-up experience, more than 35% of them had prior industry experience, about 8% had previous start-up experience whereas about 48% of them had both industry and start-up experience prior to assuming the present role of CEOs. This implies that more than 4/5 of the TBI CEOs had industry experience with or without start-up experience.

Table 4.4: TBIs: Prior Industry/Start-Up experiences of CEO

Cities→	Bangalore			Chennai			Hyderabad			Total
Typology → Prior Experience	A	B	C	A	B	C	A	B	C	
No prior industry or start-up experience	0	4	0	0	1	0	0	1	0	6
Prior industry experience	2	1	5	0	3	4	0	3	5	23
Prior start-up experience	0	1	1	0	0	2	0	1	0	5
Prior industry + start-up experience	5	7	5	0	4	1	2	5	2	31
Total	7	13	11	0	8	7	2	10	7	65

Note: A=Accelerators, B=Incubators & C=Co-working spaces.

A gender based assessment of TBIs in our sample revealed that overall 13 out of 65 (20%) of the TBIs across the three cities had female CEOs. In Bangalore, 3 out of 11 incubators, 1 out of 7 accelerators and none among the co-working spaces had women leaders managing the TBIs. In Chennai, 3 out of 8 incubators had women leaders. In Hyderabad, 4 out of 10 incubators, 1 out of 2 accelerators and 1 out of 7 co-working spaces had women leadership. Given this, the strategic objectives or revenue orientation of these institutions would vary in terms of their typology and sponsors. The university located incubators are pre-dominantly non-profit oriented, and therefore offer space, infrastructure and support services (both hard and soft) at a subsidized cost. In contrast, private sector sponsored accelerators and co-working spaces are profit oriented and therefore, aim at recovery of costs while offering their services to the prospective venture founders for undergoing incubation.

Broadly, an incubating institution for the promotion of start-ups may focus exclusively on tech start-ups or cover both tech and tech non-tech start-ups and thus remain sector agnostic. Among those which focus on tech start-ups, some may confine themselves to a specific tech sector only (such as IOT, aerospace, automotive, etc.) whereas the rest might be sector agnostic (within the technology sectors). The advantage in focusing exclusively on tech start-ups and within tech start-ups, on a specific sector is to specialize in terms of both hard and soft resources and networks, and thereby reap the benefits of specialization. But the disadvantage is that such incubating institutions may not receive many applicants for incubation and therefore the supply of "high-quality" prospective start-up founders might be minimum and even inadequate for the sustenance of an incubating institution.

On the other hand, if an incubating institution is sector agnostic, it can have a wide variety of applicants from a larger pool of prospective start-up founders, which might enable the selection of "high-quality" prospective founders rather easily. But the disadvantage is that such an incubating institution might find it difficult to put in place all the required infrastructure and facilities, apart from developing external networks, to meet the needs of prospective start-ups belonging to diverse sectors. As a result, its ability to incubate start-ups effectively will remain a challenge. The classifications of ABCs in terms of sector focus is presented in Table 4.5.

Table 4.5: TBIs: Sector Focus by Typology

Cities→	**Bangalore**			**Chennai**			**Hyderabad**			**Total**
Sector focus → **Typology**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	
Accelerator	2	1	4	0	0	0	0	1	1	9
Incubator	5	5	3	2	6	0	4	4	2	31
Co-working space	0	1	10	0	0	7	0	0	7	25
Total	7	7	17	2	6	7	4	5	10	65

Note: 1=Specific Tech sectors; 2=Sector agnostic Tech sectors, & 3=Tech & Non-tech sectors

Overall, majority of the ABCs (>52%) are sector agnostic, and the rest focused on tech sectors at large, a minority of which (20% of the total) focused on specific tech sectors such as IOT, bio-tech, etc. The reasons for this kind of sector focus prevailing in the three cities are the following:

(i) A majority of the sector agnostic incubating institutions (24 out of 34) are coworking spaces, followed equally by (5) accelerators and (5) incubators. Since coworking spaces and accelerators represent profit-making (or cost recovering) business models, they may not be able to afford to focus exclusively on tech sectors, and thereby lose opportunities of earning revenues from a wide variety of prospective start-up founders.

(ii) Start-up hubs in India in general are still evolving and therefore, the number of start-ups emerging in the hubs is on the increase. This has been revealed by Bala Subrahmanya and Balachandra (2017) in their study focused on Bangalore and Hyderabad, and the scenario is unlikely to be different with respect to the remaining start-up hubs in the country. Given this, sector specific focus of incubating institutions can be hardly justified, from the overall start-up promotion perspective.

However, unlike accelerators and coworking spaces, incubators (26 out of 31) are predominantly focused on tech sectors, of which 11 incubators focused on specific sectors such as bio-tech, IOT, hardware, etc. These are government sponsored university located incubators, which are non-profit oriented, and therefore could afford exclusive sector specific focus.

Given the sector focus of ABCs, it is appropriate to ascertain whether they have any specific stage focus or do they nurture start-ups from the early stage to the late stage of start-up lifecycle. The major responsibility of incubating institutions being providing all the components of an ecosystem at an affordable cost within, they tend to focus on early stage start-up lifecycle, with or without a focus on late stage start-up lifecycle. But this would hold good so far as the incubating institution's business model is non-profit oriented, and the whole focus would change when the business model is profit oriented. Accelerators and coworking spaces being profit oriented business models, their stage focus may be different from that of incubators. In general, literature reveals that accelerators focus more on scaling up of promising tech start-ups, and therefore their plan of action is predominantly confined to the post-incubation process or late stage start-up lifecycle. They are sector-specific so that they will be able to achieve their objective of scaling up the tech start-ups with their limited resources as effectively and soon as possible.

In contrast, business incubators focus on nurturing entrepreneurship from the scratch and therefore cover pre-incubation, incubation and post-incubation stages of venture formation. Some of them are sector specific whereas the rest are sector agnostic. As these are non-profit oriented and supported by the government, they offer subsidized space, infrastructure and common facilities, apart from mentorship. The co-working spaces, on the other, are shared workplaces utilized by different sorts of knowledge professionals (Gandini, 2017) and therefore have neither sector focus nor stage focus. They do not have any achievement objective at the end, either. Table 4.6 presents the distribution of ABCs in terms of stage focus for the three cities.

Table 4.6: TBIs: Stage Focus by Typology

Cities→	Bangalore			Chennai			Hyderabad			Total
Stage focus → Typology	1	2	3	1	2	3	1	2	3	
Accelerator	0	4	3	0	0	0	0	2	0	9
Incubator	13	0	0	8	0	0	9	1	0	31
Co-working space	0	0	11	0	0	7	0	0	7	25
Total	13	4	14	8	0	7	9	3	7	65

Note: 1. Early stage (Ideation to prototype); 2. Late stage (scaling-up); 3. Early to late stage

At the aggregate, majority of the ABCs (30 out of 65 accounting for 46%) are focused on the early stage of start-up formation, beginning from ideation to prototype development leading to minimum viable product (MVP) and market identification. Of the rest, 28 ABCs (43% of the total) are focused on both the early stage and the late stage of start-up lifecycle whereas only 7 out of 65 (11%) ABCs are focused exclusively on the late stage start-up lifecycle. The pattern of stage focus observed in the three cities can be attributed to the following:

(i) The incubating institutions which focus on both early and late stages of start-up lifecycle are coworking spaces. These coworking spaces are promoted by non-corporate private enterprises which represent profit-oriented business models, and therefore they welcome start-up founders at any stage of the start-up lifecycle, to earn rental income and permit them to stay as long as they want. They generally rent out desks on different basis (such as daily, weekly or monthly) and use of meeting rooms is included in the membership or can be rented for an additional fee (Fuzi, 2015). They hardly contain lab equipment or related infrastructure. Stage focus is unlikely to be beneficial for their business model, and a pre-defined end-result is neither an objective for them nor a promise they make to their incubatees.

(ii) The objective of accelerators is to enable the scaling up of "promising" start-ups within a fixed time schedule, and therefore, they focus primarily on the late stage start-up lifecycle, though some focused both on early stage and late stage of the start-up lifecycle. These are corporate accelerators whose "hidden objective" is to promote their own products and services through the scaled up start-ups. They would look at developed business plans which a potential for growth in line with their own corporate strategy (Becker and Gassmann, 2006).

(iii) The incubators, unlike accelerators and coworking spaces, are (with the exception of one in Hyderabad which focused on late stage scaling up) are early stage focused. Nurturing start-ups from the scratch to enable their early and smooth emergence is their primary objective. Since, prospective start-ups suffer from limited resources and liability of newness, incubators offer their support and services to the former at a subsidized price, more often, for a fixed period of time. These incubators, which are university located, invariably aim at encouraging ideation to emerge from within - from faculty or students or both together - as far as possible, for entrepreneurship generation and start-ups, which is a key objective for them (Adegbite, 2001). Therefore, such incubators hardly focus themselves on the scaling up of start-ups.

4.3 TBIs: Objectives, Facilities and Staff Strength

The objectives of setting up of ABCs is of significance, as it would largely influence the whole incubation process and vary in terms of their typology, sponsors, sector focus and strategic objectives, among others. All incubating institutions focus on nurturing, promoting, and developing start-ups (Ghosh and Joshi, 2018). Thus, the most common objective across ABCs could be entrepreneurship generation for start-ups, which would result in job creation, introduction of new products and services, income generation and thereby lead to regional development. However, to achieve this main objective resulting in multiple outcomes, an incubating institution may have multiple intermediate objectives such as creating a favourable and sustainable entrepreneurial ecosystem, encouraging generation and commercialization of innovations, promotion of entrepreneurship within an institution, etc. Give this, it is important to understand the specific objectives of ABCs with respect to start-up promotion, which are given in Table 4.7.

Table 4.7: TBIs: Objectives by Typology

Cities→	Bangalore			Chennai			Hyderabad			Total
Typology → Key objectives	·A	B	C	A	B	C	A	B	C	
Entrepreneurship generation	3	7	3	0	7	0	1	6	0	27
Ecosystem development	2	5	8	0	1	0	1	3	7	27
Revenue generation	0	2	8	0	0	7	0	0	7	24
Innovation commercialization	3	4	0	0	1	0	1	2	0	11
University-Industry linkages	2	3	2	0	1	0	0	0	0	8
Scalable enterprise promotion	0	2	1	0	1	0	0	0	0	4
Total	10	23	22	0	11	7	3	11	14	101

Note: 1. A=Accelerators, B=Incubators, & C=Coworking spaces; 2. Since many of the ABCs have multiple objectives, the sum total (101) exceeds the total (65) ABCs covered for the study.

For a maximum number of ABCs (about 42%), entrepreneurship generation as much as ecosystem development is the key objective, followed by revenue generation (about 37%), commercialization of innovation (17%), and promotion of scalable enterprises (6%). Among the ABCs, entrepreneurship generation is the key objective for a higher share of incubators followed by accelerators and then coworking spaces, across the three hubs; ecosystem development is a key objective for a higher share of coworking spaces followed by incubators and then accelerators (in Bangalore and Hyderabad), whereas revenue generation is a key objective predominantly for coworking spaces followed by some of the incubators but none of the accelerators, across the three hubs.

The commercialization of innovations is predominantly a key objective for a considerable number of incubators followed by some of the accelerators but none of the coworking spaces, in the three hubs. The promotion of university-industry linkages is almost exclusively a key objective for the ABCs of Bangalore and for one of the incubators of Chennai but not that of Hyderabad. Finally, the promotion of scalable start-ups is a key objective for two of the incubators and one of the coworking spaces in Bangalore and for just one of the incubators in Chennai but not that of Hyderabad.

What is conspicuous is the absence of job creation as an objective of ABCs in all the three start-up hubs. This could be due to the following reasons:

(i) Perhaps the prospects of ABCs to impact the job market through start-up generation for job creation are not yet assessed and understood,

(ii) Job creation is an inevitable outcome of entrepreneurship generation, and therefore, an explicit reference is unwarranted,

(iii) Since the number of start-ups that can be generated is unlikely to be large in any incubating institution, the focus has remained on successful entrepreneurship generation and ecosystem development more than anything else.

Given the diverse objectives of business incubation, it is appropriate to examine the infrastructural support and common services offered by these incubating institutions. Broadly, every incubating institution will have the most basic infrastructure such as sitting space, meeting room with internet connection, fax, telephone, apart from soft infrastructure comprising public relations, legal advice, accounting, and a network of business counsellors, financiers, etc. But sector specific incubators may have R&D oriented laboratory and equipment, proof of concept and prototype development centres to facilitate to move from ideation to commercialization of innovation for new product development, coupled with market identification.

In addition, they will have their own external networks to provide or supplement technology and business mentoring for their incubatees. Some of the accelerators which focus on scaling up, too may have specific product related technology centres, and support for business plans for a steady market penetration. Thus, the infrastructure and support services offered by incubating institutions can be classified under three broad heads: (i) Common hardware infrastructure and support services (comprising space, internet, communications, etc., (ii) Specialized hardware infrastructure and support services (including specialized machinery, laboratory & equipment), (iii) Common soft infrastructure and support services (including opportunities for internal networking), (iv)

Specialized soft infrastructure and support services (including specialized external networks), (v) technology mentoring alone, (vi) business mentoring alone, (vii) both technology and business mentoring. This would also determine the nature of intervention exercised by an incubating institution with an incubtee in the incubation process. Table 4.8 presents such a classification of incubating institutions, in terms of infrastructure and support services offered.

Table 4.8: TBIs: Infrastructure and Support Offered to Incubatees

Cities→	Bangalore			Chennai			Hyderabad			Total
Typology → / Facilities & Services	A	B	C	A	B	C	A	B	C	
Common hardware & software infrastructure + networking	7	13	11	0	8	7	2	10	7	65
Common soft infrastructure & services + networking	7	13	3	0	8	2	2	10	2	47
Specialized hardware & software infrastructure	3	7	0	0	5	0	1	8	0	24
Both technology and business mentoring services	4	8	0	0	5	0	1	6	0	24
Business mentoring services	2	2	2	0	1	2	1	2	2	14
Technology mentoring services	1	3	0	0	2	0	0	2	0	8
Specialized soft infrastructure and support services	7	12	0	0	4	0	2	7	0	32

An incubating institution which just offers common hardware infrastructure and soft services are unlikely to aid prototype development for new product development and innovation commercialization. They may implicitly facilitate such a process in an external entity but not within. Such incubating institutions may adopt a laissez-faire strategy for start-up promotion. Whereas institutions which have specialized infrastructure for R&D to undertake innovation and commercialization along with specialized external networks for technology and business mentoring for new product development, market identification and finance will have an active intervention strategy for venture creation.

Table 4.8 reveals that all the ABCs in all the three cities offer common hardware and software infrastructure to their incubatees, apart from enabling them to network among themselves informally. Such informal internal networking did enable some of them to explore appropriate external networking as well. The common hardware and software infrastructure includes working space, meeting room for presentations and discussions, fax, telephone and internet services, etc. Further, all the accelerators and incubators and a proportion of coworking spaces in the three cities do offer common soft infrastructure and services, apart from enabling structured internal networking. The soft infrastructure and services include legal advice, accountant's service, business counselling, public relations, sources of finance, etc. In addition, the management encourages formal interactions among the incubatees, at least, once a week to get acquainted with one another for networking for mutual benefit.

However, perhaps what differentiates the quality of an incubating institution is the availability and offer of specialized hardware and software infrastructure (comprising exclusive machinery, laboratory and equipment, licensed software, etc.) to enable the development of a nascent idea into POC and prototype to emerge a minimum viable product and its subsequent commercialization. The role of technology and business mentoring is crucial here, which may be available internally but need to be supplemented from external networks. Only about a half of the accelerators and 2/3 of the incubators have specialized hardware and software infrastructure but none of the coworking spaces. With respect to in-house mentoring, about 37% of the ABCs offers both technology and business mentoring in-house, but only a fraction (about 20%) of the ABCs in the three cities offer only in-house business mentoring, and a lesser fraction (about 12%) offers only in-house technology mentoring. About 31% of the ABCs do not offer either technology or business mentoring, in-house.

However, it is important to note that in-house mentoring (either technology or business or both) is predominantly confined to accelerators and incubators, whereas only some of the coworking spaces offers just business mentoring. Thus, technology mentoring is totally absent in the context of coworking spaces in all the three cities, since innovation commercialization for new product development is not a mandate for them.

Finally, specialized soft infrastructure consisting of external networks of technology and business mentors for product development and scale expansion, angels and VCs, R&D institutions, etc. represents another dimension of incubating institution quality. Incubatees can use external network resources to generate or test ideas, develop new technology, identify market opportunities, obtain access to finance, and gain legitimacy, to name a few. Most incubating institutions provide office space, funding, and basic services, but the better ones also offer an extensive network of powerful business connections, enabling fledgling start-ups to beat their competitors to market (Hansen, et al., 2000).

About 50% of the ABCs, which include all of the accelerators and more than 2/3 of the incubators, has specialized soft infrastructure involving external networks, but none of the coworking spaces has it (Table 4.8). This would enable us to infer that, other things remaining the same, accelerators and incubators have scope for offering "higher quality" and "more intense" incubation relative to coworking spaces in all the three cities.

The ability to offer incubation support would also depend on the staff strength comprising administrative staff and in-house professional/technical/domain experts, as well as access to externally empaneled experts. Table 4.9 presents the distribution of ABCs in terms of staff/in-house experts in terms of range of employment and presence of links to external experts. While all the ABCs obviously have administrative staff, which is a basic necessity to run the incubating institution, only about 2/3 of the ABCs have in-house professional/technical/domain experts, predominantly accelerators and incubators. Only 2 each of the coworking spaces in the three cities have in-house experts.

Table 4.9: TBIs: Staff, In-house Experts & External Networks

	Cities →	Bangalore			Chennai			Hyderabad			Total
Categories of Employees of TBIs	Typology → No. of employees	A	B	C	A	B	C	A	B	C	
Administrative Staff	1 to 3	7	11	8	0	6	7	1	7	4	51
	4 to 6	0	1	3	0	1	0	1	2	2	10
	7 to 14	0	1	0	0	1	0	0	1	1	4
	Total	7	13	11	0	8	7	2	10	7	65
Professional/Technical/Subject Matter/Domain Experts	1 to 3	6	8	2	0	5	2	1	6	2	32
	4 to 6	1	3	0	0	1	0	1	2	0	8
	7 to 14	0	1	0	0	1	0	0	2	0	4
	Total	7	12	2	0	7	2	2	10	2	44
Presence of External Networks (No of ABCs) →		7	9	2	0	6	0	2	7	2	35

While all the accelerators and about 2/3 of the incubators have links to external experts, only two each of the coworking spaces in Bangalore and Hyderabad have such external networks. This further substantiates our earlier inference that "high quality and more intense incubation" could be possible for accelerators and incubators relative to coworking spaces, which appear to adopt a laissez-faire approach to incubation, as they have commercial considerations more than achieving the techno-economic objectives of innovation and entrepreneurship for economic growth.

4.4 TBIs: Physical Space, Number of Seats & Promotion

Another dimension of the ability of ABCs to offer incubating facilities is the overall physical space that they have at their disposal, and the number of incubatees that they can accommodate. Table 4.10 presents the distribution of ABCs in terms of physical space and the number of incubatees that they can accommodate. More than one-half of the ABCs, predominantly accelerators and coworking spaces are small-sized (with a space ranging from 500 sq. ft. to 110,000 sq. ft.), whereas a considerable proportion of the incubators (about 45%) is medium-sized (ranging from 5001 sq. ft. to 25000 sq. ft.), and another 20% of them is large-sized (ranging from 25001 sq. ft. to 110,000 sq. ft.). Medium and large-sized accelerators and coworking spaces are exceptions than a rule.

Table 4.10: TBIs: Physical Space and Number of Seats for Incubation

	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
Physical Area (in square feet)	500-5000	7	4	9	0	3	5	1	3	4	36
	5001-25000	0	6	1	0	3	1	0	5	2	18
	25001-110000	0	3	1	0	2	1	1	2	1	11
	Total	7	13	11	0	8	7	2	10	7	65
Number of Seats	1-50	6	7	3	0	2	2	0	2	0	22
	51-500	1	5	8	0	4	5	2	7	7	39
	501-5000	0	1	0	0	2	0	0	1	0	4
	Total	7	13	11	0	8	7	2	10	7	65

The distribution of ABCs in terms of seating capacity, however, does not match with the distribution of physical space. In fact, only 1/3 of the ABCs can be considered small-sized (ranging from a minimum of 5 seats to 50 seats), whereas 60% of them are medium-sized as they can accommodate between 51 and 500 incubatees, and the rest (hardly 7%) is large sized (which can accommodate more than 500 but up to 5000 incubatees). The discrepancy between physical space and number of seats for incubatees can be explained as follows:

(i) Accelerators are small-sized both in terms of physical space and number of seats, as they have a more structured, time bound, small batch focused incubation programmes than incubators and coworking spaces. They generally make use of technology facilities of the company sponsor, and therefore, they can use their physical space entirely for accommodating incubatees.

(ii) Though majority of the incubators is either medium-sized or large sized in terms of physical space, they have a smaller number of seats to accommodate incubatees. This is because, the dedicated hardware infrastructure (laboratory, machinery and equipment) and related facilities occupy a considerable proportion of the total space of these incubators, and thereby limit the number of seats for incubatees.

(iii) Coworking spaces, unlike the incubators, do not have hardware infrastructure and therefore can optimally utilize the physical space exclusively for accommodating incubatees. Therefore, majority of them is small-sized in terms of physical space, but medium-sized in terms of number of seats for incubatees.

Further, with physical space and number of seats, apart from hard and soft infrastructure, staff strength, experts and external networks, every ABC resorts to promote its incubating facilities amongst the prospective start-up founders in a variety of ways. The objective is to attract the right kind of applications. Therefore, the dimensions of promotion adopted by the ABCs is appropriate to examine. Broadly, ABCs resort to advertise and promote their incubating facilities through their own websites, and through social media sites such as Facebook, Instagram, LinkedIn, Twitter, etc. Some of them become members of Associations, either public or private. In addition, many of them promote individual events, with or without the association of print/electronic media and/or educational institutions, periodically.

The promotional activities would aim at an effective dissemination of information among appropriate prospective start-up founders about the incubating institutions for attracting applications. An effective promotion of an incubating institution will result in the creation of a brand equity for itself. An incubating institution may promote itself with its own website, through social media campaigns, publishing newsletters periodically, and conducting events for people at large who are interested in start-ups. These promotional activities are likely to have a significant determining influence on the number of applications received by each incubating institution. Table 4.11 presents the distribution of ABCs in terms of their current involvement in promotional activities.

Table 4.11: TBIs: Forms of Promotional Activities

Cities→	Bangalore			Chennai			Hyderabad			Total
Typology → Mode of Promotion	1	2	3	1	2	3	1	2	3	
Association Affiliation	1	3	0	0	2	0	0	2	0	8
Websites + Events + Social Media	5	3	11	0	0	7	0	0	7	33
Websites + Events + Association Affiliation	0	1	0	0	2	0	0	2	0	5
All of the above	1	6	0	0	4	0	2	6	0	19
Total	7	13	11	0	8	7	2	10	7	65

Note: A=Accelerators, B=Incubators & C=Coworking spaces.

We have ascertained four different kinds of promotional activities pursued by the TBIs, namely, (i) websites, (ii) periodical promotional events in the institution premises, (iii) social media campaigns, and (iv) association membership. About 12% of the TBIs had just association affiliation and they did not have either their own websites or resorted to any promotional events or social media campaigns, and these are predominantly incubators. But more than one-half of the TBIs (predominantly coworking spaces and accelerators) had their own websites, conducted periodical events and resorted to social media campaigns to attract applications from the right kind of prospective start-up founders. Nearly 8% of the TBIs (exclusively incubators) had websites as well as association affiliation and resorted to periodical promotional events, but did not have any social media campaigns. The rest (about 30%) of the TBIs (predominantly incubators) had all of the above, as they had not only websites and association affiliations but also regularly conducted promotional events and social media campaigns.

4.5 Distinguishing Features of Institute promoted TBIs Vs. Industry promoted TBIs

The 65 TBIs surveyed by us differed in terms of age, sponsorship and location, background of the CEOs in terms of education and previous industry/start-up experience, sector/stage focus, objectives, infrastructure and support services, staff strength and in-house experts, external networks, physical space and number of seats to accommodate prospective start-ups, and finally, the nature of promotional activities pursued to win over appropriate prospective start-up founders. As observed, broadly there are two categories of TBIs, namely, government promoted which are institution based, and industry promoted which are based out of corporate sector enterprises or commercial offices. Therefore, it is appropriate to examine how these two groups of TBIs differ from each other. Accordingly, we carried out stepwise backward elimination logistic regression to ascertain the distinguishing features of institute promoted TBIs vis-à-vis industry promoted TBIs. The statistical analysis to differentiate government promoted institute based TBIs versus private sector promoted industry based TBIs indicated that the former was found out to be younger with more STEM qualified CEOs, and focused on early stage start-ups, compared to the latter. The detailed analyses including the correlation, variables used, regression results and their analysis can be found in Appendix 4.1.1 of this report.

4.6 Distinguishing Features of Early Stage TBIs Vs. Stage Agnostic TBIs and Tech Sector focused TBIs Vs. Sector Agnostic TBIs

Two regression models were built to examine and differentiate the stage focus and sector focus of the TBIs that participated in the study. The statistical analysis revealed that the objectives of early stage TBIs are non-revenue oriented and thus differed from stage agnostic TBIs, which are primarily revenue generation oriented. Also, the former had CEOs with less work experience and are tech sector focused. The statistical analysis to examine sector focus of the TBIs revealed that tech sector focused TBIs are found to have better infrastructure but engaged in less promotional activities, and their CEOs had more work experience. The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation is presented in Appendix 4.1.2 of this report.

Overall, the descriptive analysis of TBI characteristics, and logistic regression analyses to differentiate (i) institute based TBIs from industry based TBIs, (ii) early stage focused TBIs from stage agnostic TBIs, and (iii) tech sector focused TBIs from sector agnostic TBIs, broadly categorize the TBIs as follows:

- Government promoted TBIs have come up in institutions whereas private sector promoted TBIs have confined themselves to industries,
- Institute based TBIs are of recent origin relative to industry based TBIs,

- Though CEOs of all the TBIs are STEM qualified, institute based TBIs have CEOs with better qualifications compared to industry based TBIs,
- Institute based TBIs focused primarily on early stage lifecycle of start-ups, unlike industry based TBIs,
- Early stage lifecycle focused TBIs have multiple social objectives such as entrepreneurship generation, innovation commercialization, university-industry linkage promotion, ecosystem development, etc. whereas stage agnostic TBIs have revenue generation as the primary objective,
- Early stage TBIs have CEOs with less work experience relative to stage agnostic TBIs,
- Early stage TBIs are tech sector focused relative to stage agnostic TBIs,
- Tech sector focused TBIs have better infrastructure relative to sector agnostic TBIs,
- Tech sector TBIs are less engaged in promotional activities than sector agnostic TBIs,
- Tech sector TBIs have CEOs with more work experience than sector agnostic TBIs.

4.7 Summary

TBIs which have come up rather recently in Bangalore, Chennai and Hyderabad are of different kinds, with CEOs having STEM qualifications and varied work experience either in industry or in start-ups or both. They do differ in terms of stage focus as well as sector focus. Similarly, their objectives differ with some having entrepreneurship generation as the key objective, some aiming at ecosystem development, some others focusing on innovation commercialization, university-industry linkages, and scaling up whereas a considerable number of them aimed at mere revenue generation, by renting out the space and infrastructure. Given this, TBIs differed in terms of infrastructure with some providing only the common hardware and software infrastructure, some additionally providing soft infrastructure services, some others providing exclusive hardware/software infrastructure, and some more having exclusive soft infrastructure services.

In the same way, TBIs differed in terms of administrative staff as well as in-house domain experts, apart from having their own external networks. Given this, some of these TBIs are small sized in terms of space and number of seats for prospective incubatees, others are either medium-sized or large-sized. Further, TBIs differed in terms of promotional activities pursued. Some of them confined their promotion to mere association affiliation, whereas some have websites, conducted events, and resorted to social media campaigns, and some others had websites, events and association affiliation, and the rest had all of these.

Given the above, the analysis to differentiate government promoted institute based TBIs versus private sector promoted industry based TBIs broadly categorized the TBIs effectively into two groups: the former found out to be younger with more STEM qualified CEOs, and focused on early stage start-ups. Further analysis revealed that the objectives of early stage TBIs are non-revenue oriented and thus differed from stage agnostic TBIs, which are primarily revenue generation oriented, the former had CEOs with less work experience and are tech sector focused. Finally, tech sector focused TBIs are found to have better infrastructure but engaged in less promotional activities, and their CEOs had more work experience.

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CHAPTER 5

TECHNOLOGY BUSINESS INCUBATION: SELECTION, INCUBATION AND GRADUATION

5.1 Introduction:

The diverse characteristics of TBIs, in terms of their age, CEO education and work experience, sponsorship and location, stage and sector focus, objectives, infrastructure and support services, strength of staff and in-house experts, space and number of seats, and promotional activities broadly constitute the demand side for inviting applications from prospective start-up founders for incubation. Given this, the applications received for incubation and the selection process adopted by the TBIs set the stage for match making and selection of prospective incubatees.

This is followed by actual incubation process for start-up graduation, with a provision of access to diverse infrastructure and support services, soft infrastructure, mentorship from in-house experts as well as from external networks, etc. In the process, TBIs facilitate from ideation to POC, prototype development, MVP, market identification and product launching leading to venture creation. Though the actual time spent by each incubatee in a TBI would vary depending on the background of start-up founders including their domain knowledge, and uniqueness of the idea generated and innovation commercialized, the nature of support provided by TBIs will have a decisive role as well. Therefore, in this chapter we would examine the match making process as well as the incubation process for start-up creation.

5.2 TBIs: Applications from Prospective Start-Up Founders (2016/17) and Its Determinants

Given the characteristics of TBIs and the infrastructure and support that they offer to the prospective incubatees, the number of applications received by each of them from prospective start-up founders broadly represent the supply side, and thereby sets the stage for demand-supply match making for the selection process. At an individual TBI level, it can be safely presumed that only those start-up founders who consider themselves and/or their ideas appropriate for a particular incubating institution would submit their applications. Thus, self-screening could be assumed as done at this stage. Given this, the number of applications received by each of the TBIs would broadly indicate its 'reputation' in the market. Table 5.1 presents the distribution of TBIs in terms of Accelerators, Incubators and Co-working spaces (ABCs) in terms of range of applications received in 2016/17.

Table 5.1: TBIs: Number of Applications Received (2016/17)

Number of Applications	Cities → Typology →	Bangalore			Chennai			Hyderabad			Total
		A	B	C	A	B	C	A	B	C	
1-50		0	5	1	0	7	7	1	4	3	28
51-500		5	7	8	0	1	0	1	4	4	30
501-1500		2	1	2	0	0	0	0	2	0	7
Total		7	13	11	0	8	7	2	10	7	65

Note: A=Accelerators, B=Incubators, & C=Co-working spaces

In 2016/17, about 43% of the ABCs, mostly incubators and co-working spaces, have received not more than 50 applications from the prospective start-up founders, another 46% of the ABCs comprising accelerators, incubators and co-working spaces received more than 50 but not more than 500 applications, whereas hardly 11% of them received applications in the range of 501 to 1500. Given the distribution of ABCs in terms of applications received, it is appropriate to ascertain the ratio of applications received to number of seats. The distribution of ABCs in terms of ratio of number of applications to number of seats received in 2016/17, is given in Table 5.2.

More than 32% of the ABCs, exclusively confined to Chennai and Hyderabad, received applications amounting to less than 10% of the seating capacity that they had in 2016/17. About

23% of the ABCs, spread across the three hubs, received applications in the range of 10% or more but less than 100% of the seating capacity, whereas about 1/3 of the ABCs, almost exclusively in Bangalore, received applications more than their respective seating capacities, in the range of more than 100% to almost up to 700%, in 2016/17. This brings out that irrespective of whether accelerators or incubators or coworking spaces, Bangalore based ABCs have received applications in multiple proportions of their respective seating capacities, in contrast to Chennai and Hyderabad where ABCs mostly received applications less than their respective seating capacities.

Table 5.2: TBIs: Applications to Seats (2016/17) Ratio

Cities→		Bangalore			Chennai			Hyderabad			Total
Typology →		A	B	C	A	B	C	A	B	C	
Application to Seat Ratios	0.01 to <0.01	0	0	0	0	7	4	1	4	5	21
	0.1 to <1	0	3	1	0	1	3	1	5	1	15
	1 to <10	3	9	8	0	0	0	0	1	1	22
	10 to <30	3	0	2	0	0	0	0	0	0	5
	30 to <70	1	1	0	0	0	0	0	0	0	2
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**9**	**7**	**65**

This could be due to the fact that Bangalore is a steadily growing and fast emerging "leading start-up hub" in India, which has gained multiple recognitions in the global start-up landscape (Bala Subrahmanya, 2017). Bangalore has been ranked as having the best start-up ecosystem and the best innovation cluster, apart from having the second best technology infrastructure (after NCR Delhi) and the third best livable city (after Chandigarh and NCR Delhi) in India (Damodaran, 2016). Due to these reasons, S&T talent may be increasingly flowing from diverse corners of the country (apart from brain-circulation) towards Bangalore for start-up creation.

If an incubating institution has to take a judicious decision of match making between (i) demand, broadly characterized by TBI objectives, infrastructure and facilities, sector and stage focus, built-up external networks, number of seats available for incubation of prospective start-ups, and (ii) supply in terms of applications from prospective start-up founders with ideas, education, domain expertise and skills, start-up founding/industry experience, sector/stage-specific focus, and own external networks, it must aim at attracting as many good applications as possible. This would enable the TBIs to scrutinize and select the "right candidates" for incubation. Given this, it is appropriate to examine what characteristics and facilities of TBIs influence or determine the number of applications received by each of them.

A regression model was built to statistically analyse the above phenomenon. Overall, it is the TBIs with more number of in-house experts, less qualified CEOs, stage agnostic focus, non-revenue objectives, smaller sized ones with more administrative staff members which have attracted more applications relative to the rest. The number of in-house experts including technology and business mentors is likely to contribute to the provision of "quality incubation services" to incubatees. The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation is presented in the Appendix 4.2 of this report.

A second regression model was developed and examined to analyse the applications to seats ratio (ASR) for 2016/17. The statistical analysis revealed that TBIs which have external networks (ED), in addition to its own in-house experts, and those which have multiple objectives other than revenue generation (BD) have a higher application to seat ratio (ASR). At the same time, such

TBIs have indulged in less promotional activities (PA) and their CEOs are less STEM qualified (EB). The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation is presented in the Appendix 4.2 of this report.

In summary, the supply of seats and the demand (represented by the number of applications) for seats in all the three start-up hubs indicates two things, which are as follows:

- Supply of seats far outstrips demand,
- The overall number of start-up proposals is yet to emerge in a big way, as the start-up ecosystems in India are still evolving and/or maturing,

Given this, it is important to ascertain the selection process and the current occupancy scenario (absolutely as well as relative to the number of seats) in the TBIs.

5.3 TBIs: Selection Process of Prospective Incubatees and Occupancy of incubating Ventures

Given the determinants of applications to TBIs, it is important to examine the process of selection of incubatees adopted by the TBIs as that will determine the number of occupants and their subsequent graduation. The selection of incubatees is one of the core elements of the incubation and acceleration process (Hackett and Dilts, 2004). If successful start-up emergence has to be supported through entrepreneurship generation, the crucial role of an incubating institution is to pick-up a prospective start-up founder/s with an idea which has either technology potential or commercial potential or both. The crucial point for the success of any incubator is indisputably the selection process of prospective start-ups, this is because the number of graduated start-ups will be directly proportional to the quality of the selection process (Bizzotto, 2003). Therefore, every incubating institution should aim at shortlisting those start-up proposals which have a greater chance of success. Towards this end, the aim of selection is to evaluate the prospective client's potential capabilities to attain successful start-up creation (Lumpkin and Ireland, 1988).

Table 5.3 lists out the key selection criteria adopted by the TBIs, and its distribution in terms of typology and start-up hubs. The table reveals that nearly half of the TBIs attach significance to product idea coupled with a viable business model, adequately backed by the appropriate background of the prospective start-up founders. These are predominantly incubators located across the three start-up hubs, supplemented by about half of the accelerators located in Bangalore and Hyderabad. The remaining accelerators and some of the incubators (predominantly in Bangalore) give importance to those who have developed a product and identified a market already, backed by appropriate capabilities of the founders. These are the ones which focus on scaling up, rather than early stage start-up formation. In contrast, coworking spaces (accounting for about 1/3 of the TBIs) exclusively look at the professional background of prospective start-up founders, their team size and their rent paying capacity.

Table 5.3: TBIs: Key Selection Criteria

Selection Criteria	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
Unique Product Idea + Viable Business Model + Founding team background		2	9	1	0	8	0	2	9	1	32
Product Availability + Large Addressable Market + Team capabilities		5	4	1	0	0	0	0	1	0	11
Professional Background of Founders + Rent paying ability + Team Size		0	0	9	0	0	7	0	0	6	22
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Note: A=Accelerators, B=Incubators, & C=Coworking spaces

With the defined selection criteria, it is appropriate to know the number of occupants and the occupants to seats ratio in each of the TBIs. Table 5.4 presents the distribution of TBIs in terms of number of occupants by typology and start-up hubs. About 65% of the TBIs consisting of accelerators, incubators and coworking spaces across the three start-up hubs, did not have more than 15 occupants in 2016/17. About 23% of the TBIs comprising only incubators and coworking spaces had occupants in the range of 16 to 50. Only about 12% of them consisting of only incubators and coworking spaces had occupants in the range of 51 to 200. The accelerators always prefer to have small batch sizes for an intense intervention for either venture creation or scaling up, whereas incubators though predominantly focus on early stage of the start-up lifecycle, vary in sizes and therefore, in number of occupants. Coworking spaces are stage agnostic and are primarily rent seekers and therefore vary in sizes and thereby in number of occupants.

Table 5.4: TBIs: Number of Occupants (2016/17)

Number of occupants	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
1-15		7	8	5	0	3	7	2	6	4	42
16-50		0	4	3	0	4	0	0	2	2	15
51-200		0	1	3	0	1	0	0	2	1	8
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Though the distribution of TBIs in terms of occupants is important, occupants to seats (occupancy) ratio in TBIs reflects the level of vibrancy present in them and may be, on their reputation, which is given in Table 5.5. About 9% of the TBIs, comprising mostly incubators, had less than 35% occupancy rates, about 54% of them had occupancy rates ranging from 36% to 70% consisting of both incubators and coworking spaces, whereas about 37% of the TBIs, primarily including accelerators and incubators, had occupancy rates more than 70% up to 100%.

Table 5.5: TBIs: Occupancy Ratio (2016/17)

Occupancy Ratio	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
0.1 to 0.35		0	1	1	0	2	0	0	2	0	6
0.36 to 0.70		0	9	6	0	3	6	0	4	7	35
0.71 to 1.00		7	3	4	0	3	1	2	4	0	24
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

If occupancy ratio varies between the ABCs in the three start-up hubs, it is appropriate to ascertain what variables account for the differences in the number of occupants between these institutions. To ascertain the same, we carried out a stepwise backward elimination regression by means of a regression model. The results broadly indicate that TBIs which are larger in size, which have a larger number of in-house experts and administrative staff, but do not have their own external networks, whose CEOs have stronger work experience (in the form of both industry and start-up experience) have more number of occupants relative to the rest. The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation is presented in the Appendix 4.2 of this report.

5.4 TBIs: Support extended to the Incubatees during the Incubation Process

The primary role of TBIs is to provide a support environment for start-up and fledgling companies. The support environment would broadly comprise rental space, shared administrative services, specialized labs comprising machinery and equipment, and access to a network of business and technical mentors capable of providing guidance and assistance in finance, business planning, marketing, legal consulting, product development, etc. (Peters, et.al., 2004). While all these hold good in terms of characteristics of TBIs in the context of Bangalore, Chennai and Hyderabad, it is important to know what critical support do they provide to the incubatees during the incubation process, after the shortlisted applicants join them.

While all of them provide access to the common infrastructure and supporting administrative services, it is mentoring services provided to the incubatees which could prove decisive in the progress of an idea towards POC, prototype, MVP and product finalization, along with market identification. Mentoring services can be provided periodically, with regular intervals as well as need based, as and when an incbatee feels the need for it. Table 5.6 shows the distribution of TBIs, in terms of the frequency of provision of mentoring services. An overwhelming majority (60%) of the TBIs comprising accelerators, incubators and coworking spaces offer need based mentoring services as and when required by their incubatees, from in-house experts and/or through their external networks. About 14% of them provides mentoring services every week and about 26% provides mentoring services every month.

Table 5.6: TBIs: Provision of Mentoring Services

Mentorin g services	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
Need based		2	7	5	0	3	7	1	7	7	39
Weekly		2	1	0	0	3	0	1	2	0	9
Monthly		3	5	6	0	2	0	0	1	0	17
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

The need for finance is felt by the incubatees almost at the beginning of the incubation process itself. How do TBIs respond and deal with the issue of finance is of significance. From no funding support to provision of government grants of seed funds to private Angels/VCs to Corporate sector funding are the options. In general, Corporate sector promoted accelerators provide corporate finance, and institution based incubators rely on government grants as seed funds, whereas coworking spaces which primarily focus on the provision of rental space, hardly extend support of finance. Table 5.7 gives the distribution of TBIs in terms of financial support. More than 60% of the TBIs, consisting of all the coworking spaces and some of the incubators and accelerators did not provide any funding support to their incubatees. About 29% of the TBIs (predominantly incubators) provided government sponsored seed funds, whereas hardly 10% comprising accelerators and incubators enabled corporate finance or support from Angels and/or VCs.

Table 5.7: TBIs: Offer of Financial Support

Funding support	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
No support		4	6	11	0	3	7	0	2	7	40
Government provided seed funds		0	7	0	0	5	0	1	6	0	19
Corporate/Angel/VCs		3	0	0	0	0	0	1	2	0	6
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

If a fledgling start-up is able to come up with a product after obtaining adequate seed funds, the next major challenge is to identify early market adopters. To facilitate the incubatees for market identification, TBIs generally conduct market enablement activities. Table 5.8 contains the distribution of TBIs in terms of number of market enablement activities conducted in 2016/17. Nearly 1/3 (about 31%) of the TBIs largely comprising coworking spaces and some of the incubators, did not have any market enablement activities. About 23% of them conducted activities ranging from one to six, about 38% conducted seven to 24 activities, about 8% conducted more than 25 but up to 60 activities in the year.

Table 5.8: TBIs: Market Enablement Activities

Market enablement activities	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
None		2	3	5	0	3	4	0	0	3	20
1-6		0	4	0	0	2	3	1	3	2	15
7-24		5	5	4	0	3	0	1	5	2	25
25-60		0	1	2	0	0	0	0	2	0	5
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

The nature of market enablement events largely depends on the type of TBIs and the stage of the startups being incubated. Accelerators across the hubs of Bangalore and Hyderabad were found to expose their incubated startups to large enterprises and MNCs – primarily to help these late stage startups to scale and increase their revenue. In contrast, the market enablement events at Incubators were primarily focused on enabling the startups to discover the early adopters or beta customers for the product offerings of the incubated startups.

These startups that are working out of Incubators are predominantly early stage, and are in the idea validation, prototype validation, MVP validation stages. Therefore, feedback on the product / services through these market enablement events become very crucial. The co-working spaces conduct market enablement events with two objectives – the first one to enable the incubating startups to gather feedback from prospective customers/early adopters, and the second one – being the promotion of their co-working space.

5.5 TBIs: Criteria for Graduation and Determinants of Graduation

With the varieties of incubation support provided, TBIs aim at their graduation. However, the criteria adopted for graduation varies from one to the other. Broadly, three important criteria are adopted by the TBIs in the three start-up hubs to decide on the graduation and exit of incubated start-ups. Table 5.9 presents the distribution of TBIs in terms of graduation criteria adopted in the three start-up hubs.

Table 5.9: TBIs: Criteria for Graduation and Exit

Criteria for graduation — Cities →	Bangalore			Chennai			Hyderabad			Total
Typology →	A	B	C	A	B	C	A	B	C	
Achieved self-sustainability/growth	1	7	2	0	7	2	0	5	0	24
Raised external funds	1	3	7	0	0	5	0	2	7	25
Cohort duration completed	5	3	2	0	1	0	2	3	0	16
Total	**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Achieving self-sustainability or growth as well as raising external funds are two alternative, more or less equally important, criteria adopted by the TBIs to decide on the graduation of incubating start-ups for exit. The former primarily comprised incubators whereas the latter predominantly consisted of coworking spaces. Together the TBIs adopting these criteria accounted for more than 75%, whereas the rest (about 24%) of the TBIs enabled exit of the incubatees as soon as they completed the cohort duration, prescribed at the outset.

If TBIs are able to incubate start-ups effectively by providing access to infrastructural support and common services, supplemented by mentoring services, seed finance, and market identification, they would be able to graduate a good number of start-ups, if not year after year, at least, cumulatively. Table 5.10 presents the figures on the number of start-ups graduated in the TBIs in the three start-up hubs, since their inception and as of 2016/17. About 35% of them (primarily in Chennai and Hyderabad) did not graduate any start-up but 60% of them (mostly in Bangalore and Hyderabad) graduated start-ups since their inception, in the range of 1-50, since their inception and as of 2016/17. Hardly 5% of them generated more than 50 but less than 150 start-ups.

Table 5.10: TBIs: Cumulative Graduation of Start-Ups (as of 2016/17)

Number of graduations	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
None		0	3	1	0	3	7	0	4	5	23
1-50		5	10	10	0	4	0	2	6	2	39
51-150		2	0	0	0	1	0	0	0	0	3
Total		7	13	11	0	8	7	2	10	7	65

But mere cumulative graduation does not convey TBI performance adequately. It should be relative to their age or relative to the cumulative admission of incubatees, since their inception and as of 2016/17.

Table 5.11 contains data on average number of graduations achieved per year. As already revealed, 23 of the 65 TBIs did not graduate any start-up yet. About 15% of the TBIs (mostly Coworking spaces located in Chennai and Hyderabad) could graduate not more than 1 start-up per year, whereas 40% of them (largely comprising Accelerators and Incubators, located in Bangalore followed by Hyderabad) could graduate more than one and up to 10 start-ups per year. Hardly 10% of them (all located in Bangalore) could graduate more than 10 but up to 32 start-ups per year.

Table 5.11: TBIs: Graduation of Start-Ups per Year

Number of successful exits	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
None		0	3	1	0	3	7	0	4	5	23
>0-1		0	1	3	0	3	0	1	2	0	10
>1-10		6	8	3	0	2	0	1	4	2	26
>10-32		1	1	4	0	0	0	0	0	0	6
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Table 5.12 provides data on cumulative graduation to cumulative admission ratio for the TBIs. Since 23 (about 35%) of the 65 TBIs did not graduate any start-up as of 2016/17, the ratio turned out to be zero. But about 57% of the TBIs (predominantly in Bangalore) had a ratio between 0.01 to 0.50, and hardly 8% of them (located in Bangalore and Hyderabad) had a ratio higher than 0.50 but less than 0.90, as of 2016/17. Given the graduation trends of start-ups across the three start-up hubs, it is essential to ascertain what variables have contributed to the higher annual graduation, and higher cumulative graduation to cumulative admission ratio. We carried out stepwise backward elimination regression, with the following dependent and independent variables. The results of the statistical examination revealed that among the TBIs, Accelerators (AC) accounted for a higher influence on the cumulative graduation to cumulative admission ratio, relative to Co-working spaces. Similarly, among the three start-up hubs, Bangalore (BN) based TBIs have a higher influence on graduation relative to Hyderabad. The absence of funding support (NF) has a negative influence on graduation compared to Corporate funding, and laying emphasis on achieving self-sustainability/growth (GS) as a graduation criterion has a better influence on graduation than laying emphasis on mere cohort duration completion as a criterion for graduation.

Table 5.12: TBIs: Cumulative Graduation to Cumulative Admission Ratio

Graduation to Admission Ratio	Cities → / Typology →	Bangalore			Chennai			Hyderabad			Total
		A	B	C	A	B	C	A	B	C	
0		0	3	1	0	3	7	0	4	5	23
0.01 to 0.50		7	9	8	0	5	0	2	4	2	37
0.51 to 0.89		0	1	2	0	0	0	0	2	0	5
Total		**7**	**13**	**11**	**0**	**8**	7	**2**	**10**	7	**65**

The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation is presented in the Appendix 4.2 of this report.

5.6 Summary

We have explored the determinants of number of applications received by the TBIs, applications to seats ratio, number of occupants in the TBIs, and cumulative graduation to cumulative admission ratios in the TBIs. TBIs in the three start-up hubs have attracted applications, have occupants, and graduated start-ups in varying proportions relative to the number of seats that they have.

Overall, TBIs with more number of in-house experts, less qualified CEOs, stage agnostic focus, non-revenue objectives, smaller sized ones with more administrative staff members have attracted more applications relative to the rest. The number of in-house experts (EX) including technology and business mentors is likely to contribute to the provision of "quality incubation services" to incubatees. The in-house staff and experts together would largely determine the "appeal" of an incubating institution to the prospective incubatees and therefore together they influenced positively the number of applications received by TBIs. Further, the administrative staff members (AS) have a crucial role in administering the entry, incubation and exit of start-ups, at every stage. A higher number of administrative staff members would enable specialized focus on different administrative tasks which in turn would enable a better focus on the incubatees.

Given this, the education qualification of TBI CEOs (EB) beyond the basic STEM degree need not matter. This is particularly true when they are stage agnostic (SD) and have multiple objectives (BD) other than revenue generation. Further, those TBIs which are smaller sized (SE) will be able to give better attention to incubation relative to larger sized TBIs. Together such TBIs attracted more applications relative to the rest. This is largely substantiated by the analysis of applications to seats ratio as well. Overall, the number of seats far outstripped the number of applications, implying that there is excess capacity prevailing in the TBIs in the three start-up hubs for admitting and nurturing more start-ups.

The results of analysis relating to the determinants of occupants in the TBIs, broadly, indicated that TBIs which are larger in size, which have a larger number of in-house experts and administrative staff, but do not have their own external networks, whose CEOs have stronger work experience (in the form of both industry and start-up experience) have more number of occupants relative to the rest. This implies that TBIs with CEOs who have vast work experience will be able to obtain "quality" applications through their own networks and referrals received. A larger sized TBI will be able to afford to accommodate more incubatees relative to smaller sized ones. Further, TBIs which have more numbers of in-house experts and administrative staff, even without external networks, will be able to attract better applicants to get selected as incubatees.

As far as graduation of start-ups is concerned, emphasis laid on achieving self-sustainability/growth as the yard stick, with Corporate funding, particularly in Accelerators, located in Bangalore have a larger influence on successful start-up graduation.

Given the above, the following are the key findings:

- Overall number of start-up proposals is yet to emerge in a big way, as the ecosystems in India are still evolving and/or maturing,
- High-quality start-up proposals are not forthcoming to enable their entry, particularly into incubators and accelerators, thereby affecting occupancy,
- As of now, the infrastructure and facilities prevalent in the TBIs are under-utilized, and there is scope for encouraging start-up emergence in a bigger way,
- Both TBI characteristics and CEO work experience matter for the occupancy of TBIs,
- Funding, particularly Corporate funding with Accelerators, in Bangalore, enables the incubatees to achieve self-sustainability and/or growth to graduate from the TBIs.

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CHAPTER 6
TECHNOLOGY BUSINESS INCUBATORS: AN ASSESSMENT OF R&D CONTRIBUTIONS

6.1 Introduction

TBI performance is of significance, irrespective of whether they are public funded or private funded, as they consume societal resources. The available studies are of different kinds as they have used different methodological approaches focusing on different measures of outcomes. Further, while some have assessed the contributions of TBIs at the individual firm level, others have estimated the impact at a macroeconomic level (Huasberg and Korreck, 2018). Though several yardsticks have been adopted for TBI evaluation, such as start-up graduations, job creation, and income/revenue generation, etc., among all of them, their R&D contributions in terms of personnel deployed, infrastructure created, new products/services developed, patents generated, etc. stand apart. This assumes significance particularly when the TBI objective is to promote technology based start-ups, which are likely to be based on innovation generation and commercialization.

In fact, Westhead's (1997) methodology of TBI performance is one of the most followed measures for assessing the R&D performance of TBIs. For input R&D, he used the proportion of Qualified Scientists and Engineers (QSEs) employed in a firm, and some financial indicators measuring R&D intensity such as R&D expenditure, or gross R&D investment as a percentage of total sales revenue. For output R&D, he used the number of patents, and the introduction of new products or services, either for existing clients or for new markets. If TBIs indeed encourage innovation based tech start-ups, it is quite justifiable to use their R&D contribution in terms of (i) R&D inputs (such R&D personnel and R&D investments) and (ii) R&D outputs (such as new products/services, patents and contributions to sales revenue), as one of the indicators of their performance, if not, the sole indicator of performance.

6.2 TBIs: R&D Input Contribution

The contribution of R&D inputs from TBIs to national R&D efforts can emerge in the form of personnel devoted for R&D and investment incurred for R&D infrastructure creation. The R&D infrastructure in the form of specialized laboratory, testing equipment, machinery, etc. are generally established by the TBIs themselves and incubated or incubating start-ups hardly resort to such investments. But R&D personnel devoted to R&D activities (ranging from ideation to POC to prototype to MVP to product manufacturing and innovation commercialization) can emerge from the TBIs as much as from the incubated/incubatee start-ups. Therefore, R&D input contribution in the form of R&D personnel needs to be looked at comprising both TBIs and incubating start-ups.

Table 6.1 shows the distribution of TBIs in terms of cumulative R&D investment expenditure incurred in 2016/17. The cumulative R&D investment expenditure (spent in different years of a TBI operation after its inception, but are added together) is approximately stated in current prices. Thus, they broadly represent the current replacement value of capital, and therefore can be compared between the TBIs. It is important to note that this excludes investment in land and buildings. Overall, 20% of the TBIs, mostly located in Bangalore, incurred R&D expenditure for infrastructure up to Rs.10 lakh, another 35% of them, again majority located in Bangalore, incurred expenditure for infrastructure in the range of Rs.10 lakh to Rs.100 lakh, whereas the remaining 45% of them, spread more or less equally between the three hubs, incurred expenditure more than

Rs.100 lakh up to Rs.2500 lakh. Among the ABCs, incubators accounted for a majority (nearly 80% of the TBIs) in the highest slab of >Rs.100 lakh to Rs.2500 lakh expenditure incurred for R&D infrastructure. This is understandable given the fact that they are university based, and are more focused on technology start-ups, compared to Accelerators and Co-working spaces.

Table 6.1: TBIs: Cumulative R&D Investment Expenditure (as of 2016/17)

R&D Investments (Rs.)	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
	1 lakh - 10 lakh	2	4	3	0	0	2	0	1	1	13
	>10 lakh 100 lakh	4	1	7	0	1	3	1	1	5	23
	>100 lakh – 2500 lakh	1	8	1	0	7	2	1	8	1	29
	Total	**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Note: A=Accelerators, B=Incubators, & C=Co-working spaces

However, what is more important is to understand the extent of R&D investment expenditure incurred on establishing the infrastructure, which is reflected in the total quantity as well as average quantity of expenditure incurred (Table 6.2). Both average and total R&D expenditures are higher for the higher slabs of R&D expenditure relative to the lower slabs of R&D expenditure. The aggregate cumulative expenditure incurred by the TBIs as of 2016/17 amounted to almost Rs.2050 million, the average expenditure being about Rs.31.5 million.

Table 6.2: TBIs: Average and Total - Cumulative R&D Expenditure (as of 2016/17)

	Cities →		Bangalore			Chennai			Hyderabad			Total
	Typology →		A	B	C	A	B	C	A	B	C	
Investment in R&D Infrastructure (Rs. Lakh)	I	Total	20.00	20.00	30.00	0.00	0.00	16.00	0.00	10.00	1.25	97.25
		Average	10.00	10.00	10.00	0.00	0.00	8.00	0.00	10.00	1.25	8.84
	II	Total	190.00	105.00	342.00	0.00	100.00	137.00	100.00	50.00	171.00	1195.00
		Average	47.50	35.00	48.86	0.00	100.00	45.67	100.00	50.00	34.20	47.80
	III	Total	300.00	4350.00	400.00	0.00	300.00	450.00	200.00	12760.00	420.00	19180.00
		Average	300.00	543.75	400.00	0.00	300.00	225.00	200.00	1595.00	420.00	661.38
Total		Total	**510.00**	**4475.00**	**772.00**	**0.00**	**400.00**	**603.00**	**300.00**	**12820.00**	**592.25**	**20472.25**
		Average	**72.86**	**344.23**	**70.18**	**0.00**	**50.00**	**86.14**	**150.00**	**1282.00**	**84.61**	**314.96**

Note: I = >1 lakh to10 lakh; II = >10 lakh to 100 lakh; III = >100 lakh to 2500 lakh

Between the ABCs, incubators accounted for the dominant share of more than 86% in the total R&D expenditure followed by co-working spaces (about 10%) and then accelerators (hardly 4%). The incubators focus on nurturing startups in capital intensive sectors such as biotechnology, hardware-centric technology such as IoT, Augmented Reality (AR) and Virtual Reality (VR). Hence, they account for bulk of R&D investment in infrastructure. About one co-working space in each city was found to be focused on providing minimal support to hardware based startups – and these entities are documented as making investments in R&D infrastructure. Accelerators tend to fall back on their in-house teams for providing any R&D related assistance – and hence hardly need to invest independently on R&D infrastructure on their own.

Also, data from our sample indicates that Accelerators tend to focus on the late stage startups where technology development has been achieved to a commercially viable level. Hence, the focus of interventions at these accelerators tend to be on market development and on enabling the startups' offerings on their homegrown technology platforms. Between the three hubs, Hyderabad accounted for more than 2/3 (67%) of the total followed by Bangalore (28%) and then Chennai (about 5%). Since we could not obtain R&D expenditure incurred annually, it is difficult to project the R&D expenditure contribution made by the TBIs to total R&D expenditure of the country.

The personnel devoted for R&D include in-house domain experts who act as technology or technology-cum-business mentors and other personnel employed exclusively to deal with specialized laboratory, machinery and equipment. Table 6.3 presents the distribution of TBIs in terms of ranges of in-house R&D personnel employed as of 2016/17. Though every TBI has admitted to have incurred expenditure for creating R&D infrastructure, not all of them have in-house R&D personnel. About 32% of the TBIs, mostly comprising Co-working spaces, did not have any R&D personnel at all.

Almost 50% of the TBIs, largely comprising incubators followed by accelerators, employed at least one but not more than three personnel. About 12% of them, mostly incubators, employed in the range of four to six personnel and about 6% (all of them incubators) employed in the range of seven to 14 personnel. This further confirms that among the ABCs, incubators account for a larger share of TBIs having exclusive R&D personnel. The technology based start-up focused TBIs would naturally require dedicated in-house personnel not only to manage specialized machinery and equipment but also to provide technology mentoring to the incubating firms, among others. But such a specialized focus is either negligible or altogether missing in majority of the co-working spaces, and that is why more than ¾ of them did not employ any R&D personnel at all.

Table 6.3: TBIs: R&D Personnel (as of 2016/17)

No. of R&D Personnel	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
None		0	1	9	0	1	5	0	0	5	21
1 to 3 persons		6	8	2	0	5	2	1	6	2	32
4 to 6 persons		1	3	0	0	1	0	1	2	0	8
7 o 14 persons		0	1	0	0	1	0	0	2	0	4
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Table 6.4 presents the distribution of R&D personnel in terms of actual total number of personnel employed by the TBIs under three different sub-classifications as well as the grand total. The 44 TBIs which employed at least one R&D personnel, together employed 150 persons, majority (almost 81%) of which are employed in the incubators, the highest being in Hyderabad, followed

by Bangalore and then Chennai. Of all, co-working spaces accounted for the least share (about 5%) of the R&D personnel, in all the three hubs. This further confirms the argument that co-working spaces lay no or less emphasis on counseling and mentoring through in-house personnel, other than renting out the space for prospective start-ups.

Table 6.4: TBIs: Total R&D Personnel Employed (as of 2016/17)

Cities →		**Bangalore**			**Chennai**			**Hyderabad**			**Total**
Typology →		A	B	C	A	B	C	A	B	C	
No. of R&D Personnel	**1 to 3**	11	15	3	0	9	1	2	12	4	57
	4 to 6	4	19	0	0	9	0	4	10	0	46
	7 to 14	0	9	0	0	10	0	0	28	0	47
	Total	**15**	**43**	**3**	**0**	**28**	**1**	**6**	**50**	**4**	**150**

6.3 TBIs: R&D Output Contribution

Another important dimension of TBI performance is the R&D output contribution comprising new products/services, patent applications and sales revenue generation from new products/services. Table 6.5 reveals the distribution of TBIs in terms of rages of new products/services introduced through incubated start-ups. Every TBI has claimed to have generated a minimum of 5 new products/services through their incubated start-ups, since their inception till 2016/17. But majority of them (about 55%) generated not more than 50 products/services, about 42% of the TBIs generated new products/services in the range of 51 to 500, whereas a co-working space in Bangalore (BHIVE) and an incubator in Hyderabad (ALEAP) claimed to have generated more than 500 but up to 2500 new products/services. Given this, it is important to know how many new products/services these TBIs have together generated.

Table 6.5: TBIs: New Products/Services generated through Incubated Start-Ups

No. of new products/services	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
	5 to 50	5	6	3	0	4	7	2	5	4	36
	51 to 500	2	7	7	0	4	0	0	4	3	27
	501 to 2500	0	0	1	0	0	0	0	1	0	2
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Table 6.6 comprises the distribution of TBIs in terms of total as well as average number of new products/services generated for each range as well as the grand total. Overall, the TBIs have produced 8110 new products/services from their inception up to 2016/17, with an average of 125 new products/services per TBI. Of these, more than half (about 52%) of the new products/services were produced by the mid-range TBIs (which produced new products in the range of 51-500), followed by the upper range (where just two TBIs accounted for 3050 (about 37%) of the new products/services), followed by the lower range of TBIs (about 11%). Between the ABCs, incubators accounted for a majority (59%) share of the new products/services generated, followed by co-working spaces (about 34%), and accelerators (about 7%). Among the three hubs, Hyderabad accounted for the highest share of 47%, followed by Bangalore (>45%) and then Chennai (<8%).

The ALEAP Incubator in Hyderabad has been responsible for enabling about 2500 new products and services over its 25 years of existence. This incubator alone contributes to 30% of the total of new products/services as documented by our sample. This incubator also happens to be the oldest incubator in our sample – and has on an average enabled about 100 new products/services to market every year since its inception. It is also noteworthy to mention that this incubator focuses only on women entrepreneurship and has successfully enabled many women entrepreneurs through its activities. On account of its significant contribution to women entrepreneurship, it has been able to establish an exclusive 'women enterprise' industrial estate spanning two acres in Hyderabad.

Table 6.6: TBIs: Total & Average Number of New Products/Services (as of 2016/17)

	Cities →		Bangalore			Chennai			Hyderabad			Total
	Typology →		A	B	C	A	B	C	A	B	C	
No. of new products/services	**I**	**Total**	150	130	95	0	87	86	41	140	75	804
		Average	30	22	32	0	22	12	21	28	19	22
	II	**Total**	370	851	1535	0	445	0	0	635	420	4256
		Average	185	128	219	0	111	0	0	159	140	158
	III	**Total**	0	0	550	0	0	0	0	2500	0	3050
		Average	0	0	550	0	0	0	0	2500	0	1525
Total		**Total**	**520**	**981**	**2180**	**0**	**532**	**86**	**41**	**3275**	**495**	**8110**
		Average	**74**	**75**	**198**	**0**	**67**	**12**	**21**	**328**	**71**	**125**

Note: I = 5 to 50; II = 51 to 500; III = 501 to 2500

Though facilitating start-ups to generate new products/services is an important indicator of TBI performance, what is a more significant performance indicator is the number of patents produced, as a result of the generation of new products/services. However, we could not get precise statistics on the number of patents generated, but we could obtain data on the number of patent applications submitted from each of the TBIs. The distribution of number of TBIs in terms of ranges of patent applications submitted by their start-ups as of 2016/17, is given in Table 6.7.

While all of the TBIs have claimed to have produced new products/services through their start-ups, 25 (about 38%) of the TBIs (majority located in Bangalore) did not have any patent application submissions, indicating that the new products/services produced by their start-ups perhaps lacked novelty or a strong innovation base. Such start-ups, perhaps, would have introduced products/services which are new to India but innovated and introduced elsewhere (in other country markets) already. About 43% of the TBIs claimed that their start-ups have submitted patent applications in the range of 1-10, from their inception till 2016/17. About 14% had patent application submissions in the range of 11 to 50, and three (hardly 5%) of them claimed more than 50 up to 100 patent application submissions.

CCAMP in Bangalore and IKP Knowledge Park in Hyderabad are the only incubators to have enabled filing of more than 50 patents from their incumbent startups. Given the nature of innovation practiced in both these incubators are in the biotech space, IP protection becomes critical for startups operating in this space – and hence the focus on filing patents is visible. Microsoft Accelerator in Bangalore has facilitated filing of many more patents from its 130 plus incubated startups. This can be interpreted as a nudge by the Accelerator team to ensure protection of IP as it enables these startups to spread their sales to regions beyond India.

Table 6.7: TBIs: Patent Applications Submitted (as of 2016/17)

No. of patent applications submitted	**Cities →**	**Bangalore**			**Chennai**			**Hyderabad**			**Total**
	Typology →	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	
	None	0	6	8	0	0	6	0	0	5	25
	1 to 10	6	4	3	0	5	1	2	5	2	28
	11 to 50	0	2	0	0	3	0	0	4	0	9
	51 to 100	1	1	0	0	0	0	0	1	0	3
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

Given this it is appropriate to know how many total patent applications have been submitted by the start-ups of TBIs. Overall, the TBIs which claimed to have made patent application submission through their incubated start-ups, together accounted for 481 submissions, which amounted to hardly 6% of the total new products/services produced by the TBIs together (Table 6.8). This indicates a low patent intensity of the TBIs with respect to the new products/services generated through their incubated start-ups. Of the total, about 46% submitted applications emerged from Bangalore, about 38% from Hyderabad followed by Chennai (remaining 16%). Among the ABCs, incubators of the three start-up hubs accounted for more than 71% of the total patent application submissions, followed by accelerators (about 25%), and co-working spaces (hardly 4%). This substantiates our earlier contention that incubators are tuned towards nurturing tech start-ups, with specialized laboratory, machinery and equipment, and specialized R&D personnel more than accelerators and co-working spaces.

However, in terms of patent intensity (patent applications submitted as a percentage of new products/services generated), among the ABCs, accelerators had a higher intensity (about 21%), followed by incubators (about 7%), and co-working spaces (hardly 1%). Between the three hubs, Chennai had the highest patent intensity (about 12%), followed by Bangalore (> 6%), and then Hyderabad (nearly 5%).

Table 6.8: TBIs: Number of Patent Applications Submitted (as of 2016/17)

No. of patent applications submitted	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
	I	29	18	9	0	19	4	3	14	6	102
	II	0	28	0	0	51	0	0	93	0	172
	III	87	55	0	0	0	0	0	65	0	207
Total		**116**	**101**	**9**	**0**	**70**	**4**	**3**	**172**	**6**	**481**

Note: I = 1 to 10; II = 11 to 50; III = 51 to 100

Another important indicator of TBI performance is the revenue generated through the sale of new products/services. While we could not get annual sales revenue generated through the sale of new products/services by the incubated start-ups of TBIs, we could get approximate value of the cumulative sales revenue achieved through new products/services, as of 2016/17. Accordingly, the

TBIs have been classified under three different slabs of sales revenue generation (Table 6.9). About 12% of the TBIs, comprising incubators and co-working spaces, generated revenue in the range of Rs.0.5 million to Rs.5 million, about 46% generated revenue in the range of more than Rs.5 million up to Rs.50 million, about 35% in the range of more than Rs.50 million up to Rs.10 billion, and about 6% in the range of more than Rs.10 billion up to Rs.81 billion.

Table 6.9: TBIs: Classification in terms of Ranges of Revenue Generation (as of 2016/17)

	Cities →	**Bangalore**			**Chennai**			**Hyderabad**			**Total**
	Typology →	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	
Total revenue generated due to new products/services	**5 lakh to 50 lakh**	0	1	1	0	1	1	0	1	3	8
	>50 lakh to 500 lakh	2	6	9	0	3	6	1	2	1	30
	>500 lakh to 1000 crore	3	6	1	0	4	0	1	5	3	23
	>1000 crore to 8100 crore	2	0	0	0	0	0	0	2	0	4
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**

The distribution of TBIs in terms of actual revenue generation through the sale of new products/services is given in Table 6.10. The TBIs together generated a sales revenue of Rs.187985 lakh from the sales of new products/services through their incubated start-ups. Between the ABCs, accelerators accounted for the highest share of 59% of the total revenue, followed by incubators (37%) and co-working spaces (4%). Among the three hubs, Bangalore accounted for the highest share of 68% of the total revenue, followed by Hyderabad (29%) and Chennai (3%).

It is to be noted that about half (50%) of the revenue generated by the TBIs in our sample comes from two accelerators in Bangalore – namely Microsoft Accelerator and SAP Labs Accelerator. Both these two companies are global giants who are among the top 20 companies in the world –

with significant market reach and scale across the world. Hence, the startups incubated under their program have easy access to global customers and therefore has resulted in creation of revenues of this magnitude. It is also important to understand the contributions of the two incubators in Hyderabad, namely IKP Incubator and ALEAP Incubator which together contribute about 18.5% of the cumulative revenues generated from our sample of TBIs. These two incubators have been operational since more than a decade – with IKP Knowledge Park more than 12 years old and ALEAP being operational since 25 years. While IKP Knowledge Park has leveraged corporate connections to enable startups to flourish, ALEAP has managed to develop deep relationships with various State and Central Government departments and have therefore enabled the women entrepreneurs incubated in their location to have access to a large customer base.

Barring these four entities that together constitute 68.5% of the revenues generated and therefore can be considered as outliers, the total revenues generated from the remaining 61 entities is Rs. 59,485 lakh, which indicates that on an average, each TBI has been able to make an average revenue contribution of about Rs.975 lakh.

The above data indicates two important aspects concerning the TBIs in India. Firstly, our observation is that a minimum of 10 years' gestation time is required for TBIs to start demonstrating R&D outputs. Secondly, as on date, the R&D outputs contribution, viewed from the lens of sales revenue generated from the incumbent startups is yet to emerge in a significant fashion, relative to the corresponding R&D investments made in these TBIs.

Table 6.10: TBIs: Sales Revenue through New Products/Services (as of 2016/17)

	Cities →	Bangalore			Chennai			Hyderabad			Total
Total revenue generated due to new products/services (Rs. lakh)	Typology →	A	B	C	A	B	C	A	B	C	
	I	0	15	15	0	15	5	0	15	45	110
	II	410	1090	1945	0	650	1030	180	700	150	6155
	III	13500	15800	600	0	4020	0	2500	11700	3600	51720
	IV	95000	0	0	0	0	0	0	35000	0	130000
Total		**108910**	**16905**	**2560**	**0**	**4685**	**1035**	**2680**	**47415**	**3795**	**187985**

Note: I = 5 lakh to 50 lakh; II = >50 lakh to 500 lakh; III = >500 lakh to 1000 Cr; IV = >1000 Cr to 8100 Cr

6.4 TBIs: Determinants of R&D Contributions

The discussion in the previous two sections revealed that TBIs do contribute to national R&D efforts in terms of R&D investment expenditure, R&D personnel, new products/services, submission of patent applications, and revenue generated through the sale of new products/services. Given this, it is appropriate to ascertain - what determines the extent of R&D contributions that emanate from the TBIs? This has been probed by means of the following specific research questions:

1. How far the characteristics of TBIs, their CEOs, selection process and incubation process influence the R&D investment expenditure incurred by the TBIs? ---(6.1)
2. How far the characteristics of TBIs, their CEOs, selection process and incubation process influence the R&D personnel employed by the TBIs? ---(6.2)
3. How far the characteristics of TBIs, their CEOs, selection process and incubation process influence the generation of new products/services from the TBIs? ---(6.3)
4. How far the characteristics of TBIs, their CEOs, selection process and incubation process influence the number of patent application submissions from the TBIs? ---(6.4)

5. How far the characteristics of TBIs, their CEOs, selection process and incubation process influence the generation of total revenue from the sale of new products/services from the TBIs? ---(6.5)
6. Do R&D investment, R&D personnel, new products/services and patent applications influence the revenue generated from the sale of new products/services of TBIs? ---(6.6)

A total of six multiple regression models were built to analyze the above research questions. The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation for each of the regression models is presented in the Appendix 4.3 of this report. The next section summarizes the key findings and inferences from the statistical analysis.

6.5 Summary

The R&D contribution performance of TBIs can be assessed in terms of R&D inputs and R&D outputs. While R&D inputs emerge through R&D investment expenditure and R&D personnel, R&D outputs emerge in the form of new products/services, patent applications, and revenue generation. Though every TBI in all the three start-up hubs have claimed to have incurred R&D investment expenditure, almost one-third of them (21 of the 65 TBIs) did not employ any exclusive R&D personnel. While the approximate current value of gross R&D investments (incurred by the 65 TBIs) amounted to Rs.2050 million with an average of Rs.31.5 million, the 44 TBIs together employed only 150 R&D personnel., with an average of >3 (for those TBIs which have employed at least one R&D personal).

Every TBI, irrespective of age, could generate new products/services through their incubatees over a period of time, and together they generated 8110 new products/services with an average of 125 new products/services per TBI. However, what is important to note is that about 38% (25) of the 65 TBIs did not experience even a single patent application submission, despite generating new products/services. The remaining 40 TBIs together accounted for just 481 patent application submissions, amounting to an average of just 12 per TBI. As a result, the patent application submissions accounted for hardly 6% of the new products/services generated. This implies that by and large, there is no significant patent intensity among the nurtured start-ups of TBIs in the three start-up hubs. This could be a reflection on the "lack of adequate novelty" or "lack of innovativeness" in the new products/services developed by the start-ups, which would mean most of these products/services are new to Indian market but may not be new to the industry in the global context. However, together, these TBIs could generate a total of Rs. 189485 lakh from the new products/services generated by their incubating start-ups, with an average of Rs.2892 lakh per TBI.

In terms of R&D contributions, the TBIs with women leadership contributed to about 13290 lakh INR of R&D expenditure in equipment (65% of total R&D expenditure) and was responsible for generation of 138 patents (29% of the total patent applications submitted), 3295 new products & services (41% of the total new products and services), and contributed to 43,705 lakh INR (23% of the total sales) in sales revenue from new products/services. The Private and Corporate sector has been the dominant player when it comes to R&D investments and R&D outputs in the TBIs. The private sector accounted for R&D expenditure of INR 17991 lakh (88% of the total R&D investment). In terms of R&D outputs, the corporate and private sector claimed to create 6214 new products and services at their TBIs (77% of the total new P&S), 243 patent applications (51% of the total) and sales revenue of INR 161570 lakh (85% of total revenue).

With the above observations, we examined which of the variables among - TBI characteristics, CEO characteristics, help provided through incubation process, nature of TBI sponsorship, successful admissions and successful exits - influenced R&D input contributions and R&D output contributions. The TBIs with CEOs having no previous experience but have external networks and provide need based mentoring for a larger number of incubatees, accounted for larger R&D investments. But only infrastructure and number of administrative personnel mattered for the employment of R&D personnel. A higher number of new products/services emerged from older TBIs, which have exclusive external networks and have a larger number of incubatees. But corporate sponsorship, infrastructure and higher successful exits influenced patent application submissions. Further, corporate sponsorship and successful exits mattered for total revenue generation as well. Finally, when we looked at R&D inputs along with new products/services and patent applications for their influence on total revenue, we ascertained that only new products/services and patent applications together influenced total revenue generation of the TBIs but not the R&D inputs of investment and personnel. Overall, it may be appropriate to conclude that there is scope and potential for an increasing R&D contribution to emerge from the TBIs through their incubated start-ups, in the future.

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CHAPTER 7
THE R&D CONTRIBUTIONS OF START-UPs TO NATIONAL R&D EFFORTS: ROLE OF THE TBIs AND OTHER DETERMINANTS

7.1 Introduction:

The R&D contribution of TBI has two dimensions: (i) those emerging from the TBIs directly, and (ii) those emerging from the start-ups, which are either undergoing incubation in the TBIs or incubated and exited from the TBIs. While TBIs can contribute to the national R&D efforts through R&D investments on capital infrastructure and R&D personnel for mentoring and dealing with specialized laboratory, machinery and equipment, among others, R&D outputs in the form of either new products/services or patents or total revenue emerging out of the sale of new products/services would emerge from the start-ups which have completed or about to complete the incubation process or from those start-ups which have graduated and exited from the TBIs. Therefore, R&D output contribution analysis should appropriately focus on the start-ups, either undergoing the incubation process or graduated and exited from the TBIs.

Accordingly, we have gathered primary data from one each incubating start-up located in each of the 65 TBIs, and one each graduated/exited start-up from the 42 TBIs which have experienced graduation and successful exit of start-ups since their establishment. We have looked at their basic characteristics in terms of age after incorporation, nature of incorporation, size of founding team, educational qualification and previous industry/start-up experience of the CEO of the start-ups. Subsequently, we have ascertained the extent of R&D input and R&D output contributions emerged from them. Finally, we have analyzed how TBI characteristics and the incubation facilities offered by them, along with the CEO characteristics and time spent by the start-ups determine their R&D contributions.

7.2 TBI based Start-Ups: Characteristics

At the outset, it is important to understand the distribution of start-ups, graduated as well as incubating, in terms of their location of in the three start-up hubs, namely, Bangalore, Chennai and Hyderabad, and in terms of accelerators, incubators and co-working spaces. The incubating start-up distribution is akin to the distribution of TBIs, since we have chosen one each incubating start-up from each of the 65 TBIs (Table 7.1). But the distribution of graduated start-ups reveals that about 64% of them are in Bangalore, followed by about 24% in Hyderabad and the rest (12%) in Chennai. All the accelerators, a majority of the incubators and co-working spaces in Bangalore have experienced graduation of start-ups, but a lesser proportion of incubators and co-working spaces in Hyderabad, and a lesser proportion of incubators and none of the co-working spaces in Chennai have experienced graduation since the commencement of their incubating operations.

Table 7.1: Distribution of Start-Ups: Graduated and Incubating

Classification of startups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU		7	13	11	0	8	7	2	10	7	65
GSU		7	10	10	0	5	0	2	6	2	42
Total		14	23	21	0	13	7	4	16	9	107

Note: ISU – Incubating Start-Up; GSU – Graduated Start-Up

The age of a start-up is another characteristic. The age has been calculated since their incorporation and as of January 2018. The distribution of incubating start-ups and graduated start-ups in terms of age is given in Table 7.2. About 8% of the incubating start-ups have not gone for incorporation yet, as they have just made their entry into the TBIs. About 57% of the incubating ones are not more than 3 years old, another 29% incubating start-ups are more than 3 years but not more than 6 years old, whereas about 6% of them is more than 6 years but not more than 12 years old, after incorporation. Broadly, it implies that incubation process in a TBI, in general, is not bound by time and an incubating start-up can undergo incubation beyond years.

But unlike the incubating start-ups, all the graduated start-ups are incorporated. About 40% start-ups are in the age group of >0-3 years and 45% start-ups are in the age group of >3-6 years, whereas the rest (15%) are in the age group of >6-12 years. On an average, graduated start-ups appear to be older than the incubating start-ups.

Table 7.2: Age of Start-Ups

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	
ISU	**Not Incorporated**	0	0	0	0	1	0	0	1	3	5
	>0 to 3 Years	6	8	7	0	4	5	2	2	3	37
	>3 to 6 Years	1	5	3	0	3	1	0	5	1	19
	>6 to 12 Years	0	0	1	0	0	1	0	2	0	4
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	**Not Incorporated**	0	0	0	0	0	0	0	0	0	0
	>0 to 3 Years	3	5	5	0	1	0	1	2	0	17
	>3 to 6 Years	4	4	5	0	1	0	1	2	2	19
	>6 to 12 Years	0	1	0	0	3	0	0	2	0	6
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

In general, a start-up can be incorporated as a Private Limited Company (PLC), a Partnership firm or as a Limited Liability Partnership (LLP) firm or even as a One Person Company (OPC) private limited. However, start-ups are generally advised to incorporate either as a PLC or as an LLP or as an OPC private limited. This is because many times start-ups need to borrow money and take things on credit. The concept of One Person Company (OPC) allows a single person to run a company limited by shares while a Sole Proprietorship means an entity which is run and owned by one individual and where there is no distinction between the owner and the business (Vakilsearch, 2018). In case of normal Partnerships, partners' personal savings and property would be at risk incase business is not able to repay its loans. But in a, OPC, LLP or PLC, only investment in business is lost, and personal assets of the directors are safe (Startupwala, 2018). Therefore, both incubating and graduated start-ups of TBIs are likely to be incorporated in these three forms only.

The distribution of incubating and graduated start-ups in terms of incorporation is presented in Table 7.3. While all the start-ups – incubating as well as graduated – have incorporated in the form of either OPC or LLP or PLC, majority of the incubating start-ups (92%) as well as graduated start-ups (88%) have gone for incorporation in the form of PLCs. The ratio of OPC to LLP to PLC is approximately 1.5:6:92 for incubating start-ups whereas it is 7:5:88 for graduated start-ups.

. Table 7.3: Nature of Incorporation of Start-Ups

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	OPC	0	1	0	0	0	0	0	0	3	4
	LLP	0	0	0	0	1	0	0	0	0	1
	PLC	7	12	11	0	7	7	2	10	4	60
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	OPC	0	0	0	0	0	0	1	2	0	3
	LLP	0	0	0	0	2	0	0	0	0	2
	PLC	7	10	10	0	3	0	1	4	2	37
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

NOTE: OPC = One Person Company; LP = Limited Liability Partnership; PLC = Private Limited Company

Given the nature of incorporation, the size of the founding team of start-ups is important. A start-up can be formed by either single founders or multiple founders. While OPCs have to be single founder start-ups, LLPs have to comprise at least two founders but it can have multiple founders without any upper limit whereas PLCs have to consist of at least two but not more than 200 founders (Vakilsearch, 2018). The distribution of both incubating and graduated start-ups in terms of the size of founding teams is given in Table 7.4.

Table 7.4: Size of the Founding Team of Start-Ups

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	Single Founder	0	1	0	0	0	0	0	0	0	1
	Two Founders	3	8	8	0	5	3	1	5	4	37
	More than two Founders	4	4	3	0	3	4	1	5	3	27
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	Single Founder	0	0	0	0	0	0	1	2	0	3
	Two Founders	5	7	8	0	3	0	1	2	1	27
	More than two Founders	2	3	2	0	2	0	0	2	1	12
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

Single founders (1.5% and 7%, respectively) accounted for a minority share whereas two founders (57% and 64%, respectively) accounted for the majority in both incubating and graduated start-ups, and multiple (more than two) founders accounted for about 42% of the incubating start-ups and about 29% of the graduated start-ups. This brings out that start-ups in general are conceived by a group of founders consisting of two or more entrepreneurs.

However, the R&D contribution emanating from the start-ups would largely be determined by the educational qualification of their CEOs. By and large, startup CEOs get distinguished from the CEOs of MSMEs by means of their education background, as they possess a minimum of graduate qualifications, unlike the other (Bala Subrahmanya, 2015). But the CEOs of start-ups graduated/incubating in TBIs are all STEM (Science, Technology, Engineering or Math) qualified, ranging from graduation to post-graduation to doctoral degrees (Table 7.5). The ratio of graduates to post graduates to PhDs is 38:38:23 for the incubating start-up CEOs and 34:52:14 for the graduated start-up CEOs. Given this, R&D output contribution in the form of new products/services, patents and subsequently revenue is a feasible proposition.

Table 7.5: Educational Qualification of Start-Up CEOs

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	
ISU	**Bachelors in STEM**	4	4	4	0	3	3	1	1	5	25
	Masters in STEM	2	5	6	0	1	3	1	5	2	25
	PhD in STEM	1	4	1	0	4	1	0	4	0	15
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	**Bachelors in STEM**	2	3	4	0	1	0	1	2	1	14
	Masters in STEM	5	4	6	0	4	0	1	1	1	22
	PhD in STEM	0	3	0	0	0	0	0	3	0	6
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

Note: STEM = Science/Technology/Engineering/Maths

Another important influencer of R&D contribution of start-ups could be the background of CEO work experience in the form of industry work experience or start-up founding experience or both. Other things remaining the same, those who have previously worked in large companies, particularly MNCs, and/or start-ups may be able to develop new products/services, obtain patents and generate revenue better than those who do not have such a background. About 17% of the incubating start-up CEOs and about 7% of the graduated start-up CEOs did not have any previous industry/start-up work experience (Table 7.6). The rest had either previous industry work experience (43% and 55%, respectively) or previous start-up work experience (about 5% and 7%, respectively) or both (35% and 31%, respectively). Thus, a vast majority of the start-up CEOs, in both incubating and graduated start-ups, had work experience in industry and/or start-ups.

Table 7.6: Work Experience of Start-Up CEOs

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	No prior industry or startup experience	1	1	0	0	0	2	1	5	1	11
	Prior Industry Experience	3	5	5	0	6	3	1	3	2	28
	Prior Startup Experience	0	0	2	0	1	0	0	0	0	3
	Prior Startup and Industry Experience	3	7	4	0	1	2	0	2	4	23
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	No prior industry or startup experience	0	1	1	0	0	0	0	1	0	3
	Prior Industry Experience	2	6	5	0	5	0	1	4	0	23
	Prior Startup Experience	0	1	1	0	0	0	0	0	1	3
	Prior Startup and Industry Experience	5	2	3	0	0	0	1	1	1	13
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

If all of the start-up CEOs are STEM qualified – graduates/post-graduates/doctorates, and majority CEOs have previous work experience, a majority of them is likely to be middle aged and above.

The age profile of CEOs is presented in Table 7.7. The age profile ranged from as young as 19 years to as old as 60 years. About 31% of the incubating start-up CEOs and about 29% of the graduated start-up CEOs were in the age group of 19 to 30 years. About 51% of the incubating start-up CEOs and about 40% of the graduated start-up CEOs were in the age group of 31 to 40 years, whereas about 18% of the CEOs in the incubating start-ups and about 31% of the CEOs in graduated start-ups were in the age group of 41 to 60 years. Thus, majority CEOs fell in the age group of 19-40 years, particularly in the middle range of 30 to 40 years, and this is more so in the case of incubating start-ups. Other things remaining the same, those CEOs who are more STEM qualified and have acquired more knowledge and skills through their industry and/or start-up work experience relevant start-ups might be able to contribute more R&D outputs relative to the rest.

Table 7.7: Age Profile of Start-Up CEOs

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	19 – 30 Years	1	5	4	0	1	2	2	3	2	20
	31 – 40 Years	4	5	6	0	5	4	0	5	4	33
	41 – 60 Years	2	3	1	0	2	1	0	2	1	12
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	19 – 30 Years	2	2	5	0	2	0	0	0	1	12
	31 – 40 Years	4	5	4	0	1	0	0	2	1	17
	41 – 60 Years	1	3	1	0	2	0	2	4	0	13
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

The time spent for undergoing incubation till graduation and exit from a TBI by a prospective start-up may determine its success to develop new products/services, obtain patents and generate revenue. While some start-ups might emerge after a few months of incubation, some others might take a couple of years to complete the incubation process for graduation and exit. This variance in the duration of time spent undergoing incubation largely depends on the nature of the new products/services and the customer segments that these startups cater to. Table 7.8 presents the distribution of incubating start-ups as well as graduated start-ups in terms of time spent in the TBIs.

For incubating start-ups, the duration of incubation is calculated as the time spent in months from their onboarding (entry) till January 2018, and for graduated start-ups, the duration of incubation is calculated as the time spent in months between their entry to successful exit from the TBI. Of the 65 incubating start-ups, about 45% start-up CEOs have spent a minimum of 3 months but not more than 12 months, another 43% CEOs have spent 13 months to 36 months, and the rest (13%) 36 months to 84 months, as of January 2018.

Table 7.8: Duration of Incubation undergone in the TBIs

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	3 to 12 Months	3	5	7	0	3	2	2	3	4	29
	13 to 36 Months	4	5	3	0	3	4	0	6	3	28
	36 to 84 Months	0	3	1	0	2	1	0	1	0	8
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	3 to 12 Months	2	4	5	0	1	0	2	1	1	16
	13 to 36 Months	3	4	4	0	1	0	0	4	1	17
	36 to 84 Months	2	2	1	0	3	0	0	1	0	9
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

However, what is more significant is the time spent by the graduated start-up CEOs. About 38% of them spent time between 3 months to 12 months, more than 40% spent time between 13 months to 36 months, and about 21% spent time between 36 months to 84 months for incubation and graduation. This implies that more than 3/4 of the graduated start-up CEOs did not spend more than 3 years for the incubation process and successful graduation and exit.

7.3 TBI based Start-Ups: Extent of R&D Contributions

Given the varied characteristics of start-ups and their CEOs, it is important to understand the extent of R&D input as well as output contributions emerged from them. While R&D inputs comprise R&D investments and R&D personnel, R&D outputs would include new products/services. Patent application submissions and patent grants, and finally, revenue generated from the sale of new products/services. A start-up might require exclusive specialized machinery & equipment for its research and innovation for product development, and therefore incur R&D investment expenditure in the process of venture creation. Table 7.9 presents the distribution of start-ups, incubating as well as graduated, in terms of ranges of current value of R&D investments incurred as of 2016/17.

Table 7.9: Start-Ups in terms of Range of Current Value of R&D Investments (2016/17)

Classification of Start-Ups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	>1 to 10 (Rs. Lakh)	4	12	8	0	5	7	1	6	7	50
	>10 to 50 (Rs. Lakh)	0	1	3	0	1	0	1	2	0	8
	>50 to 100 Rs. Lakh)	0	0	0	0	1	0	0	2	0	3
	>100 to 200 (Rs. Lakh)	3	0	0	0	1	0	0	0	0	4
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	>1 to 10 (Rs. Lakh)	1	5	9	0	1	0	1	5	0	22
	>10 to 50 (Rs. Lakh)	5	5	1	0	4	0	1	0	2	18
	>50 to 100 Rs. Lakh)	1	0	0	0	0	0	0	1	0	2
	>100 to 200 (Rs. Lakh)	0	0	0	0	0	0	0	0	0	0
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

It is important to note that every incubating as well as incubated/graduated start-up has incurred R&D investments. About 77% of the incubating start-ups and about 52% of the graduated start-ups have incurred R&D investment expenditure in the range of >Rs.1 lakh to Rs.10 lakh; about 12% of the incubating start-ups and 43% of the graduated ones invested in the range of >Rs.10 lakh to Rs.50 lakh, and about 5% each of the incubating start-ups and the graduated ones invested in the range of >Rs.50 lakh to Rs.100 lakh, whereas about 6% of the incubating ones and none of the graduated ones invested in the range of >Rs.100 lakh to Rs.200 lakh, in 2016/17. How much expenditure these start-ups have actually incurred for R&D is the other relevant issue. Table 7.10 presents the distribution of start-ups in terms of actual expenditure incurred for R&D investments.

Table 7.10: Current Value of R&D Investments by Start-Ups for 2016/17 (Rs. Lakh)

Classification of Startups	Cities → / Typology →	Bangalore A	Bangalore B	Bangalore C	Chennai A	Chennai B	Chennai C	Hyderabad A	Hyderabad B	Hyderabad C	Total
ISU	I	23	44.9	42	0	16	24	10	27.3	27.3	214.5
	II	0	50	56.5	0	12	0	30	65	0	213.5
	III	0	0	0	0	78	0	0	156	0	234
	IV	300	0	0	0	200	0	0	0	0	500
Total		**323**	**94.9**	**98.5**	**0**	**306**	**24**	**40**	**238.3**	**27.3**	**1162**
GSU	I	10	36	30	0	5	0	7	30.9	0	119
	II	200	186	35	0	112	0	18	0	55	606
	III	70	0	0	0	0	0	0	55	0	125
	IV	0	0	0	0	0	0	0	0	0	0
Total		**280**	**222**	**65**	**0**	**117**	**0**	**25**	**85.9**	**55**	**850**

Note: I = 1 to 10 lakh; II = >10 lakh to 50 lakh; III = >50 lakh to 99 lakh; IV = >99 lakh to 200 lakh

The total R&D investments incurred were more in the higher ranges of investments compared to the lower range of investments for incubating start-ups. The respective percentages with respect to the total for I, II, III and IV slabs were 18.5%, 18.37%, 20% and 43% for incubating start-ups, and for I, II and III slabs were 14%, 71%, and 15% for the graduated start-ups. Overall, the incubating start-ups had invested about Rs.11.62 crore and the graduated start-ups invested Rs.8.5 crore worth R&D investment expenditure, in 2016/17. The total R&D investment of both incubating and incubated start-ups stood at more than Rs.20 Crore.

The other dimension of R&D input contribution is R&D personnel employed by the start-ups. The distribution of start-ups in terms of ranges of R&D personnel employed as of 2016/17, is given in

Table 7.11. When an incubating start-up begins with ideation for POC, prototype development, MVP and product manufacturing for venture creation, they need exclusive technical personnel for carrying out such tasks. Even graduated start-ups would need them more in number for product modification based on initial customer feedback for market penetration, and even for scaling up. Therefore, one can expect R&D personnel employment in the start-ups which are undergoing incubation as much as in the graduated start-ups.

Table 7.11: Start-Ups in terms of Range of R&D Personnel employed (2016/17)

Classification of Start-Ups	Cities -→	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	1 to 5 persons	3	11	10	0	7	7	2	7	7	54
	6 to 10 persons	2	2	1	0	1	0	0	3	0	9
	11 to 15 persons	2	0	0	0	0	0	0	0	0	2
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	1 to 5 persons	2	6	10	0	2	0	2	5	2	29
	6 to 10 persons	5	4	0	0	2	0	0	0	0	11
	11 to 15 persons	0	0	0	0	1	0	0	1	0	2
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

Almost 83% of the incubating start-ups and about 69% of the graduated start-ups have employed at least one but not more than five R&D personnel, about 14% of the incubating start-ups and about 26% of the graduated start-ups have employed R&D personnel in the range of six to 10 persons, whereas bout 3% of the incubating start-ups and about 5%of the graduated ones have employed more than 10 but note more than 15 persons, as of 2016/17. But how much R&D personnel together these start-ups have employed is the pertinent issue (Table 7.12).

While incubating start-ups accounted for a total R&D personnel employment of 232 persons, graduated start-ups employed 199 persons. Further, in the incubating start-ups, the R&D personnel were distributed between all the three – I, II and III - slabs in the ratio of 61:29:10, and thus they were more confined to the lowest employment slab. The respective ratios for graduated start-ups were 41:46:13 and thus majority personnel were employed in the II slab. Similar to the R&D investment expenditure, incubating start-ups accounted for a higher number of R&D personnel than the graduated start-ups, though the latter accounted for a higher per unit investment and per unit personnel.

Table 7.12: Actual R&D Personnel employed by the Start-Ups (2016/17)

Classification of startups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	I	9	32	35	0	14	16	6	16	13	141
	II	15	16	8	0	8	0	0	21	0	68
	III	23	0	0	0	0	0	0	0	0	23
Total		**47**	**48**	**43**	**0**	**22**	**16**	**6**	**37**	**13**	**232**
GSU	I	7	22	16	0	5	0	7	15	9	81
	II	44	32	0	0	15	0	0	0	0	91
	III	0	0	0	0	12	0	0	15	0	27
Total		**51**	**54**	**16**	**0**	**32**	**0**	**7**	**30**	**9**	**199**

Note: I = 1 to 5 persons; II = 6 to 10 persons; III = 11 to 15 persons

Are these start-ups able to produce new products/services with their R&D investment and personnel is the next relevant issue. Each one of the incubating as well as graduated start-ups have admitted that they are able to produce at least, one new product/service while in the TBI. The distribution of start-ups in terms of ranges of new products/services produced is presented in Table 7.13. About 29% of the incubating start-ups and about 7% of the graduated ones have not produced any new product/service in 2016/17, 63% of the incubating ones and about 64% of the graduated ones produced one each new product/service, about 5% of the incubating start-ups and about 17% of the graduated ones produced two new products/services each, whereas about 3% of the incubating start-ups and about 12% of the graduated ones produced three new products/services each, in 2016/17.

Table 7.13: Start-Ups in terms of Range of New Products/Services (during 2016/17)

Classification of Startups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	None	0	4	3	0	2	2	0	2	6	19
	1 product	7	9	7	0	4	5	2	6	1	41
	2 products	0	0	1	0	2	0	0	0	0	3
	3 products	0	0	0	0	0	0	0	2	0	2
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	None	0	0	3	0	0	0	0	0	0	3
	1 product	5	7	6	0	2	0	0	5	2	27
	2 products	2	1	1	0	1	0	1	1	0	7
	3 products	0	2	0	0	2	0	1	0	0	5
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

The actual number of new products/services produced in 2016/17, by the incubating and graduated start-ups under different ranges of new products/services is given in Table 7.14. Those incubating start-ups which produced one each new product/service accounted for more than 77% of the total 53 products, incubating start-ups which produced two new products/services each accounted for about 11% of the total and those which produced three new products/services each accounted for another 11% of the total 53 products, in 2016/17.

Table 7.14: Actual # of new product offerings created by the Start-Ups

Classification of Startups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	I	0	0	0	0	0	0	0	0	0	0
	II	7	9	7	0	4	5	2	6	1	41
	III	0	0	2	0	4	0	0	0	0	6
	IV	0	0	0	0	0	0	0	6	0	6
Total		**7**	**9**	**9**	**0**	**8**	**5**	**2**	**12**	**1**	**53**
GSU	I	0	0	0	0	0	0	0	0	0	0
	II	5	7	6	0	2	0	0	5	2	27
	III	4	2	2	0	2	0	2	2	0	14
	IV	0	6	0	0	6	0	3	0	0	15
Total		**9**	**15**	**8**	**0**	**10**	**0**	**5**	**7**	**2**	**56**

Note: I = No new product/service; II = 1 new product/service; III = 2 new products/services; IV = 3 new products/services

The graduated start-ups together produced 56 new products/services in 2016/17. Of these, those which produced one new product/service each accounted for about 48%, those produced two new products/services each accounted for 25% and those which produced three new products/services each accounted for about 27% of the total 56 new products/services. Overall, this indicates that a majority of the TBI network in the three start-up hubs is indeed able to facilitate the generation of new products/services by start-ups, ranging from a minimum of one to three products.

But the real test of innovativeness lies in the ability of a start-up to obtain patents for the new products/services developed. That will be reflected in the number of patent applications submitted and the number of patents obtained subsequently. We could not obtain data form the start-ups, incubating as well as graduated, either on the number of patent applications submitted or on the number of patents obtained. However, we could obtain information on whether they have submitted an application for a patent or not. Accordingly, both the incubating and the graduated start-ups have been classified into two groups each, those which have not submitted any application for a patent and those which have submitted, at least, one patent application in 2016/17 (Table 7.15).

It is significant to note that despite developing at least, one new product majority of both the incubating start-ups (about 58%) and graduated start-ups (about 55%) have not submitted any application for a patent, thereby supporting the observation already made (in the previous chapter) about the "lack of innovativeness" in the new products/services developed by the incubating/incubated start-ups in the three start-up hubs in the country.

Table 7.15: Distribution of Start-Ups that have filed Applications for Patents

Classification of Startups	Cities →	Bangalore			Chennai			Hyderabad			Total
	Typology →	A	B	C	A	B	C	A	B	C	
ISU	No Patent application	0	7	5	0	4	6	2	7	7	38
	At least one Patent filed	7	6	6	0	4	1	0	3	0	27
	Total	7	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	No Patent application	1	3	6	0	5	0	2	4	2	23
	At least one Patent filed	6	7	4	0	0	0	0	2	0	19
	Total	7	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

Finally, it is important to know whether the start-ups which have developed new products/services are able to generate revenue out of it. The distribution of start-ups in terms of ranges of revenue generation from none up to Rs.200 lakh in 2016/17 is presented in Table 7.16. About 48% of the incubating start-ups and about 17% of the graduated start-ups did not generate any revenue from their new products/services, but 40% of the incubating start-ups and 38% of the graduated start-ups have generated revenue up to Rs.10 lakh, about 9% of the incubating start-ups and about 36% of the graduated start-ups generated revenue more than Rs.10 lakh up to Rs.50 lakh, and about 3% of the incubating start-ups and about 10% of the graduated start-ups generated revenue more than Rs.50 lakh up to Rs.200 lakh.

Table 7.16: Start-Ups in terms of Ranges of Revenue Generated in 2016/17

Classification of Startups	Cities → Typology →	Bangalore A	Bangalore B	Bangalore C	Chennai A	Chennai B	Chennai C	Hyderabad A	Hyderabad B	Hyderabad C	Total
ISU	None	0	8	5	0	4	2	1	5	6	31
	>0 to 10 (Rs. Lakh)	5	5	3	0	2	5	1	4	1	26
	>10 to 50 (Rs. Lakh)	1	0	3	0	1	0	0	1	0	6
	>50 to 200 (Rs. Lakh)	1	0	0	0	1	0	0	0	0	2
Total		**7**	**13**	**11**	**0**	**8**	**7**	**2**	**10**	**7**	**65**
GSU	None	1	2	4	0	0	0	0	0	0	7
	>0 to 10 (Rs. Lakh)	0	4	5	0	1	0	1	5	0	16
	>10 to 50 (Rs. Lakh)	2	4	1	0	4	0	1	1	2	15
	>50 to 200 (Rs. Lakh)	4	0	0	0	0	0	0	0	0	4
Total		**7**	**10**	**10**	**0**	**5**	**0**	**2**	**6**	**2**	**42**

The distribution of start-ups in terms of actual revenue generated in 2016/17 is given in Table 7.17. Overall, incubating start-ups generated a total revenue of Rs.617 lakh out of the sale of their new products/services in 2016/17 while undergoing incubation in the TBIs, whereas the graduated start-ups generated about Rs.930 lakh after their graduation in 2016/17. The shares in the three slabs of revenue generation amounted to 19%, 33% and 49% for incubating start-ups, and 5%, 52% and 43% for graduated start-ups, respectively.

Table 7.17: Actual Revenue Generated by the Start-Ups (Rs. Lakh) in 2016/17

Classification of Startups	Cities → Typology →	Bangalore A	Bangalore B	Bangalore C	Chennai A	Chennai B	Chennai C	Hyderabad A	Hyderabad B	Hyderabad C	Total
ISU	I	0	0	0	0	0	0	0	0	0	0
	II	45	27	14.3	0	3.8	9.5	2	12.5	2	116.1
	III	50	0	65	0	50	0	0	36	0	201
	IV	200	0	0	0	100	0	0	0	0	300
Total		**295**	**27**	**79.3**	**0**	**153.8**	**9.5**	**2**	**48.5**	**2**	**617.1**
GSU	I	0	0	0	0	0	0	0	0	0	0
	II	0	17	5.3	0	7	0	1	19.3	0	49.6
	III	34	160	20	0	126	0	25	38	77	480
	IV	400	0	0	0	0	0	0	0	0	400
Total		**434**	**177**	**25.3**	**0**	**133**	**0**	**26**	**57.3**	**77**	**929.6**

Note: I = None, II = >0 to 10 lakh; III = >10 lakh to 50 lakh; IV = > 50 lakh to 200 lakh

7.4 TBI based Start-Ups: Determinants of their R&D Contributions

The discussion in the previous two sections revealed that both incubating and graduated start-ups do contribute to national R&D efforts in terms of R&D investment expenditure, R&D personnel, new products/services, submission of patent applications, and revenue generated through the sale of new products/services. Given this, it is appropriate to ascertain - what determines the extent of R&D contributions that emanate from the TBI nurtured start-ups? This has been probed by means of the following specific research questions:

1. How do the characteristics of incubated/incubating start-ups, their CEOs, and support obtained from the TBIs influence the R&D investment expenditure incurred by the start-ups? ----(7.1)
2. How do the characteristics of incubated/incubating start-ups, their CEOs, and support obtained from the TBIs influence the R&D personnel employed by the start-ups? ----(7.2)
3. How do the characteristics of incubated/incubating start-ups, their CEOs, and support obtained from the TBIs influence the generation of new products/services by the start-ups? ----(7.3)
4. How do the characteristics of incubated/incubating start-ups, their CEOs, and support obtained from the TBIs influence the patent application submissions from the start-ups? ----(7.4)
5. How do the characteristics of incubated/incubating start-ups, their CEOs, and support obtained from the TBIs influence the generation of total revenue from the sale of new products/services by the start-ups? ----(7.5)

6. Do R&D investment, R&D personnel, new products/services and patent application submission influence the revenue generated from the sale of new products/services by the start-ups? ---(7.6)

A total of six multiple regression models were built to analyze the above research questions. The variables used for the examination, their description, the correlation between the variables, initial descriptive statistics, regression results and their detailed interpretation for each of the regression models is presented in Appendix 4.4 of this report. The next section summarizes the key findings and inferences from the statistical analysis.

7.5 Summary

Since R&D contributions through R&D investments, R&D personnel, new products/services and revenue generation can only come through incubating/incubated start-ups, we have gathered primary data on these variables from one start-up each from all the 65 TBIs which are incubating start-ups and one each incubated start-up from 42 TBIs which have nurtured and graduated start-ups since their inception. The primary data gathered from these 107 start-ups formed the basis of our discussion and analysis of research objectives in this chapter.

A higher proportion of TBIs experienced graduation of start-ups in Bangalore followed by Hyderabad and then, Chennai. A large majority of both incubating and graduated start-ups were in the range of >0 to 6 years, after incorporation. Similarly, majority of both incubating and incubated startups were incorporated as private limited companies, and most of these were founded by two or more founders. All of the start-up CEOs are STEM graduates/post-graduates/doctorates and majority had either prior industry experience or startup experience or both. A majority of the

CEO founders were either younger (in the 20s) or middle aged (in their 30s). The duration of incubation for both incubating and incubated start-ups ranged from a minimum of 3 months to as much as 84 months, which virtually stretched up to the entire duration of life as prescribed by the official definition of a start-up in India.

The R&D contribution emanating from start-ups has been looked at in terms of R&D investments incurred by them on capital equipment and machinery, R&D personnel employed by them for the exclusive task of product development, testing and launching, etc., number of new products/services generated by them, whether they have submitted any application for a patent, and the revenue generated out of the sale of new products/services, as in 2016/17. While every incubating as well as incubated start-up has claimed to have incurred R&D investment and employed R&D personnel in 2016/17, not all of them could generate a new product/service, and a majority of those who generated new products/services, produced just one product in 2016/17. Overall, while a majority of the incubating start-ups which produced new products/services has gone for patent application submission, only a minority of the graduated start-ups which produced new products/services had submitted patent applications. Further, not all the incubating as well as graduated start-ups, even if they could produce new products/services, were able to generate revenue in 2016/17.

Given the above, we examined the variables which influence the contributions of start-ups in terms of R&D investment, R&D personnel, new products/services, patent application submissions, and revenue generation. We ascertained that both start-up specific characteristics including that of the CEOs and TBI specific characteristics influenced the R&D contributions of both incubating and incubated start-ups in the three hubs of India. Since the very concept of technology business incubation is still evolving in India, the contributions emerging from TBI based start-ups are still at its infancy, to say the least. Therefore, to do a more meaningful analysis to facilitate policy support for the promotion of R&D contributions from start-ups through TBIs, we may have wait for a decade, if not more.

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CHAPTER 8
SUMMARY AND CONCLUSIONS

8.1 Backdrop

Technology based firms lay the foundation for new wealth-creating industries. Therefore, there is a need to develop appropriate policy and program mechanisms to help create and develop regions that enable new technology start-ups. TBIs are considered to be promising policy tools that support innovation and technology-oriented entrepreneurial growth. TBIs are generally established through public-private collaborations among universities, industry, and at all levels of government. The purpose of TBIs is promoting technology transfer and diffusion of products, thereby developing local innovative firms.

TBIs are popular tools to accelerate the creation of successful entrepreneurial ventures. TBIs typically support new ventures in the hope that they will later develop into self-sustaining, thriving companies. This support encompasses several dimensions such as office space, shared resources, business support, and access to networks. Successful TBIs serve a critical role in the development of local, regional and national economies through the creation of jobs and the generation of profits, technology development and innovations.

TBIs are distinct organizations within the entrepreneurial value chain. This value chain comprises the set of organizations whose activities are linked by the successive transformation of resource and knowledge inputs to marketable outputs in the period leading to and shortly after the creation of a new firm. TBIs are the intermediate organizations that provide the social environment, technological and organizational resources and managerial expertise for the transformation of a technology-based business idea into an efficient economic organization. In short, TBIs are an ecosystem within an entrepreneurial ecosystem in a region, aiming at producing "healthy and vibrant" technology based start-ups.

Therefore, TBIs are anticipated to play a unique role, particularly with respect to promotion of innovation, technology commercialization, generation of new products/services and thereby facilitate the emergence of technology based start-ups. Given this, their contribution to a national economy in terms of employment, investment, innovations, output and income creation can be considerable. Both technology based start-ups and incubators as a mechanism of promotion of tech start-ups are increasingly gaining the attention of policy makers in India in the recent period. In addition, private sector initiatives to promote tech start-ups through accelerators (by the Corporate Sector, particularly MNCs) and co-working spaces (by local private organizations/individuals) have been gaining ground.

It is against this backdrop that this exploratory study has been undertaken to assess the performance of TBIs (comprising accelerators, incubators and co-working spaces) located in three of the leading start-up hubs of India, namely, Bangalore, Chennai, and Hyderabad. The TBI performance assessment has been done with specific reference to their contribution to national R&D efforts in terms of R&D investment, R&D personnel, new products/services, patents, and R&D revenue. The study explored the specific research objectives as detailed in the Chapter 2 of this report. These research objectives have been formulated based on the research gaps derived out of an exhaustive literature survey covering published research papers in professional journals, and research reports of national and international organizations, presented as Appendix 2 of this report.

8.2 TBIs: Key Research Gaps derived out of Literature Survey

TBIs form a part of the support system as one of the indispensable components of an entrepreneurial ecosystem for tech start-ups, and they provide access to various components of an ecosystem in a structured manner for the incubating ventures within, by themselves. But TBIs vary in typology and sponsors, goals and objectives, functions and services, incubation processes, outcomes and achievements. Thus, TBIs encompass independent organizations, and they can be examined from different perspectives and at different levels and subjects of analysis. At the broadest level, TBIs can be classified in terms of their revenue orientation or strategic objective: (i) Not for profit and (ii) For profit. Not for profit TBIs come under the government and mostly located in universities or industrial centres, whereas for profit TBIs come under the private sector promoted by either the corporate sector in the form of accelerators or by private individuals/organizations located in commercial centres in the form of co-working spaces.

TBIs are found to have multiple goals, the most important being (i) regional economic growth, (ii) fertile environment for innovation generation, commercialization and technology development, and (iii) prosperous climate for technology entrepreneurship. In turn, they will have numerous objectives such as new venture creation, job generation, promotion of innovation and commercialization, technology development and transfer, university-industry interaction, income and wealth creation, industry growth, etc.

To achieve the diverse goals and multiple objectives, TBIs play certain common functions such as helping prospective entrepreneurs to develop their ideas from inception through commercialization to the launching of a new venture; facilitating the transformation of a technology-based business idea into an efficient economic organization; linking technology, capital and know-how to leverage entrepreneurial talent, accelerate the development of new ventures, and thus speeding up the exploitation of technology; and thereby enabling the timely graduation of its tenants. These functions are performed by providing shared space either at subsidized rents or at market rates, shared basic services and equipment at little or no cost, business assistance, legal & technical advices, and financial support, internal networking among incubating ventures, and access to TBIs' external networks.

Though the process of incubation followed by TBIs might vary from one another, broadly, it subscribes to a commonly observed pattern. Every TBI follows its own process of scrutinizing and selecting applications received from the prospective start-up founders, with the help of an expert team or on its own, and provides admission. On admission, prospective start-up founders are provided space and access to common infrastructure and services, provided with legal, technical and business advice, seed funds, and enabled to move from ideation to product generation, leading to venture creation.

Given the differences/commonality in the typology and location, goals and objectives, functions and services, process of incubation of TBIs, their overall success would largely depend on their ability to incubate and generate start-ups through (i) development and exploitation of internal and external networking, (ii) ideation and generation of innovations and its commercialization, (iii) development of new technologies and transfer for venture creation. This would result in the generation of new products/services, obtain patents, create jobs, and generate income and wealth, with an overall positive impact on regional economic growth.

While empirical literature reveals the diverse issues concerning incubation of start-ups by TBIs in the context of diverse regions in the global economy, there is no comprehensive study yet to answer the question on how does incubation help the creation of successful start-ups leading to multiple benefits such as innovation commercialization and technology transfer for start-up formation through R&D inputs and R&D outputs, employment generation, income creation and thereby benefiting regional economies. The key challenge for theorizing technology business incubation, as observed by us, is logically describing the dynamics of incubation process, and explaining how and why these factors come together and foster incubatee success or failure in the early stages of new venture development.

Obviously, such a theory must focus on pre-incubation, incubation and post-incubation stages, covering both incubatees and TBIs. Accordingly, we proposed a conceptual framework for technology business incubation comprising (i) pre-incubation, (ii) incubation and (iii) post-incubation phases of start-up development involving both TBIs and prospective start-ups which undergo incubation, subsequent to its selection, for graduation and exit. We set our research objectives against this backdrop, for exploration and analysis.

8.3 An Empirical Assessment of TBI Performance: Method of Investigation and Results

8.3.1 Method of Research

At the outset, we developed an exhaustive database of all the operational incubators, accelerators and co-working spaces in the three start-up hubs, by means of accessing all possible – official as well as private - secondary data sources and social network sites. This resulted in the identification of a total of 239 TBIs comprising 72 incubators, 37 accelerators and 130 co-working spaces. We focused only on those (189) TBIs which were at least, two years old as of January 2017. Thereafter, we approached each of them personally and/or virtually to ascertain and ensure that they promote technology start-ups, which resulted in obtaining responses from 114 TBIs. Subsequently, we personally approached and interviewed the CEO of each short-listed TBI in all the three cities, with a semi-structured questionnaire. We could successfully approach and gather primary data from 65 TBIs consisting of 31 incubators, 9 accelerators and 25 co-working spaces together in Bangalore, Chennai and Hyderabad. In addition, we gathered primary data from one each incubated and graduated start-up from the 42 TBIs which have experienced start-up graduation, and one each incubating start-up from all the 65 TBIs covered for the study. The primary data thus gathered formed the basis for the analysis of research objectives proposed.

To begin with, to describe the basic profiles of TBIs, we classified them in terms of start-up hubs, nature of TBIs (accelerators, incubators, and co-working spaces), sponsors, location, age, qualification and prior experience of CEOs, stage and sector focus of TBIs, their objectives, infrastructure and staff strength, internal expertise and external networks, physical space, nature of promotional activities adopted, etc. and used tables, figures and charts for the descriptive analysis. These basic profiles enabled us to differentiate institute promoted TBIs from industry promoted TBIs, early stage focused TBIs from stage agnostic TBIs, and tech sector focused TBIs from sector agnostic TBIs, by means of stepwise (backward elimination) logistic regression analyses.

Thereafter, the process of selection for incubation, incubation process and graduation of start-ups are explored and ascertained. What determines the number of applications received by TBIs and the application to seat ratios in TBIs, respectively was examined by means of stepwise (backward elimination) multiple regression analysis. The key selection criteria for incubatees, number of occupants, occupancy ratios in the TBIs were described with the help of tables and figures, and the variables influencing the number of occupants in the TBIs are analyzed by means of stepwise multiple regression analysis. The graduation criteria adopted, number of start-up graduations achieved, graduation to admission ratios in the TBIs are examined descriptively whereas the variables influencing cumulative graduation to cumulative admission are ascertained by means of multiple regression analysis.

Similarly, the R&D contributions comprising both input and output contributions are described with the help of tables, figures and charts, whereas the determinants of R&D contributions emanating from the TBIs comprising R&D investments, R&D personnel, new products/services, patent applications, and R&D revenue are analyzed by means of separate individual multiple regression models. Finally, the TBI based start-up characteristics and R&D contributions are examined with the help of tables, figures and charts, supplemented by multiple regression/logistic analyses to ascertain the variables which influenced their R&D input and R&D output contributions.

8.3.2 Empirical Analysis Results

TBIs, in general, have emerged rather recently in Bangalore, Chennai and Hyderabad. They are of different kinds though broadly they fall under accelerators, incubators, and co-working spaces. The TBI CEOs, without exception, are STEM qualified, varying from graduation to Ph.Ds. They have varied work experience either in industry or in start-ups or both, though some did not have any previous industry or start-up experience. TBIs differed in terms of stage focus as well as sector focus. Similarly, their objectives differed with some having entrepreneurship generation as the key objective, some aiming at ecosystem development, some others focusing on innovation commercialization, university-industry linkages, and scaling up whereas a considerable number of them aimed at mere revenue generation, by renting out the space and infrastructure. Given this, TBIs differed in terms of infrastructure with some providing only the common hardware and software infrastructure, some additionally providing soft infrastructure services, some others providing exclusive hardware/software infrastructure, and some more having exclusive soft infrastructure services.

In the same way, TBIs differed in terms of number of administrative staff and number of in-house domain experts. While majority TBIs had exclusive external networks, some did not have these networks particularly co-working spaces. Some of the TBIs are small sized in terms of space and number of seats for prospective incubatees, whereas the rest are either medium-sized or large-sized. Further, TBIs differed in terms of promotional activities pursued. Some of them confined their promotion to mere association affiliation, whereas some have websites, conducted events, and resorted to social media campaigns, and some others had websites, events and association affiliation, and the rest had all of these.

The logistic regression analysis to differentiate government promoted institute based TBIs versus private sector promoted industry based TBIs revealed that the former found out to be younger with more STEM qualified CEOs, and focused on early stage start-ups, relative to the latter. The logistic regression analysis to differentiate the early stage focused TBIs from the stage agnostic TBIs brought out that the objectives of early stage TBIs are non-revenue oriented and thus differed from stage agnostic TBIs, which are primarily revenue generation oriented, the former had CEOs with less work experience and are tech sector focused. Finally, tech sector focused TBIs are found to have better infrastructure but engaged in less promotional activities, and their CEOs had more work experience relative to sector agnostic TBIs.

It was the TBIs with more number of in-house experts, less qualified CEOs, stage agnostic focus, which had non-revenue objectives, smaller sized ones with more administrative staff members have attracted more applications relative to the rest. The number of in-house experts including technology and business mentors is likely to contribute to the provision of "quality incubation services" to incubatees. The in-house staff and experts together would largely determine the "appeal" of an incubating institution to the prospective incubatees and therefore together they influenced positively the number of applications received by TBIs. Further, the administrative staff members have a crucial role in administering the entry, incubation and exit of start-ups, at every stage. A higher number of administrative staff members would enable specialized focus on different administrative tasks which in turn would enable a better focus on the incubatees, which would have influenced more prospective incubatees to get attracted to such TBIs.

Given this, the education qualification of TBI CEOs (EB) beyond the basic STEM degree did not matter. This was particularly true for those which were stage agnostic (SD) and had multiple objectives (BD) other than revenue generation. Further, those TBIs which were smaller sized (SE) would have been able to give better attention to incubation relative to larger sized TBIs. Together such TBIs attracted more applications relative to the rest. This was largely substantiated by the analysis of applications to seats ratio as well. Overall, the number of seats far outstripped the number of applications, implying that there was excess capacity prevailing in the TBIs in the three start-up hubs for admitting and nurturing more start-ups.

The multiple regression analysis which probed the determinants of occupants in the TBIs brought out that TBIs which were larger in size, which had a larger number of in-house experts and administrative staff, but did not have their own external networks, whose CEOs had rich and diversified work experience (in the form of both industry and start-up experience) had more number of occupants relative to the rest. This implied that TBIs with CEOs who had vast work experience obtained "quality" applications through their own networks and referrals received. A larger sized TBI would have afforded to accommodate more incubatees relative to smaller sized ones. Further, TBIs which had more numbers of in-house experts and administrative staff, even without external networks, would have attracted better applicants to get selected as incubatees. As far as graduation of start-ups is concerned, those TBIs which laid emphasis on achieving self-sustainability/growth as the yard stick, with corporate funding, particularly in accelerators, located in Bangalore experienced more number of successful start-up graduations.

The R&D contributions of TBIs can be assessed in terms of R&D inputs and R&D outputs. While R&D inputs comprise R&D investment expenditure and R&D personnel employed, R&D outputs consist of new products/services, patent applications, and revenue generation. Though every TBI in all the three start-up hubs had incurred R&D investment expenditure, almost one-third of them did not employ any exclusive R&D personnel. While the approximate current value of gross R&D investments amounted to Rs.2050 million with an average of Rs.31.5 million per TBI, the total employment of R&D personnel stood at 150, with an average of >3 (for those TBIs which have employed at least one R&D personnel).

Every TBI had generated new products/services through their incubatees over a period of time, and together they generated 8110 new products/services with an average of 125 new products/services per TBI. However, about 38% of the TBIs did not submit even a single patent application, despite generating new products/services. The remaining TBIs together accounted for just 481 patent application submissions, amounting to an average of just 12 per TBI. Overall, the patent application submissions accounted for hardly 6% of the total new products/services generated, implying that by and large, a low patent intensity prevailed among the nurtured start-ups of TBIs in the three start-up hubs. This could be a reflection on the "lack of adequate novelty" or "lack of innovativeness" in the new products/services developed by the start-ups, which would mean most of these products/services were new to Indian market but might not be new to the industry in the global context. However, these TBIs could generate a total of Rs.1879.85 crore from the new products/services generated by their incubating start-ups, with an average of Rs.28.92 crore per TBI.

The TBIs with CEOs who had no previous experience, which had external networks and provided need based mentoring for a larger number of incubatees, accounted for larger R&D investments. But only infrastructure and number of administrative personnel employed in the TBIs mattered for the employment of exclusive R&D personnel in those TBIs. A higher number of new products/services emerged from older TBIs, which had exclusive external networks and had a larger number of incubatees. But corporate sponsorship, TBI infrastructure and higher successful graduation and exits influenced the patent application submissions of TBIs. Further, corporate sponsorship and successful exits mattered for the total revenue generation of TBIs as well. Finally, we ascertained that only R&D outputs in the form of new products/services and patent applications influenced new product/service led total revenue generation of the TBIs but not the R&D inputs of investment and personnel.

Finally, we examined the R&D contributions in the form of R&D investments, R&D personnel, new products/services and revenue generation emerged through incubating/incubated start-ups. The characteristics of incubated start-ups revealed that a higher proportion of start-ups graduated from Bangalore based TBIs followed by that of Hyderabad and then, that of Chennai. A large majority of both incubating and graduated start-ups were in the range of >0 to 6 years, after incorporation. Similarly, majority of both incubating and incubated startups were incorporated as private limited companies, and most of these were founded by two or more founders. All of the start-up CEOs were STEM graduates/post-graduates/doctorates and majority had either prior industry experience or startup experience or both. A majority of the CEO founders were either younger (in the 20s) or middle aged (in their 30s). The duration of incubation for incubating/incubated start-ups ranged from a minimum of 3 months to as much as 84 months, which virtually stretched up to the entire duration of life as prescribed by the official definition of a start-up in India.

The R&D contributions which emanated from start-ups were examined in terms of R&D investments incurred by them on capital equipment and machinery, R&D personnel employed by them for the exclusive task of product development, testing and launching, etc., number of new products/services generated by them, whether they have submitted any application for a patent, and the revenue generated out of the sale of new products/services, as in 2016/17. While every incubating as well as incubated start-up had incurred R&D investment and employed R&D personnel in 2016/17, not all of them could generate a new product/service, and a majority of those which generated new products/services, produced just one product in 2016/17. Overall, while a majority of the incubating start-ups which produced new products/services had gone for patent application submission, only a minority of the graduated start-ups which produced new products/services had submitted patent applications. Further, not all the (incubating as well as graduated) start-ups, despite producing new products/services, were able to generate revenue in 2016/17. Further, we ascertained that both start-up specific characteristics including that of the CEOs and TBI specific characteristics influenced the R&D contributions of start-ups in the three hubs of India.

8.3.3 Key Observations and Findings

Given the analysis of research objectives and obtained results, the key observations and findings of our study can be summarized as follows:

- The nurturing of start-ups is done not only in incubators promoted by the government but also in accelerators promoted by the Corporate Sector, particularly MNCs, and co-working spaces promoted by private organizations/individuals, in Bangalore, Chennai and Hyderabad.
- The CEOs of TBIs (incubators, accelerators and co-working spaces) are all STEM qualified, ranging from graduates to post-graduates to doctorates.
- TBIs differ in terms of focus on stages as well as sectors. While some exclusively focus on early stage venture formation, the rest is stage agnostic. Similarly, while some are exclusively tech sector focused, others are sector agnostic.
- TBIs have multiple objectives such as entrepreneurship development, ecosystem promotion, innovation commercialization, institute-industry interaction, and even mere revenue generation.
- TBIs differed in terms of size, infrastructural support, staff strength, in-house experts, and external networks. Most importantly, while some had specialized laboratory, machinery and equipment, others offered the bare-minimum critical support in terms of rented space and support services for incubation.
- Given the differences in objectives, infrastructural facilities and support extended, TBIs resorted to different kinds of TBI promotional events to attract prospective start-up founders.
- Government promoted TBIs are of more recent origin headed by more qualified CEOs and focused on early stage start-up formation located in higher education institutions. In contrast, industry promoted TBIs are older but headed by less qualified CEOs, and are stage agnostic.

- Tech sector focused TBIs have exclusive infrastructure in the form of specialized laboratory/machinery & equipment unlike sector agnostic TBIs. The former is headed by more experienced CEOs relative to the latter.
- TBIs in general accounted for a low application to seat ratio as well as occupancy to seat ratio across the three start-up hubs, but it was more pronounced in Chennai and Hyderabad relative to Bangalore.
- TBIs in general accounted for a low cumulative graduation to cumulative admission ratio, with more than 1/3 not graduating any start-up yet.
- TBIs with more in-house experts and administrative staff members, stage agnostic focus, non-revenue objectives, smaller sized ones have attracted more applications relative to TBIs with less in-house experts and administrative staff, only early stage focused, having revenue objectives and large sized ones.
- TBIs which are larger in size, with more in-house experts and administrative staff, CEOs having stronger work experience (in the form of both industry and start-up experience) though do not have their own external networks, accounted for more occupants/incubatees relative to TBIs which are smaller in size, less in-house experts and administrative staff, less experienced CEOs even though having external networks.
- TBIs which laid emphasis on achieving self-sustainability/growth as the yard stick for graduation, promoted by Corporate funding, particularly in Accelerators, located in Bangalore graduated more number of successful start-ups.
- R&D investment expenditure is common among the TBIs but not exclusive R&D personnel. Similarly, they do generate new products/services thereby enabling generation of revenue, but do not go for patent application submissions.

- The graduation of start-ups is an important determinant of revenue generation of TBIs.
- The strength of TBIs as well as resourcefulness of start-ups importantly determine the R&D contributions of start-ups.
- Overall, the R&D contributions that emerge from the TBIs as well as from the incubated start-ups are still at a moderate level, which could be due to multiple factors such as the following:
    - The number of start-up proposals is yet to emerge in a big way,
    - High-quality start-up proposals are not forthcoming to enable their entry, particularly into incubators and accelerators, thereby affecting occupancy,
    - As of now, the infrastructure and facilities prevalent in the TBIs are under-utilized, and there is scope for encouraging start-up emergence in a bigger way,
    - Even all the admitted/occupied prospective start-ups or incubatees do not graduate successfully, reflecting on the efficacy of incubation,
    - TBI promotion and growth in India is a recent phenomenon, and full-fledged operations (in terms of number, size and experience) on a significant scale is yet to be visible, as the ecosystems in India are still evolving and/or maturing.

Since the very concept of TBI is still emerging in India, the contributions of TBI based start-ups are still at its infancy, to put it modestly. Therefore, to do a more meaningful analysis to facilitate policy support for the promotion of R&D contributions from start-ups through TBIs, we may have to wait for a decade, if not more.

8.4 Inferences and Policy Recommendations

As revealed by an earlier empirical study, ecosystems for tech start-ups in Bangalore and Hyderabad are still evolving. The ecosystem of Chennai is unlikely to be different from the other two, rather it is likely to be much more infant, given the lesser number of tech start-ups operating there (Bala Subrahmanya and Balachandra, 2017). The policy support for the promotion of tech start-ups, their ecosystem components, and TBIs has emerged only recently, and that is why government promoted TBIs are younger by age. Even the private promoted TBIs, be it accelerators and co-working spaces have been growing rapidly only in the recent years. This is reflected in the fact that 63% of the TBIs is not more than 5 years old and another 23% is more than 5 years but not more than 10 years old. Thus, the experience base of the TBIs, located in the three evolving ecosystems, is short and limited.

As of now, institution based TBIs are dependent on government grants and none of them seems to be self-reliant, in terms of resource generation. Co-working spaces are primarily driven by revenue generation motive through renting of space, and are hardly focused on entrepreneurship development through start-up graduation. As a result, about 1/3 of the TBIs has not yet graduated any start-up, and more than a half could not graduate even 50% of their admitted incubatees. About 1/3 of the TBIs did not have in-house experts and nearly ½ of the total did not have any external networks. Similarly, more than ½ had neither specialized hardware and software nor both technology and business mentors.

Perhaps, it is due to the issues discussed above that these TBIs are not able to:

(i) **Attract** an adequate number of applications from prospective start-up founders, which reflects on the number of prospective start-up founders available and/or the external appeal of TBIs, in these start-up hubs,

(ii) **Admit** the prospective start-up founders as the incubatees in adequate numbers, relative to the number of applications, which reflects on the quality of applications submitted by the prospective start-up founders and/or the quality of scrutiny for selection adopted by the TBIs, in these start-up hubs, and

(iii) **Graduate** the incubatees successfully and adequately, relative to the admissions, which reflects on the quality of incubatees admitted and/or the quality of incubation offered by the TBIs, in these start-up hubs.

All these observations raise the core question: are our TBIs adequately equipped for nurturing tech entrepreneurship and tech start-ups for enhanced R&D contributions? In general, our TBIs have to mature yet as most of them is yet to find the right model for sustainability and growth. However, there are some "role model TBIs", well-equipped in terms of diverse specialized hard and soft infrastructure, mentorship and external networks, which have a decent record of "graduating successful start-ups" over a period of time, in all the three start-up hubs, such as Centre for Cellular and Molecular Platforms (C-CAMP) of NCBS in Bangalore, Research Park of IIT Madras in Chennai, and Centre for Innovation and Entrepreneurship (CIE) of IIITH in Hyderabad. Institution based TBIs should take the lead in promoting early stage start-ups, which are sustainable and scalable, whereas the responsibility of scaling-up such start-ups could be done by accelerators, and the supplementary role of "understanding the pre-requisites of start-up formation" can be played by co-working spaces.

Equally important is to encourage and nurture "entrepreneurial ideas" among young under-graduate students in all the engineering institutions. Here, we would like to recommend the model of Centre For Innovation (CFI) of IIT Madras: A sandbox where students come and work on their ideas for development. It was started to bring together several student hostel centered clubs to experiment with their ideas. A part of students' contribution diverted to CFI for its sustenance to experiment with students' ideas. In CFI, senior students evaluate the projects of junior students. On average, about 1200 students forming about 300 to 400 teams operate out of CFI. This is purely a student centric entity and a tech play-ground for them. Therefore, their business acumen is hardly tested here. Here, faculty members play only an advisory role. Short-listed projects are encouraged to move to NIRMAAN, a pre-incubation cell.

In NIRMAAN, every short-listed CFI project gets a grant of about Rs.5 lakh as a seed money, to encourage the experimentation of these student idea generated projects, evaluated and short-listed by IITM faculty and external experts. These are typically 3rd year students moving into the 4th year. Such students are allowed to have deferred placements (for 2 years) to encourage risk-taking. About 30 to 40 projects out of the projects of 300 to 400 teams from CFI graduate into NIRMAAN. However, there is a provision to directly move into NIRMAAN by-passing CFI, if a student has a viable idea for technology development, nurtured in a faculty lab at IITM. In NIRMAAN, IITM alumni and 3 to 4 IITM faculty members play a role. The family background of students is assessed and their ability to understand the markets plays a crucial role in risk-taking.

NIRMAAN finally feeds into the TBIs of IITM in the Research Park. The graduated projects with successful POCs and prototypes coupled with a business plan is encouraged to form a start-up. The Research Park based TBIs of IITM focus on commercialization of innovation for venture creation. The philosophy is that an innovation must have a commercial value and it must generate revenue at the earliest. Generally, it encourages a team of founders and it and single-founders are discouraged. The stage where a start-up is independent of the TBI support is a signal for graduation. At this stage, they would have started generating revenue to take care of the costs, obtained institutional follow-on funding, and market stability. As of 2017, IITM Research Park based TBIs housed about 130 incubatees comprising 65 from NIRMAAN, 45 spin-offs from IIM faculty, and 30 from external groups, which got linked to the R&D ecosystem of IITM. As of 2017, the Research Park graduated about 40 start-ups.

The Startup India Action Plan of Government of India has justifiably proposed to set up seven new Research Parks modeled on the Research Park Setup of IIT Madras (DIPP, 2016). But what is additionally required is to club the model of Research Park with that of CFI and NIRMAAN, to increasingly encourage the emergence of student-idea led and faculty-led entrepreneurial ventures. Such initiatives will steadily expand the base for entrepreneurship creation for technology start-ups for their successful entry into, incubation in, and graduation from TBIs, resulting in higher contributions to national R&D efforts of India.

8.5 Major Contributions

This research work has made three important research contributions to literature. Firstly, it has unraveled the structure and composition of TBIs along with their key characteristics in the context of Bangalore, Chennai and Hyderabad. Particularly, it has differentiated the TBIs in terms of sponsorship, stage focus and sector focus, and thereby provided an understanding of the typology of TBIs with respect to three leading start-up hubs of India.

Secondly, it has examined the role and performance of TBIs in terms of applications received, admission made, occupancy of incubatees, and graduation of start-ups and thereby revealed the pre-incubation, incubation and post-incubation phases of start-up formation in the context of three start-up hubs. As a result, it has thrown light on the extent of physical infrastructure and human expertise employed, apart from the prevalence of external networks, in these TBIs and its adequacy/inadequacy.

Thirdly, it has analyzed the determinants of R&D contributions in terms of inputs (of capital and employment) as well as outputs (in terms of new products/services, patent applications and revenue generated) at the TBI level as well as at the incubating/incubated start-up level. Thus, it has answered the key research question affirmatively: do TBIs and tech start-ups contribute to the national R&D efforts in India?

8.6 Limitations and Scope for Future Work

The present study is confined to only three of the six leading start-up hubs in India, each of which has its own peculiarities in terms of culture, language, industry concentration, infrastructure development and start-up ecosystems. Therefore, the results obtained from the study based on the empirical analysis of TBIs located in the three start-up hubs may not be generalizable.

The study has not tried to ascertain whether any of the TBIs which were established earlier in the three cities have winded up their operations due to constraints and unviability, and what kind of R&D contributions would have emerged from them. This might have portrayed a different kind of scenario on TBI contribution to national R&D efforts.

Finally, the primary data obtained from the TBIs and incubating/incubated start-ups are largely cross-sectional. A systematic time-series data on R&D inputs and R&D outputs from the TBIs as well as from the start-ups would have enabled a more in-depth analysis on the R&D contributions emanated from these entities to the national R&D efforts.

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REFERENCES

Aaboen, L (2009): "Explaining Incubators using firm analogy, *Technovation*, 29(10), 657-670.

Adegbite, O (2001): "Business Incubators and Small Enterprise Development: The Nigerian Experience", *Small Business Economics*, 17(3), 157-166.

Aernoudt (2004): "Incubator: tool for entrepreneurship", *Small Business Economics*, 23, 127-135.

Aerts, K, P Matthyssens and K Vandenbempt (2007): "Critical role and screening practices of European business incubators", 27(5), 254-267.

Ahmad, A J (2014): "A mechanisms-driven theory of business incubation", *International Journal of Entrepreneurial Behaviour and Research*, 20(4), 375-405.

Akcomak, S (2009): "Incubators as Tools for Entrepreneurship Promotion in Developing Countries", UNU-WIDER Working Paper 2009-054, World Institute for Development Economics Research, Helsinki.

Albort_Morant, G and P Oghazi (2016): "How useful are incubators for new entrepreneurs?", *Journal of Business Research*, 69(6), 2125-2129.

Albort_Morant, G and D Ribeiro-Soriano (2015): "A bibliometric analysis of international impact of business incubators", *Journal of Business Research*, 69(5), 1775-1779.

AICTE (2016): *Start-Up Policy, AICTE-2016*, All India Council for Technical Education, New Delhi.

AIM (2018): http://aim.gov.in/overview.php, accessed on 24th May 2018.

Al-Mubaraki, H an M Busler (2014): "Incubator Successes: Lessons learned from successful incubators towards the twenty-first century", *World Journal of Science, Technology and Sustainable Development*, Volume 11, No.1, pp.44-52.

Ayatse, F A, N Kwahar and A S Iyortsuun (2017): "Business incubation process and firm performance: an empirical review", *Journal of Global Entrepreneurship Research*, 7(2), 17 pages.

Ayawongs, N., Kanjana-Opas, A., Chayabutra, S. and Noipitak, W. (2007), *Development and Future Challenges of Business Incubators in Thailand*, Technology Management Center, National Science and Technology Development Agency, Bangkok.

Azih, E and E L Inanga (2014): "Performance Effectiveness of Technology Incubation in Nigeria", *Business and Economics Journal*, 5(4), 22 pages.

Azriel, J A and M V Laric (2008): "Cracking open the black box of the business incubation process: Creating mutually beneficial relationships between incubators and entrepreneurs", *USASBE 2008 Proceedings*, 0814-0829.

Bala Subrahmanya, M H (2017): "How did Bangalore emerge as one of the Global Start-up Hubs in India: Entrepreneurial Ecosystem - Emergence, Structure and Role", *Journal of Developmental Entrepreneurship*, 22(1), March, 22 pages.

Bala Subrahmanya, M H and P Balachandra (2017): *A Study on the Ecosystem for High-Technology Start-Ups in Bangalore and Hyderabad*, Research Project Report, National Science and Technology Management Information System (NSTMIS) Division, Department of Science and Technology, New Delhi.

Bala Subrahmanya, M H (2015): "New Generation Start-Ups in India: What Lessons Can We Learn from the Past?" *Economic and Political weekly*, 50(12), 56-63.

Barbero, J L, J C Casillas, A Ramos and S Guitar (2012): "Revisiting incubation performance: How incubator typology affects results", *Technological Forecasting & Social Change*, 79, 888-902.

Barringer, B R, F F Jones and D O Neubaum (2005): "A quantitative content analysis of the characteristics of rapid growth firms and their founders", *Journal of Business Venturing*, Volume 20, pp. 663-687.

Becker, B and O Gassmann (2006): "Gaining leverage effects from knowledge modes within corporate incubators", *R&D Management*, 36 (1), 1-16.

Bollingtoft, A and J P Ulhoi (2005): "The networked business incubator – leveraging entrepreneurial agency?" *Journal of Business Venturing*, 20(2), 265-290.

Bergek, A and C Norrman (2008): "Incubator best practice: a framework", *Technovation*, 28(1-2), 20-28.

Bigliardi, B, I Dormio, A Nosella and G Petroni (2006): "Assessing Parks performance: directions from selected Italian case studies", *Technovation*, 26(4), 489-505.

Birch, D G W (1979): "The Job Generation Process", Working Paper, University of Illinois at Urbana-Champaign, USA.

Bizzotto, C (2003): *The Incubation Process*, InfoDev Incubation Support Center (IDISC), Santa Catarina.

Breschi, S and F Lissoni (2001): "Knowledge Spillovers and Local Innovation Systems: A Critical Survey", *Industrial and Corporate Change*, 10(4), 975-1005.

Bruneel, J, T Ratinho, B Clarysse and A Groen (2012): "The Evolution of Business Incubators: Comparing demand and supply of business incubation services across different incubator generations", *Technovation*, 32, 110-121.

Caiazza (2014): "Benchmarking of business incubators", *Benchmarking: An International Journal*, 21(6), 1062-1069.

Carayannis, E and Von Zedtwitz (2005): "Architecting gloCal (global-local), real virtual incubator networks (G-RVINs) as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices form current development and business incubation practices", *Technovation*, 25(2), 95-110.

Centre for Internet and Society (2015): *Technology Business Incubators: An Indian Perspective & Implementation Guidance*, New Delhi.

Chan, K F and T Lau (2005): "Assessing technology incubator programs in the science park: the good, the bad and the ugly", *Technovation*, 25(10), 1215-1228.

Chandra, A and C Chao (2011): "Growth and Evolution of High-Technology Business Incubation in China", *Human Systems Management*, 30(1/2), 55-69.

Charry, G P, J E A Perez and N E L Barahona (2014): "Business incubator research: a review and future directions", Working Paper, Pensamiento & Gestion, 37, Universidad del Norte, 41-65.

Chen, S and F A Sisk (2016): "Business Incubators as Drivers of "Pivotal Talent" Development in China, *The Journal of Global Business Management*, 12 (2), 164-172.

Clarysse, B M Wright, A Lockett, E Ven de Velde and A Vohora (2005): "Spinning out new venture: a typology of incubation strategies from European Research Institution", *Journal of Business Venturing*, 20(2), 183-216.

Colombo,M and M Delmastro (2002): "How effective are technology business incubators? Evidence from Italy", *Research Policy*, 31(7), 1103-1122.

Cooper, S Y and J S Park (2008): "The impact of incubator organizations on opportunity recognition and technology innovation in new, entrepreneurial high-technology ventures", *International Small Business Journal*, 26(1), 27-56.

Corsi, C and D D Berardino (2014): "Assessing the Business Incubators' performance referring the Local development in Italy", *European Scientific Journal*, 1, 323-334.

Coworker (2018): Website: https://www.coworker.com/india (accessed on 27th March 2018).

Damodaran, S (2016): "India's Top 12 Tech Cities: Digital Indian Cities Survey, 2016", News Item, *CEO World Magazine*, http://ceoworld.biz/2016/12/02/indias-top-12-tech-cities-digital-indian-cities-survey-2016/ (accessed on 13th April 2018).

DIPP and MMSMEs (2016): *MSME Sector: Achievements Report 2017, Make in India*, Department of Industrial Policy & Promotion, and Ministry of Micro, Small and Medium Enterprises, Government of India, New Delhi.

Department of Science and Technology (2016): *NIDHI – TBI, Guidelines and Proforma for submission of Proposals*, Ministry of Science and Technology, Government of India, New Delhi.

EU (2010): "The smart Guide to Innovation-Based Incubators (IBI)", European Union Regional Policy Report,

Eveleens, C P, F J van Rijnsoever and E M M Niesten (2017): "How network-based incubation helps start-up performance: a systematic review against the background of management theories", *Journal of Technology Transfer*, 42, 676-713.

Foertsch, C (2013): "4.5 New Coworking Spaces per day", *Deskmag*, The Coworking Magazine, March 4, 2013.

Foertsch (2015): "First Results of the New Global Coworking survey", *Deskmag*, The Coworking Magazine, November 20 2013.

Fuzi, A (2015): "Co-working spaces for promoting entrepreneurship in sparse regions: the case of South Wales", *Regional Studies, Regional Science*, 2(1), 462-469.

Gandini, A (2015): "The rise of co-working spaces: A literature review", *Ephemera: theory & politics in organization*, 15(1), 193-205.

Gerdenitsch, C, T E Scheel, J Andorfer and C Korunka (2016): Coworking spaces: A Source of Social Support for Independent Professionals", *Frontiers in Psychology*, 7, 107.

Ghosh, S and A Joshi (2018): *Handbook for Non-profit Incubator Managers*, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, New Delhi.

Grimaldi, R and A Grandi (2005): "Business incubators and new venture creation: an assessment of incubating models", *Technovation*, 25(2), 111-121.

Hackett, S M and D M Dilts (2004a): "A Real Options-Driven Theory of Business Incubation", *Journal of Technology Transfer*, 29, 41-54.

Hackett, S M and D M Dilts (2004b): "A Systematic Review of Business Incubation Research", *Journal of Technology Transfer*, 29, 55-82.

Hair, J F, W C Black, B J Babin, R E Anderson and R L Tatham (2007): *Multivariate Data Analysis*, Pearson Education, Sixth edition, New Delhi.

Hansen, M T, H W Chesbrough, N Nohria and D N Sull (2000): "Networked incubators – hoyhouses of the new economy, *Harvard Business Review*, 78(5), 74.

Hathway, I (2016): "What startup Accelerators really do?", *Harvard Business Review*, March 1.

Hausberg, J P and S Korreck (2018): "Business incubators and accelerators: a co-citation analysis-based, systematic literature review", *Journal of Technology Transfer*, https://doi.org/10.1007/s10961-018-9651-y, accessed on 26th March 2018.

Inc42 Media (2018): https://inc42.com/startup-101/top-startup-incubators-india/ (accessed on 27th March 2018).

ISBA (2018): http://isba.in/members/directory/ (accessed on 27th March 2018).

ICAR (2015): *Agri Business Incubator (ABI): General Guidelines and Proforma for Submission of Proposals*, Indian Council of Agricultural Research, New Delhi.

Joshi, K A and S Krishna (2014). "What Ecosystem Factors Impact the Growth of High-Tech Start-ups in India", *Asian Journal of Innovation and Policy*, 3(2), 216-244.

Kirchhoff, B A (1994): *Entrepreneurship and Dynamic Capitalism: The Economics of Business Firm Formation and Growth*, Westport, CT: Praeger.

Kitagawa, F and S Robertson (2012): "High-tech entrepreneurial firms in a university-based business incubator: spaces of knowledge, resource heterogeneity and capital formation, *The international Entrepreneurship and Innovation*, 13(4), 249-259.

Leclercq-Vandelannoitte, A and H Isaac (2016): "The new office: how coworking changes the work concept", *Journal of Business Strategy*, 37(6), 3-9.

Lindelof, P and H Loftsen (2004): "Proximity as a resource base for competitive advantage: university-industry links for technology transfer", *Journal of Technology Transfer*, 29(3), 311-326.

Lindholm-Dahlstrand, Å and M Klofsten (2002): "Growth and innovation support in Swedish science parks and incubators", in Oakey, R., During, W., and S Kauser, (eds), *New Technology-Based Firms in the New Millennium*, EIsevier Science, Oxford, pp 31–46.

Lumpkin, J R and R D Ireland (2001): "Screening Practices of New Business Incubators: The Evaluation of Critical Success Factors", *American Journal of Small Business*, 12(4), 59-81.

M'Chirgui, Z (2012): "Assessing the Performance of Business Incubators: Recent France Evidence", *Business and Management Research*, 1(1), 62-75.

Mian, S, W Lamine and A Fayolle (2016): Technology Business Incubation: An overview of the state of knowledge", *Technovation*, 50-51, 1-12.

Mian, S A (1997): "Assessing and managing the technology business incubator: an integrative framework", *Journal of Business Venturing*, 12(4), 251-285.

Ministry of MSMEs (2015): *Scheme for Promotion, Innovation and Agro-Industry*, Government of India, New Delhi.

Mutambi, J, J K Byaruhanga, L Trojer and K B Buhwezi (2010): "Research on the state of business incubation systems in different countries: lessons from Uganda", *African Journal of Science, Technology, Innovation and Development*, 2(2), 190-214.

NCL Innovations (2018): http://www.venturecenter.co.in/incubatordb/ (accessed on 27th March 2018).

NSTEDB (2018): http://www.nstedb.com/institutional/tbi-2016.htm (accessed on 27th March 2018).

OECD (2013): *Start-up Latin America: Promoting Innovation in the Region*, Development Centre Studies, Paris.

OECD (2010): http://www.oecd.org/innovation/policyplatform/48136826.pdf (accessed on 10th March 2018).

Ozdemir, O C and Y Sehitoglu (2013): "Assessing the Impacts of Technology Business Incubators: A framework for Technology Development Centers in Turkey", *Procedia – Social and Behavioural Sciences*, 75, 282-291.

Peria, I (2004): "Business incubation centres and new firm growth in the basque country", *Small Business Economics*, 22(3), 223-236.

Peters, L, M Rice and M Sundararajan (2004): "The role of incubators in the entrepreneurial process", *Journal of Technology Transfer*, 29(1), 83-91.

Pettersen, I B, J Aarstad, O S Hovig and A E Tobiassen (2016): "Business incubation and the network resources of start-ups", *Journal of Innovation and Entrepreneurship*, 5(7), 1-17.

Phan, B, D Siegel and M Wright (2005): "Science Parks and Incubators: observations, synthesis and future research", *Journal of Business Venturing*, 20(2), 165-182.

Phillips, R G (2002): "Technology business incubators: how effective as technology transfer mechanisms?", *Technology in Society*, 24, 299-316.

Porter, M and M Kramer (2011): "Creating shared value: How to reinvent capitalism and unleash the wave of innovation and growth", *Harvard Business Review*, 89(1/2), 62-77.

Ramidus Consulting (2015): *Supporting Places of Work: Incubators, Accelerators and Co-working Spaces*, Report prepared on behalf of the Greater London Authority by Ramidus Consulting, Norfolk, UK.

Rogova, E (2014): "The effectiveness of business incubators as the element of the universities' spin-off strategy in Russia", Working Paper, National Research University Higher School of Economics, St. Petersburg, Russia.

Romanelli, E and C B Schoonhoven (2001): "The local origins of new firms", In C B Schoonhoven and E Romanelli (Eds): *The entrepreneurship dynamic*, Stanford University Press, Stanford, pp. 40-67.

Rosenberger, J (2003): "What are real options? A review of empirical research", Paper presented at the *Academy of Management*, Seattle, WA.

Rothaermel, F T and M Thursby (2005): "Incubator firm failure or graduation? The role of university linkages", *Research Policy*, 34(7), 1076-1090.

Sa, C and H Lee (2012): "Science, business, and innovation: understanding networks in technology-based incubators", *R&D Management*, 42(3), 243-253.

Salvador, E and S Rolfo (2011), "Are incubators and science parks effective for research spin-offs? Evidence from Italy", *Science and Public Policy*, 38(3),170-184.

Schutjens, V, and E Stam (2003). "The evolution and nature of young firm networks: a longitudinal perspective", *Small Business Economics*, 21(2), 115-134.

Schwartz, M and C Hornych (2008): "Specialization as strategy for business incubators: An assessment of the Central German Multimedia Centre", *Technovation*, 28(7), 436-449.

Scillitoe, J L and A K Chakrabarti (2010): "The role of incubator interactions in assessing new ventures", *Technovation*, 30(3), 155-167.

Sithole, N and R O Rugimbana (2014): "Commercialization of research and technology: A multiple case study of university technology business incubators", *African Journal of Business Management*, 8(16), 641-649.

Smilor, R W and M D Gill, (1986): *The New Business Incubator: Linking Talent, Technology, Capital, and Know-How*, Lexington Books, Massachusetts, Toronto.

Somsuk, N, J Wonglimpiyarat and T Laosirihongthong (2012): "Technology business incubators and industrial development: resource-based view", *Industrial Management & Data Systems*, 112(2), 245-267.

Song, M, K Podoynitsyna, H Bij and J I M Halman (2008): "Success Factors in New Ventures: A Meta-analysis", *The Journal of Product Innovation Management*, 25(1), 7-27.

Startupindia (2017): *Guidelines for Corporates to set up Incubators*, Department of Industrial Policy & Promotion, Government of India, New Delhi.

Startupindia (2016): *Guidelines for Corporates to set up Incubators: A Concept Note*, Department of Industrial Policy & Promotion, Government of India, New Delhi.

Startupwala (2018): Startup Registration, https://www.startupwala.com/startup-registration.html, accessed on 14th May2018.

Stokes, D and N Wilson (2010): *Small Business Management and Entrepreneurship*, Cengage Learning Inc., UK.

Sungur, O (2015): "Business Incubators, Networking and Firm Survival: Evidence from Turkey", *International Journal of Business and Social Science*, 6(5), 136-149.

Tavoletti, E (2013): "Business Incubators: Effective Infrastructures of Waste of Public Money? Looking for a Theoretical Framework, Guidelines and Criteria", *Journal of Knowledge Economy*, 4, 423-443.

The Centre for Internet & Society (2015): *Technology Business Incubators: An Indian Perspective & Implementation Guidance*, New Delhi.

Thierstein, A and B Wilhelm (2001): "Incubator, technology and innovation centres in Switzerland", *Entrepreneurship and Regional development*, 13(4), 315-331.

Tsai F-S., Hsieh L. H.Y., Fang S-C., Lin J. L. (2009): "The co-evolution of business incubation and national innovation systems in Taiwan", *Technological Forecasting & Social Change,* 76, 629–643.

Vakilsearch (2018): https://vakilsearch.com/advice/one-person-company-vs-sole-proprietorship/, accessed on 14th May 2018.

Von Zedwitz, M and R Grimaldi (2006): "Are service profiles incubator specific? Results from an empirical investigation in Italy", *Journal of Technology Transfer*, 31(4), 459-468.

Walter, A, M Auer, T Ritter (2006): "The impact of network capabilities and entrepreneurial orientation on university spin-off performance", *Journal of Business Venturing*, 21(4), 541-567.

Westhead, P (1997): "R&D inputs and outputs of technology based firms in science parks", *R&D Management*, 27(1), 45-62.

Westhead, P and S Batstone (1999): "Perceived Benefits of a Managed Science Park Location for Independent Technology-Based Firms", *Entrepreneurship and Regional Development* **11**, 129-154.

Whittingham, M J, P A Stephens, R B Bradbury and R P Freckleton (2006): "Why do we still use stepwise modelling in ecology and behavior?" *Journal of Animal Ecology*, Volume 75, pp. 1182-1189.

Wiggins, J and D V Gibson (2003): "Overview of US incubators and the case of the Austin Technology Incubator", *International Journal of Entrepreneurship and Innovation Management*, 3(1/2), 56-66.

Wonglimpiyarat, J (2014): "Incubator policy to support entrepreneurial development, technology transfer and commercialization", *World Journal of Entrepreneurship, Management and Sustainable Development*, 10(4), 334-351.

Zahra, S. A. (2005): "Entrepreneurial risk taking in family firms", *Family Business Review*, 18(1), 23–40.

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Appendix 1

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Appendix 2: Technology Business Incubation for New Venture Creation: A Theoretical Perspective

TBIs which originated in the USA in the 1950s have increasingly proliferated all over the world since then, across developed as well as emerging and other developing economies, as a means of promoting technology based start-ups. Accordingly, it is argued that they have played an important role in hatching start-ups, especially in high-technology sectors (Azriel and Laric, 2008). The strongest argument in the promotion of TBIs is that the incubation process undergone by the prospective start-up founders due to the incubation process provided and facilitated by an incubator produces a synergistic effect on the economic value that results from creation of start-ups.

The prospective start-up founders (who are tenants in a TBI) while gaining access to a host of TBI based resources and services, also benefit from the subsidized costs of such resources and services, while hatching their start-ups (Azriel and Laric, 2008). A steady increase in the emergence of successful start-ups cumulatively will contribute to regional economic development through job creation and income generation.

However, the core issue to be theorized is how does incubation help the creation of successful start-ups leading to multiple benefits such as innovation commercialization and technology transfer for start-up formation through R&D inputs and R&D outputs, employment generation, income creation and thereby benefiting regional economies. The key challenge for theorizing technology business incubation is providing a logical explanation on the dynamics of the factors of incubation process, and explain how and why these factors come together and foster incubatee success or failure in the early stages of new venture development (Hackett and Dilts, 2004b).

Obviously, such a theory must focus on pre-incubation, incubation and post-incubation stages, covering both incubatees and TBIs, as these are the three critical stages of new venture development (Table A2.1).

Table A2.1: Technology Business Incubation Process for Start-Up formation & graduation

Pre-incubation	→	Incubation	→	Post-incubation
Decision making for the admission of prospective start-ups		**Start-up formation**		**Start-up graduation & exit**

Different theoretical propositions have been applied in empirical research to logically explain the incubation process and its overall outcomes, but with little unanimity. A brief reference to some of these theoretical attempts is in order.

A2.1 Real options theory

One of the widely referred theories is an options-driven theory, derived from the domain of finance and investments for business incubation, by Hackett and Dilts (2004b). When an initial investment decision is made an option is created, which is followed by subsequent investment decisions to be made in successive stages (Rosenberger, 2003). Option creation and subsequent incrementally staged investments (option exercises) confer on an investor future decision rights, preferential access to opportunities, access to a potentially valuable upside, ability to contain downside risk by limiting the cost of failure to the sunk cost of constructing the option, minus any remaining option value (Hackett and Dilts, 2004b).

Hackett and Dilts (2004b) contended that the real options theory is the best available theoretical approach for conceptualizing the operational setting and the basis that connects the incubation process of selection, monitoring and assistance, and resource infusions with respect to selected incubatees for start-up formations. A real options perspective would view the selection of an incubatee as the 'creation of an option', whereas subsequent provision of facilities, advice, access to resources as well as monitoring, are 'option exercises'. This is explained with the help of an incubation process model by Hackett and Dilts (2004b).

The selection of an incubatee/s from a multiple number of applicants for incubation in a TBI is the creation of an option, and this is followed by (i) subsequent infusion of resources and provision of facilities coupled with (ii) monitoring, advice and assistance, for incubating tenants, which are considered option exercises. These two together would determine the outcome of technology business incubation in the form of emergence or non-emergence of successful start-ups. The population size of regions, current state of the economy, incubator size and inclusive level of development would be the control variables (Hackett & Dilts, 2004b).

The model is explained in a functional form as follows:

BIP = f (SP + M&BAI + RM)

Where BIP = Business Incubation Performance

SP = Selection Performance

M & BAI = Monitoring & Business Assistance Intensity, and

RM = Resource Munificence.

BIP is measured in terms of growth of incubatees and their financial performance at the time of incubator exit. They proposed a direct and positive relationship between BIP on the one hand, and SP, M & BAI, and RM, respectively, on the other. However, it is not made clear by Hackett and Dilts (2004a) about how the three explanatory variables are measured. Further, the theory was not able to throw any light on the influence of quantity and quality of (knowledge/networks, etc.) resources that an incubator has on incubation outcomes ((Azriel and Laric, 2008).

A2.2 Social network theory

An alternative theory proposed for business incubation focuses on the function of networking and social interaction in incubators, using network theory or social capital theory. Many empirical studies have underlined networking services of TBIs as the most important element of the incubation process ((Sungur, 2015). The basic elements of a network are nodes and the ties that connect these nodes. Nodes are typically defined at different organizational levels such as industry, universities and government, whereas ties usually represent relational characteristics including friendship, cooperation, power, and exchange of advice, assets and information. There could be multiple relationships or ties connecting different nodes.

The basic argument is that TBIs help incubatees to form and develop their networks within the incubator as well as externally, and the networks developed by an incubatee due to an incubator influences start-up formation and graduation, and thereby performance of a TBI (Eveleens, et.al., 2017). An incubatee may have its own network of resources acquired through education and work experience, which are valuable in the critical phase of start-up formation. These are called "private" external networks acquired mainly through the start-ups' own efforts, which are labeled as "idiosyncratic" as they are unique to an incubatee and they satisfy the specific needs of that start-up (Pettersen, e.al., 2016). A prospective start-up while undergoing incubation in a TBI, would make use of networks which the TBI provides in the form of access to resources and capabilities, knowledge and learning, and social capital, to complement with its own.

It is the resources that a prospective start-up has at its disposal, and its knowledge and capabilities to form and develop networks internally as well as externally facilitated by the TBI in which it has joined for incubation, by complementing it with its own networks, which would together determine start-up performance. The networked incubation leads to intermediary benefits for the incubatees such as acquisition of additional resources, capabilities, knowledge, learning, and social capital, to supplement its own (personal networks).

However, many empirical studies which made use of social network theory for business incubation have simply assumed that more 'intermediary benefits' will automatically lead to better start-up performance, but without adequate empirical substantiation (Eveleens, et.al., 2017). Further, social network theory does not elaborate on what kinds of prospective start-ups are able to develop effective and productive networks by making use of TBI support. Similarly, it does not reveal what kinds of TBI attributes favour or hinder its incubatees to form and develop networks, to complement with its own networks for successful start-up graduation and exit (Ahmad, 2014).

A2.3 Resource-based view (RBV) Theory

The RBV theory has been widely adopted to analyze firm level attributes under different concepts such as resources, capabilities, and strategies which are crucial for firm performance and competitive advantage. The RBV theory views a firm as a bundle of resources and capabilities which have a profound influence on its performance (M'Chirgui, 2012). According to RBV, a firm's resources can provide a sustainable competitive advantage if its resources are valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1991).

A number of researchers have adopted this theory to describe the role of TBIs in firm creation and promotion (Ahmad, 2014). These researchers have viewed incubation as a mechanism of awarding a stock of tangible and in-tangible resources to incubatees that results in, in addition to other benefits, venture formation. While tangible resources would include infrastructure including labs and equipment, common facilities, etc., intangible resources would comprise monitoring and advice, opportunities for networking with other incubatees, links to TBI's external networks comprising technology and business mentors, angels and VCs, universities, large firms, etc. These resources provide the incubatees access to new knowledge, expertise and networks, in addition to their own, which enable firm formation and graduation (Ahamad, 2014). Thus, in the context of TBIs, the RBV implies that TBI resources offered to its incubatees enable them to acquire superior competitive advantage for successful firm formation and emergence and thereby an important determinant of the success of TBIs (Sumsuk, et.al., 2014).

However, the application of RBV theory to TBI mechanism has lacunae as it does not throw light on an incubatee's capacity and willingness to absorb the TBI resources and networks as well as internal environment of a TBI including the relationship between incubatees and incubatior management, among others (Ahmad, 2014). Further its primary focus is on the incubation process, but not on the pre-incubation and post-incubation phases of venture formation, which are equally crucial and significant.

A2.4 Technology Business Incubation: A Conceptual Framework

It is against this backdrop that we propose a conceptual framework for technology business incubation comprising (i) pre-incubation, (ii) incubation and (iii) post-incubation phases of start-up development involving both TBIs and prospective start-ups which undergo incubation, subsequent to its selection for graduation and exit. This is presented in Figure A2.1.

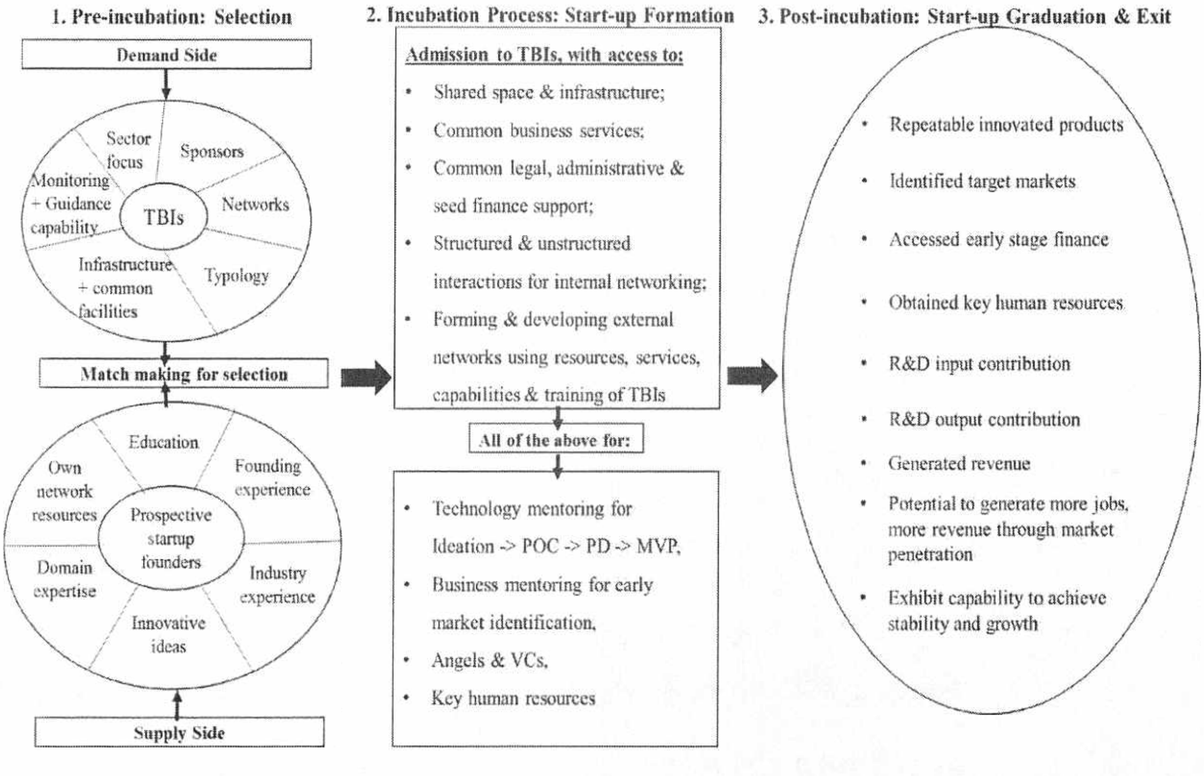
(i) Pre-incubation phase:

In the pre-incubation phase, a TBI has to take a crucial decision in terms of choosing among the various applicants (prospective start-ups) who have submitted applications to a TBI seeking admission for incubation. This is a match-making process. This has two dimensions: demand-side and supply-side:

- Demand-side: is represented by the TBIs which look for quality proposals, which would meet their objectives, appropriate to their functions and services, so that they can optimally render their incubation process through appropriate monitoring and guidance, to reap the best benefits possible (in terms of start-up graduation and exit). The nature of sponsors of TBIs (in the form of government, university, corporate or private), their sector focus and external networks would also matter in the selection process.
- Supply-side: is represented by the various prospective start-ups which approach the TBIs for seeking admission for incubation. The prospective start-up founder/s have to assess their appropriateness to a particular TBI (in terms of nature of sponsor and sector focus), before submitting their application/s.

Match-making: Once the applications are submitted, a TBI would look at the technology and market potential of a proposal, and its promoters, in terms of their education and industry work/previous start-up founding experience, domain expertise, and their current network resources. The extent of complementarity between the TBI and the prospective start-up founders, and the former's assessment of capability of both to contribute to start-up formation through the incubation process would play a decisive role in the selection of a start-up proposal for subsequent incubation.

Figure A2.1: Technology Business Incubation for Start-Up Formation and Graduation: A Conceptual Framework



(ii) Incubation phase:

The incubation process would begin with providing shared space, access to common infrastructure, common service facilities, and common advisory services such as legal, administrative and financial, etc. This will be followed by promotion of internal networking among the incubatees, by conducting periodical interactive meetings. The continuous monitoring and interaction between the incubation management and the incubating start-ups would enable both to look for and exploit appropriate external networks to complement with the latter's own networks, to achieve the following:

- identify and link with suitable technology mentors to move from ideation to proof of concept and further to prototype development followed by a Minimum Variable Product (MVP),
- identify and access early product markets through business mentors,
- identify and access angel investors or early stage venture capitalists for financing early stage production operations,
- identify and access key human resources, wherever necessary.

Thus the four functional management inputs are facilitated to converge for start-up formation. The time taken for its successful convergence would depend on the quality and efficacy of (i) TBI infrastructure, services, and internal networking, as much as that of (ii) external networking, and (iii) the complementarity of both with the incubating start-up's own networks. The efficiency of incubation management as well as that of start-up founder/s will have an overall decisive role.

(iii) Post-incubation phase:

The start-up formation with well-defined new products and repeatable production, clearly identified target markets, with adequate - human resources and early stage finance, marks its readiness for graduation and exit. Such start-ups would have generated revenue as well as contributed in terms of R&D inputs and R&D output. Such start-ups would have acquired and exhibited potential to generate more jobs and revenue through further market penetration for sustenance and subsequent growth. This marks the end of overall process of new venture development or start-up formation, and thereby ceases the venture formation responsibility of a TBI.

Appendix 3

Appendix 3.1 List of TBIs that provided complete data in Bangalore

Incubators

1	**GINSERV** CA Site No:1, Behind Hotel Leela Palace, HAL 3rd Stage, 560008, Kodihalli, Bengaluru, Karnataka 560017	2	**Excubator** Building No. 3rd floor,, 758, 19th Main Rd, Sector 3, HSR Layout, Bengaluru, Karnataka 560102
3	**Bangalore Bioinnovation Centre** Helix Biotech Park, Electronics City Phase 1, Bengaluru, Karnataka 560100	4	**M.S. Ramaiah University of Advanced Studies Incubator** 470-P, Peenya Industrial Area, Peenya 4th Phase, Peenya, Bengaluru, Karnataka 560058
5	**M S Engineering College Incubator** New International Airport Road, Navarathna Agrahara, Sadahalli, Bengaluru, Karnataka 562110	6	**CCAMP** NCBS-TIFR, GKVK Post, Bellary Road,, Bengaluru, Karnataka 560065
7	**WinTrans Consulting Pvt. Ltd Incubator** 334/28, 14th Cross Rd, 2nd Block, Jaya Nagar East, Jayanagar, Bengaluru, Karnataka 560011	8	**NDBI (NID Design Business Incubator)** B-112, Rajajinagar Industrial Estate, Bengaluru, Karnataka
9	**IIIT B Innovation Center / Incubator** IIIT Bangalore, 26/C, Electronics City, Hosur Road, Bangalore	10	**IBAB** Biotech Park, Electronics City Phase 1, Electronic City, Bengaluru, Karnataka 560100
11	**SID Innovation Centre,** Indian Institute of Science Campus, (Near Maramma Circle Gate, Close to J.N. Tata Auditorium), Bengaluru, Karnataka 560012	12	**DERBI** Dayananda Sagar university, 2nd Floor, Block 1,, Kudlu Gate, Hongasandra Village, Hosur Road, Bengaluru, Karnataka 560068
13	**NSRCEL** Indian Institute of Management Bangalore, Bannerghatta Road, Sundar Ram Shetty Nagar, Bilekahalli, Bengaluru, Karnataka 560076		

Accelerators

1	**NUMA Accelerator** Cobalt Building, 46/1, Church Street, Shanthala Nagar, Ashok Nagar, Bengaluru, Karnataka 560001	2	**Microsoft Accelerator** Opposite Kanteerava Stadium, Hotel IBIS Premises, Sampangi Rama Nagar, Bengaluru, Karnataka 560027
3	**REVVX Hardware Accelerator** #536,100 Feet Rd, Amarjyothi Layout, Stage 3, Indiranagar, Bengaluru, Karnataka 560038	4	**SAP Labs Accelerator** #138, EPIP Zone, Whitefield, Bengaluru, Karnataka 560066
5	**AXIS Bank – Thought Factory Incubator** Tower D, 2nd Floor, Diamond District, Old Airport Road, ISRO Colony, Domlur, Bengaluru, Karnataka 560008	6	**TATA Elxsi Accelerator** Old Airport Road, Near HAL Museum, Bangalore 560048 India
7	**Oracle Startup Cloud Accelerator** Prestige Tech Park, Kadubeesanahalli, Bengaluru, Karnataka 560103		

Co-working Spaces

1	**Bangalore Alpha Labs** #136/C,I Floor,9th Cross,J.P. Nagar II Phase,Bangalore – 560078	2	**HACKLAB** 4th Floor, CJR Arcade, Marathahalli - Sarjapur Outer Ring Rd, Bellandur, Bengaluru, Karnataka 560103
3	**Silicon Business Space** 156, 27th Cross Rd, Jayanagar East, Jayanagar 6th Block, Jayanagar, Bengaluru, Karnataka 560070	4	**Co-Work India** #5, 14th Main Road, 15th Cross Rd, HSR Layout, Bengaluru, Karnataka 560102
5	**JAAGA** 5/1, Penthouse 01, 6th Floor, Rich Homes Apartment, Richmond Road, Bengaluru, Karnataka 560025	6	**Work ADDA** 98/1, 1st Floor, MMR Plaza, Sarjapur Main Road, Above DCB Bank, Kormangala 1st Block, Jakkasandra, Bengaluru, Karnataka 560034
7	**Startup Huts** 2nd & 3rd Floor, #108, Opposite Corner House, 27th Main Road, Sector 2, HSR Layout, Bengaluru, Karnataka 560102	8	**Tech Hub** 3rd Floor Salarpuria Business Centre 4th B Cross Road, 5th Block, Koramangala Industrial Layout, Bengaluru, Karnataka 560095
9	**Co-Work Café** 8, BLOOMINGDALE LAYOUT, OPPOSITE QUETZEL, KAIKONDRAHALLI, Bengaluru, Karnataka 560035	10	**BHIVE** No. 269, Behind Station, 18th D Main Road, 6th Block, Koramangala, Bengaluru, Karnataka 560095
11	**91 Spring Board** 4th Floor, Salarpuria Tower -1, No. 22, Industrial Layout, Landmark: Forum Mall, Hosur Road, Koramangala, Bengaluru, Karnataka 560095		

Appendix 3.2: List of TBIs that provided complete data in Chennai

Incubators

1	**IIT M Incubation Center** Module 2, D Block, Third Floor Phase II, IIT Madras Research Park Kanagam Road, Taramani Chennai - 600113, Tamil Nadu, India	2	**Rural Technology Business Incubator (RTBI)** Module #6, I Floor IITM Research Park, Kanagam Road, Taramani Chennai - 600113
3	**Golden Jubilee Biotech Park for Women Society** Inside SIPCOT- IT Park, 4th Main Road, 2nd Cross Road, Old Mahabalipuram Road, Navalur Post, Kanchipuram District, Siruseri, Tamil Nadu 603103	4	**Veltech TBI** (Veltech Dr.RR & Dr.SR University Campus) #400 Feet Outer Ring Road, Avadi, Chennai, Tamil Nadu – 600 062
5	**University of Madras Incubator** Navalar Nagar, Chepauk, Triplicane, Chennai, Tamil Nadu 600005	6	**Anna University TBI** Between TICCL Park & Ascendas IT Park, Old OMR Road, Chennai, Tamil Nadu
7	**Sathyabama TBI** Rajiv Gandhi Salai, Jeppiaar Nagar, Chennai, Tamil Nadu 600119	8	**IIT M Bio Incubator** 3rd Floor, IIT Madras Research Park, No 1, Kanagam Road, Tharamani, Chennai, TN 600113

Co-working Spaces

1	**IVS Co-working Spaces** 3-F, 3rd Floor ,Gee Gee Emerald,151,Village Road Nungambakkam Chennai	2	**Rhytha Shared Office and Co-working Space** 2/268, 1st Floor, 1st Main Road Mogappair Chennai
3	**AirLoyal Co-working Space** 56/21, Giriguja Enclave, 1st floor, 1st avenue shastrhi nagar Adyar Chennai	4	**Launchpad** # 11, Greams Road, Thousand Lights, Near Apollo Hospital, Greams Road Chennai
5	**Co-working Space @ T Nagar** #117,CITI Tower,6th Floor,Sri Thiyagarajanagar Road,T.Nagar,Chennai	6	**Swastart Co-working Space** # 28,Oppose The Westin hotel, KR Ramasamy Road, Velachery Main Road Chennai - 42
7	**Spaceterior Design and Co-working Space** 84E/7, sampoorna Avenue, Vadapalani, Chennai 600026		

Appendix 3.3: List of TBIs that provided complete data in Hyderabad

Incubators

1	**University of Hyderabad TBI** Prof C. R. Rao Road, CUC, Gachibowli, P O Central University, Hyderabad, Telangana 500046	2	**Centre for Innovation and Entrepreneurship (CIE) Incubator** Gachibowli,IIITH Campus,Hyderabad, Telangana
3	**Entrepreneurship Development Center - JNTU** Kukatpally,Hyderabad,Telangana – 500085	4	**T-Hub** IIIT Campus,Gachibowli,Hyderabad, Telangana
5	**BITS Pilani Hyderabad Campus TBI** Shamirpet-Keesara Road, Jawahar Nagar, Shameerpet, Hyderabad, Telangana 500078	6	**ISB DLabs Incubator** Gachibowli, Hyderabad, Telangana 500 111
7	**IKP Life Sciences Incubator** IKP - Knowledge Park,3rd Floor,Indira Towers,Genome Valley,Turkapally,Hyderabad – 500101	8	**ICRISAT TBI** Patancheru, Hyderabad, Telangana
9	**A-idea, NAARM Incubator** NAARM Road, Acharya Ng Ranga Agricultural University, Rajendranagar mandal, Hyderabad, Telangana 500030	10	**ALEAP TBI** #77/6,KSD Nagar,Yellareddyguda,Srinagar Colony,Hyderabad - 500073

Accelerators

1	**Centre for Innovation and Entrepreneurship (CIE) – Aavishkar Accelerator** Gachibowli,IIITH Campus,Hyderabad, Telangana	2	**ISB DLabs Accelerator** Gachibowli, Hyderabad, Telangana 500 111

Co-working Spaces

1	**Autonetic Spaces** GB2, Hyndava Technopark, Sector III, HUDA Techno Enclave, Phase II, HITECH City, Opp. Raheja Mind Space, Hyderabad, Telangana 500081	2	**Co-Work Zone** 4th Floor, Plot No:63, Before Anagha Prime, Kavuri Hills Phase 1, Kavuri Hills, Jubilee Hills, Hyderabad, Telangana 500033
3	**91 SpringBoard** Plot no. 44, Kavuri Hills, Phase 1, Behind Hotel Jubilee Ridge, Hyderabad, Telangana 500033	4	**CLOWork** 103, First Floor, New Mark House,, Opposite Maxcure Hospital, Hitech City Rd, Patrika Nagar, HITEC City, Hyderabad, Telangana 500081
5	**Unico WorkSpaces** 4th floor, H.no. 2-37/134/NR, Vinayaka Nagar, Gachibowli, Behind Green, Bawarchi, Hyderabad, Telangana 500032	6	**Spacion Business Center** Level 1,2 & 5, Mindspace Tower, Vittal Rao Nagar, Next To Westin Hotel, Hitech City, Hyderabad, Telangana 500081
7	**Matrix IT Hub** MIG 648, Indian Overseas Bank Bldg, Near Temple Bus Stop, KPHB Phase 2, Kukatpally, Hyderabad, Telangana 500072		

Appendix 4

Appendix 4.1 Statistical analysis and inferences related to Chapter 4

A4.1.1 Distinguishing Features of Institute promoted TBIs Vs. Industry promoted TBIs

A description of the dependent variable and the explanatory variables used for the analysis is in order.

Dependent variable

To distinguish government promoted institution based TBIs from industry promoted private sector based TBIs, a binary dependent variable (ownership dummy represented by OD) is used for stepwise backward elimination logistic regression. All the government backed, institution based TBIs are coded as 1 to distinguish them from private sector based, industry promoted TBIs (which are coded as 0).

Independent variables

AG: Firm age in number of years (since inception till January 2016).

EB: Education background of CEOs (1=STEM graduates; 2=STEM PGs; & 3=STEM doctorates).

WE: Work experience of CEOs (1=no prior industry/start-up experience; 2=prior industry experience; 3=prior start-up experience; 4=prior industry & start-up experience).

SD: Stage dummy (1=early stage and 0=late stage and early to late stage)

TD: Sector dummy (1=specific tech and tech-wide and 0=sector agnostic)

BD: Objective dummy (0=revenue generation and 1=other objectives).

IN: Infrastructure (1=common hardware + software; 2= 1 + soft infra; 3= 1+2+unique hardware; 4=1+2+3+business or tech mentors; 5= 1+2+3+both business and tech mentors; 6=1+2+3+4+5+external networks).

AS: Number of Administrative staff members.

EX: Number of in-house experts.

ED: Dummy variable for the presence of external networks (1=yes and 0=no).

SE: Number of seats for accommodating prospective start-ups.

PA: Promotional activities (1=association; 3=websites + events + social media or websites + events + association; 4= websites + events + social media + association).

The logistic regression equation is as follows:

Ln [p/(1-p)] = b0+b1AG +b2EB+b3WE+b4SD+b5 TDb6OB+b7IN+b8AS+b9EX+b10ED+b11SE+b12PA – (1)

Where p represents the probability of an event (institute based TBI), b0 is the y-intercept, and each independent variable's association with the outcome (log odds) is indicated by the coefficients b1 to b11. In effect, we are trying to model the probability that an event (institute based TBI) is represented by a linear combination of variables as indicated in the equation above.

The summary statistics of the dependent and the explanatory variables comprising number of observations, mean, standard deviation, minimum and maximum variables is presented in Table A4.1. The ownership dummy (OD) mean value is about 0.42 indicating that government backed, institute based TBIs accounted for about 42% of the total. The age (AG) of TBIs varied from a minimum of 2 years to a maximum of 25 years, with a mean age of about 7 years, implying in general, a younger age profile of the TBIs. In general, the education background (EB) of CEOs of TBIs is post-graduation and above, and majority of them had work experience (WE), either in industry or in a start-up or both. The early stage (SD) focused TBIs accounted for about 46% and tech sector focused (TD) TBIs accounted for about 48%, and predominantly they had multiple objectives (OB) excluding that of revenue generation. A sizable proportion of them had multiple infrastructure (IN) with minimum administrative staff (AS) and in-house experts (EX). About half of them had external networks (ED), and on average, had about 500 seats (SE) for accommodating prospective start-ups. Finally, majority of them pursued multiple promotional activities (PA) to attract the right kind of prospective start-ups.

Table A4.1: Descriptive Statistics of Variables

```
. summarize OD AG EB WE SD TD BD IN AS EX ED SE PA
```

Variable	Obs	Mean	Std. Dev.	Min	Max
OD	65	.4153846	.4966232	0	1
AG	65	6.661538	4.937981	2	25
EB	65	2.107692	.8314723	1	3
WE	65	3.030769	1.045365	1	4
SD	65	.4615385	.5023981	0	1
TD	65	.4769231	.5033541	0	1
BD	65	.6307692	.4863522	0	1
IN	65	3.723077	2.019496	1	6
AS	65	3.369231	3.276666	1	17
EX	65	2.307692	3.06147	0	18
ED	65	.5076923	.5038315	0	1
SE	65	499.9692	2184.171	4	17600
PA	65	3.046154	.8914659	1	4

The correlation coefficients between the variables are presented in Table A4.2. All the coefficients >+/- 0.24 are statistically significant (non-directional) at 0.05 level. Given this, OD has a statistically significant positive relationship with EB, SD, TD, BD, IN, EX, and ED. AG has a positive relationship which is statistically significant, with EB, SD, TD, IN and SE. EB has a significant positive relationship with WE, SD, TD, BD, IN, EX and ED. WE has a positive relationship with TD, IN, EX, ED and PA, and SD has a significant positive relationship with TD, BD, IN, EX and ED. TD has a positive relationship with BD, IN, EX and ED. BD has a significant positive relationship with IN, EX and ED, and IN has a strong positive relationship with EX and ED. AS has a positive relationship with EX and SE. EX has a positive relationship with ED, SE and PA, and ED has a positive relationship with PA. The remaining coefficients are not statistically significant.

Table A4.2: Correlation Coefficients between the Variables

```
. correlate OD AG EB WE SD TD BD IN AS EX ED SE PA
(obs=65)
```

	OD	AG	EB	WE	SD	TD	BD	IN	AS	EX	ED	SE	PA
OD	1.0000												
AG	0.1920	1.0000											
EB	0.6846	0.3705	1.0000										
WE	0.2158	0.0717	0.4276	1.0000									
SD	0.7852	0.2529	0.5898	0.0915	1.0000								
TD	0.6953	0.2797	0.6594	0.2983	0.7224	1.0000							
BD	0.5155	0.1944	0.4863	0.2686	0.5804	0.5391	1.0000						
IN	0.6773	0.2694	0.6508	0.3890	0.6824	0.7468	0.7851	1.0000					
AS	0.0099	0.0272	0.0368	0.0924	-0.0387	-0.0611	-0.1582	-0.0575	1.0000				
EX	0.4079	0.1889	0.4165	0.2655	0.4650	0.4812	0.3818	0.5978	0.5337	1.0000			
ED	0.3929	0.2272	0.4642	0.4149	0.3561	0.5090	0.5857	0.7392	0.1402	0.5556	1.0000		
SE	-0.0503	0.4614	0.0401	-0.0887	-0.0664	-0.0770	0.1163	0.1197	0.3040	0.2557	0.1637	1.0000	
PA	-0.0087	0.0852	0.2040	0.5518	-0.0134	0.0198	0.1120	0.2329	0.2294	0.3039	0.4688	0.0316	1.000

The stepwise backward elimination logistic regression analysis results are given in Table A4.3. The stepwise (backward elimination) logistic regression model is statistically significant and it adequately explains the factors which distinguish institute based TBIs from industry based TBIs. The stepwise logistic regression model eliminated seven independent variables, but retained five of the 12 independent variables, namely, AG, EB, PA, SD and IN. While EB, SD and IN have a statistically significant positive influence, AG and PA have a statistically significant negative influence on the dependent variable. An explanation on each of the statistically significant explanatory variables is in order.

Table A4.3: Distinguishing Features of Institute TBIs Vs. Industry TBIs: Stepwise Logistic Regression Analysis Results

```
. stepwise, pr(.10): logit OD AG EB WE SD TD BD IN AS EX ED SE PA
                      begin with full model
p = 0.8088 >= 0.1000  removing BD
p = 0.7195 >= 0.1000  removing ED
p = 0.7248 >= 0.1000  removing TD
p = 0.4145 >= 0.1000  removing SE
p = 0.2364 >= 0.1000  removing WE
p = 0.1158 >= 0.1000  removing EX
p = 0.5989 >= 0.1000  removing AS
p = 0.1078 >= 0.1000  removing PA
p = 0.1011 >= 0.1000  removing IN

Logistic regression                               Number of obs   =         65
                                                  LR chi2(3)      =      60.33
                                                  Prob > chi2     =     0.0000
Log likelihood = -13.954414                       Pseudo R2       =     0.6837
```

OD	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
AG	-.2562226	.1510693	-1.70	0.090	-.552313	.0398678
EB	2.848639	.9832893	2.90	0.004	.9214277	4.775851
SD	4.803906	1.421161	3.38	0.001	2.018481	7.58933
_cons	-7.860811	2.291682	-3.43	0.001	-12.35242	-3.369197

Age (AG) with a negative coefficient differentiates institute based (government promoted) TBIs from industry based (private sector promoted) TBIs, implying that institute based TBIs are younger relative to industry based TBIs. This could be primarily due to the recent policy initiatives of the government to promote TBIs in institutions, both public and private.

The educational qualification (EB) of the TBI CEOs is another major distinguishing feature of institute based TBIs relative to industry based TBIs. Though all the CEOs are STEM graduated and above, a majority of the STEM doctorates are in institute based TBIs and a majority of the institute based TBI CEOs are doctorates in STEM, whereas majority of the STEM graduates and post-graduates are in industry based TBIs, and a majority of the industry based TBI CEOs are either STEM graduates or STEM post-graduates. This supports the fact that to nurture entrepreneurship from the scratch with all the specialized infrastructure and external networks in place, a more qualified CEO would be helpful whereas to develop a common workplace with common infrastructural facilities even mere graduation or post-graduation will suffice.

Institute based TBIs are focused on early stage (SD) venture creation by nurturing entrepreneurship from the scratch, relative to industry based TBIs, which are focused on either late stage (primarily accelerators) or both early and late stages (coworking spaces). The industry based TBIs, mostly comprising coworking spaces, did not explicitly take up the responsibility of entrepreneurship nurturing as they have adopted largely a laissez-faire approach by renting out space, with minimum common infrastructural facilities, and hardly any unique hardware infrastructure. Given this, they did not have any specific stage focus, whereas accelerators are primarily involved in "scaling up the promising start-ups".

Thus, overall, institute based TBIs are younger by age, with more qualified CEOs, with a primary focus on early stage venture creation relative to industry based TBIs, which are older by age, with less qualified CEOs, with no distinct stage focus for venture formation and growth.

A4.1.2 Distinguishing Features of Early Stage TBIs Vs. Stage Agnostic TBIs and Tech Sector focused TBIs Vs. Sector Agnostic TBIs

With the understanding of the differentiating features of institute based TBIs with respect to industry based TBIs, it is appropriate to examine how do the characteristics of TBIs vary in terms of their stage focus and sector focus. To explore the answers to these questions, we carried out two different stepwise backward elimination logistic regression analyses, and the respective models are as follows:

Stage focus model:

$$\text{Ln}\,[p/(1-p)] = b0+b1AG+b2EB+b3WE+b4OD+b5\,TD+b6OB+b7IN+b8AS+b9EX+b10ED+b11SE+b12PA \quad -(2)$$

Sector focus model:

Ln [p/(1-p)] = b0+b1AG +b2EB+b3WE+b4SD+b5 OD+ b6OB+b7IN+b8AS+b9EX+b10ED+b11SE+b12PA – (3)

The stepwise backward elimination logistic regression analysis results for differentiating early stage TBIs from stage agnostic TBIs are given in Table A4.4. The stepwise (backward elimination) logistic regression model is statistically significant and it adequately explains the factors which distinguish early stage TBIs from stage agnostic TBIs. The stepwise logistic regression model retained four of the 12 independent variables, after eliminating eight independent variables. The four retained explanatory variables are BD, OD, WE and TD. Of these, BD, OD and TD have a statistically significant positive influence whereas WE has a statistically significant negative influence on early stage TBIs relative to the rest.

The early stage TBIs have multiple objectives (BD) such as entrepreneurship generation, ecosystem development, innovation commercialization, etc. excluding revenue generation, whereas stage agnostic TBIs have primarily revenue generation as their key objective while offering incubation services.

The early stage TBIs are primarily institute based and promoted by the government (OD), whereas stage agnostic TBIs are promoted by the private sector and are located in industry. Further, early stage TBIs are primarily focused on technology sectors (TD), unlike stage agnostic TBIs which are focused on both tech and non-tech sectors. Finally, CEOs of early stage TBIs had less industry/start-up experience relative to stage agnostic TBIs. This is primarily because, CEOs of TBIs which are focused on either late stage lifecycle of start-ups (like accelerators) or both early and late stages of start-up lifecycle (like coworking spaces) need to have more work experience of either industry or start-ups or both, relative to early stage lifecycle of start-ups, where ideation to POC to MVP to start-up creation is the major focus.

Table A4.4: Distinguishing Features of Early Stage TBIs Vs. Rest of the TBIs: Stepwise Logistic Regression Analysis Results

```
. stepwise, pr(.10): logit SD AG EB WE TD OD BD IN AS EX ED SE PA
                      begin with full model
p = 0.9093 >= 0.1000  removing EB
p = 0.8705 >= 0.1000  removing IN
p = 0.7179 >= 0.1000  removing PA
p = 0.6333 >= 0.1000  removing AS
p = 0.4226 >= 0.1000  removing SE
p = 0.9094 >= 0.1000  removing AG
p = 0.2068 >= 0.1000  removing EX
p = 0.3722 >= 0.1000  removing ED

Logistic regression                             Number of obs   =         65
                                                LR chi2(4)      =      65.67
                                                Prob > chi2     =     0.0000
Log likelihood = -12.028318                     Pseudo R2       =     0.7319
```

SD	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
BD	2.942646	1.600624	1.84	0.066	-.1945195	6.079811
OD	4.987973	1.660834	3.00	0.003	1.732798	8.243147
WE	-2.297714	.9989229	-2.30	0.021	-4.255567	-.339861
TD	4.480696	1.682631	2.66	0.008	1.1828	7.778591
_cons	.6782886	2.431731	0.28	0.780	-4.087817	5.444395

Thus, overall, sustenance and scaling up of start-ups in sector agnostic fields, particularly when revenue generation is the primary objective, is more external market oriented whereas early stage nurturing of start-ups in technology sectors is more internal dynamics oriented. Therefore, work experience of CEOs will be of more value for stage agnostic TBIs compared to early stage focused TBIs. Further, industry will always have a better access to CEOs with work experience relative to institutions, which explains why early stage TBIs are mostly institute based and with CEOs having less work experience relative to stage agnostic TBIs which are industry based with CEOs having more work experience.

The stepwise backward elimination logistic regression analysis results for differentiating Tech sector focused TBIs from sector agnostic TBIs are given in Table A4.5. The stepwise (backward elimination) logistic regression model is statistically significant and it adequately explains the factors which distinguish tech sector TBIs from sector agnostic TBIs. The stepwise logistic regression model eliminated eight but retained four of the 12 independent variables. The four explanatory variables are IN, PA, WE and SD. Of these, IN, WE and SD have a statistically significant positive influence whereas PA has a statistically significant negative influence on tech sector TBIs relative to sector agnostic TBIs.

The tech sector focused TBIs are having better infrastructure (IN), are into less promotional activities (PA), have CEOs with more work experience (in industry or start-ups or both) (WE), and are primarily focused on early stage lifecycle of start-ups (SD) relative to sector agnostic TBIs. The tech sector focused TBIs are equipped with better infrastructure, hard as well as soft, coupled with business and technology mentors, and added by external networks. This is because, they focused on early stage venture creation by nurturing entrepreneurship from the scratch, and this required "active intervention" through not only hardware and software infrastructure but also soft infrastructure and mentorship with in-house mentors supplemented by externally networked mentors. The building up of appropriate infrastructure for incubating tech start-ups would call for CEOs having previous industry/start-up work experience. Such TBIs would be able to prospective tech start-ups through their own networks and therefore need not indulge in promotional activities as much as TBIs which are sector agnostic.

Table A4.5: Distinguishing Features of Tech Sector TBIs Vs. Sector Agnostic TBIs: Stepwise Logistic Regression Analysis Results

```
. stepwise, pr(.05): logit TD AG EB WE SD OD BD IN AS EX ED SE PA
                     begin with full model
p = 0.7238 >= 0.0500  removing EB
p = 0.7074 >= 0.0500  removing OD
p = 0.4799 >= 0.0500  removing AG
p = 0.2180 >= 0.0500  removing SE
p = 0.2241 >= 0.0500  removing ED
p = 0.0970 >= 0.0500  removing BD
p = 0.1295 >= 0.0500  removing AS
p = 0.3041 >= 0.0500  removing EX

Logistic regression                               Number of obs   =         65
                                                  LR chi2(4)      =      61.00
                                                  Prob > chi2     =     0.0000
Log likelihood = -14.487772                       Pseudo R2       =     0.6779
```

TD	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
IN	1.334813	.5107312	2.61	0.009	.3337982	2.335828
PA	-1.87041	.9259202	-2.02	0.043	-3.68518	-.0556396
WE	1.757083	.8803401	2.00	0.046	.0316477	3.482517
SD	2.969503	1.162743	2.55	0.011	.6905672	5.248438
_cons	-6.959097	2.567944	-2.71	0.007	-11.99218	-1.926018

Appendix 4.2: Statistical analysis and inferences related to chapter 5

A4.2.1 TBIs: Applications from Prospective Start-Up Founders (2016/17) and Its Determinants

The analysis of this objective is done by means of two regression models which are defined as follows:

AP = b0+b1AG+b2EB+b3WE+b4BD+b5IN+b6AS+b7EX+b8ED+b9SE+b10PA+b11SD+b12TD +b13BD -- (1)

ASR = b0+b1AG+b2EB+b3WE+b4BD+b5IN+b6AS+b7EX+b8ED+b9PA+b10SD+b11TD +b12BD ---------- (2)

Where AP = Number of applications received from the prospective start-up founders in 2016/17, which is the dependent variable in the first regression model, and ASR = Applications to seats ratio for 2016/17, which is the dependent variable in the second regression model. The explanatory variables are defined as follows:

AG = Age of TBIs in number of years;

EB = Education background of TBI CEOs;

WE = Work (industry/start-up) experience of TBI CEOs;

OD = Ownership dummy (1=Government sponsored and 0=Industry sponsored);

IN = Infrastructure availability ranging from common hardware and software to specialized hardware and software, soft services, business mentors and/or technology mentors, and external networks, expressed in numbers (1 to 6);

AS = Number of administrative staff;

EX = Number of employed in-house experts;

ED = External networks (1 = presence and 0 = absence);

PA = Promotional activities pursued (1 to 4);

SD = Stage dummy (1= early stage focus and 0 = stage agnostic or late stage focus);

TD = Sector dummy (1=tech sector focus and 0=sector agnostic);

BD = Objective dummy (0=revenue generation and 1=rest of the objectives), and

SE = Number of seats for incubatees (which is an explanatory variable only for the first model).

To ascertain the influence of various explanatory variables described above on the dependent variable (number of applications), we used stepwise backward elimination multiple regression. The backward elimination multiple regression starts with a multiple regression equation including all the explanatory variables, and then deletes those variables which do not contribute at a pre-determined statistical significance, sequentially. Sequential search methods which include backward elimination multiple regression, among others, offer a perfect solution to empirical researchers in exploratory research because it results in a model with maximum predictive power with only those variables that contribute in a statistically significant amount to explain the dependent variable (Hair, et al, 2007).

Though stepwise modelling has certain demerits, it is particularly useful in exploratory research as a screening device (Whittingham, et al, 2006). The descriptive statistics of the variables are given in Table A4.6 and the correlation coefficients between the variables are presented in Table A4.7. All the coefficients >+/- 0.24 are statistically significant (non-directional) at 0.05 level.

Table A4.6 Descriptive Statistics of the Variables

```
. summarize AP ASR AG EB WE OD IN AS EX ED PA SD TD BD SE
```

Variable	Obs	Mean	Std. Dev.	Min	Max
AP	65	201.4154	292.1593	3	1200
ASR	65	4.120923	9.741083	0	62.5
AG	65	6.661538	4.937981	2	25
EB	65	2.107692	.8314723	1	3
WE	65	3.030769	1.045365	1	4
OD	65	.4153846	.4966232	0	1
IN	65	3.723077	2.019496	1	6
AS	65	3.369231	3.276666	1	17
EX	65	2.307692	3.06147	0	18
ED	65	.5076923	.5038315	0	1
PA	65	3.046154	.8914659	1	4
SD	65	.4615385	.5023981	0	1
TD	65	.4769231	.5033541	0	1
BD	65	.6307692	.4863522	0	1
SE	65	499.9692	2184.171	4	17600

Table A4.7: Correlation Coefficients between the Variables

```
. correlate AP ASR AG EB WE OD IN AS EX ED PA SD TD BD SE
(obs=65)
```

	AP	ASR	AG	EB	WE	OD	IN	AS	EX	ED	PA	SD	TD	BD	SE
AP	1.0000														
ASR	0.3243	1.0000													
AG	-0.0425	-0.0895	1.0000												
EB	-0.1245	-0.3263	0.3705	1.0000											
WE	0.1962	-0.1807	0.0717	0.4276	1.0000										
OD	-0.0960	-0.0625	0.1920	0.6846	0.2158	1.0000									
IN	0.1045	0.0827	0.2694	0.6508	0.3890	0.6773	1.0000								
AS	0.3505	-0.0845	0.0272	0.0368	0.0924	0.0099	-0.0575	1.0000							
EX	0.3426	-0.0556	0.1889	0.4165	0.2655	0.4079	0.5978	0.5337	1.0000						
ED	0.1508	0.1356	0.2272	0.4642	0.4149	0.3929	0.7392	0.1402	0.5556	1.0000					
PA	0.1188	-0.2527	0.0852	0.2040	0.5518	-0.0087	0.2329	0.2294	0.3039	0.4688	1.0000				
SD	-0.0676	-0.0688	0.2529	0.5898	0.0915	0.7852	0.6824	-0.0387	0.4650	0.3561	-0.0134	1.0000			
TD	-0.0183	-0.0216	0.2797	0.6594	0.2983	0.6953	0.7468	-0.0611	0.4812	0.5090	0.0198	0.7224	1.0000		
BD	0.1434	0.2170	0.1944	0.4863	0.2686	0.5155	0.7851	-0.1582	0.3818	0.5857	0.1120	0.5804	0.5391	1.0000	
SE	-0.0226	-0.0887	0.4614	0.0401	-0.0887	-0.0503	0.1197	0.3040	0.2557	0.1637	0.0316	-0.0664	-0.0770	0.1163	1.0000

The results of the stepwise backward elimination multiple regression analysis (along with VIF values for the statistically significant explanatory variables) for model 1 are presented in Table A4.8. The regression model is statistically significant as revealed by the F value, and it has a reasonable explanatory power as indicated by the adjusted R^2 square value of 28%. The model rejected seven of the 13 independent variables and retained only EX, EB, SD, BD, SE and AS since their coefficients are statistically significant at >0.10 level. These six explanatory variables did not have any multi-collinearity problem, as reflected in their respective VIF values.

Table A4.8: Variables influencing the Number of Prospective Start-Up Applications: Results of Stepwise Multiple Regression Analysis

```
. . stepwise, pr(.10): regress AP AG EB WE OD IN AS EX ED PA SD TD BD SE
                      begin with full model
p = 0.5826 >= 0.1000  removing TD
p = 0.5379 >= 0.1000  removing OD
p = 0.5493 >= 0.1000  removing IN
p = 0.6168 >= 0.1000  removing ED
p = 0.2504 >= 0.1000  removing PA
p = 0.2995 >= 0.1000  removing WE
p = 0.1997 >= 0.1000  removing AG
```

Source	SS	df	MS
Model	1900015.47	6	316669.244
Residual	3562836.32	58	61428.2124
Total	5462851.78	64	85357.0591

Number of obs =	65
F(6, 58) =	5.16
Prob > F =	0.0003
R-squared =	0.3478
Adj R-squared =	0.2803
Root MSE =	247.85

AP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
EX	33.84192	15.73932	2.15	0.036	2.33626	65.34759
EB	-102.5046	47.99674	-2.14	0.037	-198.5805	-6.428639
SD	-173.9924	89.88908	-1.94	0.058	-353.925	5.940117
BD	241.3366	87.57782	2.76	0.008	66.03049	416.6426
SE	-.034819	.0155166	-2.24	0.029	-.0658788	-.0037592
AS	27.03083	13.14478	2.06	0.044	.7186837	53.34298
_cons	193.7786	99.48886	1.95	0.056	-5.37004	392.9271

```
. vif
```

Variable	VIF	1/VIF
EX	2.42	0.413387
SD	2.12	0.470628
AS	1.93	0.517388
BD	1.89	0.529051
EB	1.66	0.602655
SE	1.20	0.835646
Mean VIF	1.87	

This brings out that it is the in-house staff and experts together which would largely determine the "visibility" of an incubating institution and therefore the number of applications received by it. Similarly, the administrative staff members (AS) play a crucial role in facilitating the entry, incubation and exit of start-ups, at every stage. A higher number of administrative staff members would enable specialized focus on different administrative tasks which in turn would enable a better focus on the incubatees. Given this, the education qualification of TBI CEOs (EB) beyond the basic STEM degree need not matter. This is particularly true when they are stage agnostic (SD) and have multiple objectives (BD) other than revenue generation. Further, those TBIs which are smaller sized (SE) will be able to give better attention to incubation relative to larger sized TBIs. Together such TBIs attracted more applications relative to the rest.

The results of the stepwise backward elimination multiple regression analysis (along with VIF values for the statistically significant explanatory variables) for model 2 are presented in Table A4.9. The regression model is statistically significant as revealed by the F value, and it has a moderately high explanatory power as indicated by the adjusted R^2 square value of 36%. The model rejected eight of the 12 independent variables and retained only ED, PA, BD and EB since their coefficients are statistically significant at >0.10 level. These four explanatory variables did not have any multi-collinearity problem, as reflected in their respective VIF values.

Table A4.9: Variables influencing the Applications to Seats Ratio: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.10): regress ASR AG IN AS EX ED OD PA EB WE SD TD BD
                      begin with full model
p = 0.8935 >= 0.1000  removing WE
p = 0.8128 >= 0.1000  removing AG
p = 0.7326 >= 0.1000  removing TD
p = 0.5334 >= 0.1000  removing AS
p = 0.6920 >= 0.1000  removing EX
p = 0.6692 >= 0.1000  removing IN
p = 0.3777 >= 0.1000  removing OD
p = 0.5139 >= 0.1000  removing SD
```

Source	SS	df	MS
Model	2437.7436	4	609.435901
Residual	3635.13305	60	60.5855508
Total	6072.87665	64	94.8886976

Number of obs =	65
F(4, 60) =	10.06
Prob > F =	0.0000
R-squared =	0.4014
Adj R-squared =	0.3615
Root MSE =	7.7837

ASR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ED	7.511962	2.806639	2.68	0.010	1.897848	13.12608
PA	-3.825145	1.270644	-3.01	0.004	-6.366812	-1.283479
BD	6.303343	2.658944	2.37	0.021	.9846632	11.62202
EB	-6.892373	1.386337	-4.97	0.000	-9.665459	-4.119287
_cons	22.51019	4.33243	5.20	0.000	13.84404	31.17634

. vif

Variable	VIF	1/VIF
ED	2.11	0.473419
BD	1.77	0.566068
EB	1.40	0.712453
PA	1.36	0.737788
Mean VIF	1.66	

.

Those TBIs which have external networks (ED), in addition to its own in-house experts, and those which have multiple objectives other than revenue generation (BD) have a higher application to seat ratio (ASR). At the same time, such TBIs have indulged in less promotional activities (PA) and their CEOs are less STEM qualified (EB). The TBIs which have their own external networks perhaps, would be getting applicants from such networks to meet their multiple objectives of entrepreneurship generation, innovation commercialization, university-industry linkages, ecosystem development, etc. and therefore need not indulge in promotional activities to the extent revenue seeking TBIs have to do, which do not have external networks of their own. Given this, the STEM qualifications of their CEOs need not be higher.

A4.2.2 TBIs: Selection Process of Prospective Incubatees and Occupancy of incubating Ventures

To ascertain the outcomes of the selection process at TBIs using statistical analysis, we carried out a stepwise backward elimination regression by means of the following regression model:

OC = b0+b1AG+b2EB+b3WE+b4IN+b5AS+b6EX+b7ED+b8SD+b9TD+b10PA+b11BD+b12CD+b13CC+b14SE -- (3)

Where OC = Number of occupants, CD = Dummy for Unique product idea (=1 and 0 for the rest), and CC = Already developed product and identified market (=1 and 0 for the rest). The descriptive statistics and correlation coefficients of the variables are presented in Table A4.10. The results of the stepwise regression are given in Table A4.11. The overall regression model is statistically significant as revealed by the F value, and it has a moderately high explanatory power, as the statistically significant variables together accounted for more than 52% of the variation in the dependent variable as reflected in the value of adjusted R squared value. The stepwise regression model eliminated nine independent variables and retained five (EX, ED, WE, SE and AS) of the 14 independent variables.

The results broadly indicate that TBIs which are larger in size, which have a larger number of in-house experts and administrative staff, but do not have their own external networks, whose CEOs have stronger work experience (in the form of both industry and start-up experience) have more number of occupants relative to the rest. These results can be elaborated as follows. The TBIs with CEOs who have vast work experience will be able to obtain "quality" applications through their own networks and referrals received. A larger sized TBI will be able to afford to accommodate more incubatees relative to smaller sized ones. Further, TBIs which have more numbers of in-house experts and administrative staff, even without external networks, will be able to attract better applicants to get selected as incubatees.

Overall it is the "external appeal/image" of a TBI which would play a decisive role in the attraction of right kind of applicants to get shortlisted as the incubatees. It is important to note that neither of the selection dummies (CD or CC) turned out to be significant because, selection process did not significantly differentiate the number of incubatees present in the accelerators, incubators and coworking spaces. The five statistically significant explanatory variables did not have any multi-collinearity problem, as reflected in their respective VIF values.

At the aggregate, the number of occupants, in all the three start-up hubs, indicates three things, which are as follows:

- The overall number of start-up proposals is yet to emerge in a big way, as the ecosystems in India are still evolving and/or maturing, as observed in the previous section analysis,
- High-quality start-up proposals are not forthcoming to enable their entry, particularly into incubators and accelerators,
- As of now, the infrastructure and facilities prevalent in the TBIs are under-utilized, and there is scope for encouraging start-up emergence in a bigger way.

Given this, let us understand the support extended by the TBIs to the incubatees during the incubation process.

Table A4.10: Descriptive Statistics and Correlation Coefficients of the Variables

. summarize OC AG EB WE IN AS EX ED SD TD PA BD CD CD SE

Variable	Obs	Mean	Std. Dev.	Min	Max
OC	65	26.38462	37.25239	2	191
AG	65	6.661538	4.937981	2	25
EB	65	2.107692	.8314723	1	3
WE	65	3.030769	1.045365	1	4
IN	65	3.723077	2.019496	1	6
AS	65	3.369231	3.276666	1	17
EX	65	2.307692	3.06147	0	18
ED	65	.5076923	.5038315	0	1
SD	65	.4615385	.5023981	0	1
TD	65	.4769231	.5033541	0	1
PA	65	3.046154	.8914659	1	4
BD	65	.6307692	.4863522	0	1
CD	65	.4923077	.5038315	0	1
CD	65	.4923077	.5038315	0	1
SE	65	499.9692	2184.171	4	17600

. correlate OC AG EB WE IN AS EX ED SD TD PA BD CD CD SE
(obs=65)

	OC	AG	EB	WE	IN	AS	EX	ED	SD	TD	PA	BD	CD	CD	SE
OC	1.0000														
AG	0.1890	1.0000													
EB	0.1596	0.3705	1.0000												
WE	0.2176	0.0717	0.4276	1.0000											
IN	0.0737	0.2694	0.6508	0.3890	1.0000										
AS	0.5820	0.0272	0.0368	0.0924	-0.0575	1.0000									
EX	0.4633	0.1889	0.4165	0.2655	0.5978	0.5337	1.0000								
ED	0.0444	0.2272	0.4642	0.4149	0.7392	0.1402	0.5556	1.0000							
SD	-0.0505	0.2529	0.5898	0.0915	0.6824	-0.0387	0.4650	0.3561	1.0000						
TD	0.0442	0.2797	0.6594	0.2983	0.7468	-0.0611	0.4812	0.5090	0.7224	1.0000					
PA	0.1378	0.0852	0.2040	0.5518	0.2329	0.2294	0.3039	0.4688	-0.0134	0.0198	1.0000				
BD	0.0105	0.1944	0.4863	0.2686	0.7851	-0.1582	0.3818	0.5857	0.5804	0.5391	0.1120	1.0000			
CD	0.0447	0.3130	0.5801	0.1785	0.6275	-0.0077	0.3156	0.3542	0.6315	0.6000	0.0182	0.4983	1.0000		
CD	0.0447	0.3130	0.5801	0.1785	0.6275	-0.0077	0.3156	0.3542	0.6315	0.6000	0.0182	0.4983	1.0000	1.0000	
SE	0.4715	0.4614	0.0401	-0.0887	0.1197	0.3040	0.2557	0.1637	-0.0664	-0.0770	0.0316	0.1163	0.1541	0.1541	1.0000

Table A4.11: Variables influencing the Number of Occupants: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.05): regress OC AG EB WE IN AS EX ED SD TD PA BD CD CC SE
                      begin with full model
p = 0.9344 >= 0.0500  removing IN
p = 0.8920 >= 0.0500  removing AG
p = 0.8545 >= 0.0500  removing BD
p = 0.8313 >= 0.0500  removing PA
p = 0.5103 >= 0.0500  removing CD
p = 0.2860 >= 0.0500  removing TD
p = 0.2210 >= 0.0500  removing SD
p = 0.2870 >= 0.0500  removing EB
p = 0.1969 >= 0.0500  removing CC

      Source |       SS       df       MS              Number of obs =      65
-------------+------------------------------           F(  5,    59) =   14.90
       Model |  49565.7363     5  9913.14726           Prob > F      =  0.0000
    Residual |  39249.6483    59  665.248277           R-squared     =  0.5581
-------------+------------------------------           Adj R-squared =  0.5206
       Total |  88815.3846    64  1387.74038           Root MSE      =  25.792

------------------------------------------------------------------------------
          OC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          EX |   3.874061   1.524276     2.54   0.014     .8239926     6.92413
          ED |  -26.42224   8.438903    -3.13   0.003    -43.30844   -9.536029
          WE |   10.15358   3.460537     2.93   0.005     3.229059     17.0781
          SE |    .006414   .0015953     4.02   0.000     .0032218    .0096063
          AS |   3.655772   1.224327     2.99   0.004       1.2059    6.105644
       _cons |  -15.43826   10.37008    -1.49   0.142    -36.18874    5.312219
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
          EX |      2.09    0.477328
          ED |      1.74    0.574991
          AS |      1.55    0.645870
          WE |      1.26    0.794293
          SE |      1.17    0.856111
-------------+----------------------
    Mean VIF |      1.56
```

A4.2.3 TBIs: Criteria for Graduation and Determinants of Graduation

Dependent variable: (i) CG: Cumulative graduation to cumulative admission ratio.

The multiple regression model is as follows:

CG = b0+b1UD+b2LD+ b3NF+b4GF+b5NM+b6WM+b7GS+b8GD+b9AG+b10AC+b11BI+b12BN+b13CH -- (4)

Independent variables: (i) UD = Dummy variable (1=Unique product idea and 0 for others), (ii) LD = Dummy variable (1=developed product & large market and 0 for others); (iii) NF = Dummy variable (1=No funding support and 0 for others); (iv) GF = Dummy variable (1=Government sponsored seed funds and 0 for others); (v) NM = Dummy variable (1=Need based mentoring support and 0 for others); (vi) WM = Dummy variable (1=Weekly mentoring and 0 for others); (vii) GS = Dummy variable (1= graduation criteria of achieved self-sustainability/growth and 0 for others); (viii) GD = Dummy variable (1=graduation criteria of raising external funds and 0 for others); (ix) AG = Age in number of years (since inception till 2016/17); (x) AC = Dummy variable (1=Accelerators and 0 for others); (xi) BI = Dummy variable (1=Incubators and 0 for others); (xii) BN = Dummy variable (1=Bangalore and 0 for others); (xiii) CH = Dummy variable (1=Chennai and 0 for others).

The descriptive statistics and correlation coefficients between the variables are presented in Table A4.12. The stepwise regression analysis results along with VIF values are presented in Table A4.13. The model eliminated nine of the 13 independent variables and retained four variables, namely, AC, BN, NF and GS. These four explanatory variables together accounted for more than 37% of the variation in the cumulative graduation to cumulative admission ratio, as reflected in the value of adjusted R^2. The model is statistically significant as revealed by the F value. There is no multicollinearity problem among the retained explanatory variables as shown by the VIF values.

Table A4.12: Descriptive Statistics and Correlation Coefficients of the Variables

```
. summarize CG UD LD NF GF NM WM GS GD AC BI BN CH AG
```

Variable	Obs	Mean	Std. Dev.	Min	Max
CG	65	.2547692	.2581854	0	.89
UD	65	.4923077	.5038315	0	1
LD	65	.1692308	.3778736	0	1
NF	65	.6153846	.4902903	0	1
GF	65	.2923077	.4583625	0	1
NM	65	.6	.4937104	0	1
WM	65	.1384615	.3480716	0	1
GS	65	.3692308	.4863522	0	1
GD	65	.3076923	.4651303	0	1
AC	65	.1384615	.3480716	0	1
BI	65	.4769231	.5033541	0	1
BN	65	.4769231	.5033541	0	1
CH	65	.2307692	.4246039	0	1
AG	65	6.661538	4.937981	2	25

```
. correlate CG UD LD NF GF NM WM GS GD AC BI BN CH AG
(obs=65)
```

	CG	UD	LD	NF	GF	NM	WM	GS	GD	AC	BI	BN	CH	AG
CG	1.0000													
UD	0.0934	1.0000												
LD	0.3007	-0.4444	1.0000											
NF	-0.2531	-0.4866	-0.0649	1.0000										
GF	0.1003	0.4497	-0.0194	-0.8129	1.0000									
NM	-0.2067	0.0503	-0.3853	0.1291	-0.1657	1.0000								
WM	0.1334	0.0507	0.2943	-0.1409	0.2320	-0.4910	1.0000							
GS	0.1214	0.3944	-0.1753	-0.2470	0.4195	-0.0260	0.0625	1.0000						
GD	-0.2414	-0.3898	-0.0342	0.3215	-0.4285	0.2041	-0.1708	-0.5101	1.0000					
AC	0.4620	-0.0384	0.4130	-0.1409	-0.1597	-0.2182	0.2262	-0.2144	-0.1708	1.0000				
BI	0.0291	0.6616	-0.0202	-0.5114	0.6053	-0.1006	0.1523	0.4821	-0.3029	-0.3828	1.0000			
BN	0.4331	-0.2009	0.3905	0.1218	-0.1396	-0.2892	-0.1153	-0.0923	-0.2361	0.2415	-0.1101	1.0000		
CH	-0.3480	0.0449	-0.2472	0.0577	0.0494	0.0745	0.0976	0.2619	0.0304	-0.2196	0.0619	-0.5230	1.0000	
AG	0.0236	0.3130	-0.1196	-0.3063	0.2998	0.0077	-0.0450	0.2480	-0.0152	-0.1723	0.3677	-0.2484	0.1720	1.0000

Table A4.13: Variables influencing Cumulative Graduation-Cumulative Admission Ratio: Results of Stepwise (backward elimination) Regression Analysis

```
. stepwise, pr(.10): regress CG UD LD NF GF NM WM GS GD AC BI BN CH AG
                      begin with full model
p = 0.9917 >= 0.1000  removing BI
p = 0.9639 >= 0.1000  removing UD
p = 0.9149 >= 0.1000  removing LD
p = 0.6321 >= 0.1000  removing GF
p = 0.6035 >= 0.1000  removing NM
p = 0.4083 >= 0.1000  removing WM
p = 0.4190 >= 0.1000  removing AG
p = 0.3411 >= 0.1000  removing GD
p = 0.2012 >= 0.1000  removing CH
```

Source	SS	df	MS
Model	1.77316143	4	.443290358
Residual	2.49306016	60	.041551003
Total	4.26622159	64	.066659712

Number of obs =	65
F(4, 60) =	10.67
Prob > F =	0.0000
R-squared =	0.4156
Adj R-squared =	0.3767
Root MSE =	.20384

CG	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AC	.2834975	.0792018	3.58	0.001	.1250703	.4419247
BN	.1962084	.0528642	3.71	0.000	.0904643	.3019526
NF	-.1048325	.0554764	-1.89	0.064	-.2158017	.0061368
GS	.1005872	.0559875	1.80	0.077	-.0114046	.2125789
_cons	.1493118	.0571325	2.61	0.011	.0350298	.2635938

```
. vif
```

Variable	VIF	1/VIF
AC	1.17	0.854268
GS	1.14	0.875623
NF	1.14	0.877564
BN	1.09	0.916919
Mean VIF	1.14	

Among the TBIs, Accelerators (AC) accounted for a higher influence on the cumulative graduation to cumulative admission ratio, relative to Co-working spaces. This can be attributed to the mode of operations that Accelerators employ. Most of the Accelerators are corporate funded, and have short-term goals to achieve. This drives the Management in the Accelerators to adopt a short time based and cohort based program to select, nurture and graduate startups. Usually, all accelerators graduate at least two batches of startups in a year – which explains the high cumulative graduation to cumulative admission ratio.

Similarly, among the three start-up hubs, Bangalore (BN) based TBIs have a higher influence on graduation relative to Hyderabad. The absence of funding support (NF) has a negative influence on graduation compared to Corporate funding, and laying emphasis on achieving self-sustainability/growth (GS) as a graduation criterion has a better influence on graduation than laying emphasis on mere cohort duration completion as a criterion for graduation.

Appendix 4.3: Statistical analysis and inferences related to Chapter 6

A4.3.1 TBIs: Determinants of R&D Contributions

To answer these research questions, we used the following dependent variables, TBI wise:

- Current value of R&D investment expenditure (RI) for research question 6.1,
- Number of R&D personnel (RP) for research question 6.2,
- Number of new products/services (NP) for research question 6.3,
- Number of patent application submissions (PA) for research question 6.4,
- Total sales revenue (for 2016/17) generated (RR) from the sale of new products/services for research questions 6.5 and 6.6.

The explanatory variables used for eliciting answers for research questions from 6.1, 6.3, 6.4 and 6.5 are as follows:

AG: TBI age in number of years (since inception till January 2018);

EB: Education background of CEOs (1=STEM graduates; 2=STEM PGs; & 3=STEM doctorates);

WE: Work experience of CEOs (1=no prior industry/start-up experience; 2=prior industry experience; 3=prior start-up experience; 4=prior industry & start-up experience);

IN: Infrastructure (1=common hardware + software; 2= 1 + soft infra; 3= 1+2+unique hardware; 4=1+2+3+business or tech mentors; 5= 1+2+3+both business and tech mentors; 6=1+2+3+4+5+external networks);

AS: Number of Administrative staff members;

EX: Number of in-house experts;

ED: Dummy variable for the presence of external networks (1=yes and 0=no);

NF = Dummy variable (1=No funding support and 0 for others);

GF = Dummy variable (1=Government sponsored seed funds and 0 for others);

NM = Dummy variable (1=Need based mentoring support and 0 for others);

WM = Dummy variable (1=Weekly mentoring and 0 for others);

ME = Number of marketing events held per year

GS = Dummy variable (1= graduation criteria of achieved self-sustainability/growth and 0 for others);

GD = Dummy variable (1=graduation criteria of raising external funds and 0 for others);

GV = Government sponsor dummy (1= TBIs sponsored by the government and 0 for others);

CD = Corporate sector sponsor dummy (1= Corporate sector sponsored TBIs and 0 for others);

CA = Number of cumulative admissions;

SE = Number of successful exits.

The explanatory variables for research question 6.2 included all of the above variables excluding EX, and the explanatory variables for research question 6.6 are the dependent variables for the first four research questions, namely, R&D expenditure (RI), R&D personnel (RP), number of new products/services (NP), and number of patent application submissions (PA).

The six multiple regression models are as follows:

$$RI=b0+b1AG+b2EB+b3WE+b4IN+b5AS+b6EX+b7ED+b8NF+b9GF+b10ME+b11NM +b12WM+b13GS+b14GD+b15GV+b16CD+b17CA+b18SE \quad \text{---- (6.1)}$$

$$RP=b0+b1AG+b2EB+b3WE+b4IN+b5AS+b6ED+b7NF+b8GF+b9NM+b10WM+b11ME+b12 GS +b13GD+b14GV+b15CD+b16CA+b17SE \quad \text{---- (6.2)}$$

$$NP=b0+b1AG+b2EB+b3WE+b4IN+b5AS+b6EX+b7ED+b8NF+b9GF+b10ME+b11NM +b12WM+b13GS+b14GD+b15GV+b16CD+b17CA+b18SE \quad \text{---- (6.3)}$$

$$PA=b0+b1AG+b2EB+b3WE+b4IN+b5AS+b6EX+b7ED+b8NF+b9GF+b10ME+b11NM$$

$$+b12WM+b13GS+b14GD+b15GV+b16CD+b17CA+b18SE \quad ---- (6.4)$$

$$RR=b0+b1AG+b2EB+b3WE+b4IN+b5AS+b6EX+b7ED+b8NF+b9GF+b10ME+b11NM$$

$$+b12WM+b13GS+b14GD+b15GV+b16CD+b17CA+b18SE \quad ---- (6.5)$$

$$RR=b0+b1RI+b2RP+b3NP+bIN+b5AS+ \quad ---- (6.6)$$

We have carried our stepwise (forward selection) regression analysis for each of the above referred regression equations. The descriptive statistics of the variables are given in Table A4.12, and the correlation coefficients between the variables are presented in Table A4.13.

Table A4.12: Descriptive Statistics of the Variables

```
. summarize RR RI RP NP PA AG EB WE AS IN EX ED NF GF NM WM ME GS GD CA SE GV CD
```

Variable	Obs	Mean	Std. Dev.	Min	Max
RR	65	9.72e+07	3.51e+08	166666.7	2.70e+09
RI	65	4.01e+07	1.35e+08	25000	1.00e+09
RP	65	2.307692	3.06147	0	18
NP	65	124.7692	318.183	5	2500
PA	65	7.4	15.68518	0	87
AG	65	6.661538	4.937981	2	25
EB	65	2.107692	.8314723	1	3
WE	65	3.030769	1.045365	1	4
AS	65	3.369231	3.276666	1	17
IN	65	3.723077	2.019496	1	6
EX	65	2.307692	3.06147	0	18
ED	65	.5076923	.5038315	0	1
NF	65	.6153846	.4902903	0	1
GF	65	.2923077	.4583625	0	1
NM	65	.6	.4937104	0	1
WM	65	.1384615	.3480716	0	1
ME	65	10.07692	13.04836	0	60
GS	65	.3692308	.4863522	0	1
GD	65	.3076923	.4651303	0	1
CA	65	100.5231	266.0796	2	2000
SE	65	20.03077	36.40011	0	250
GV	65	.4153846	.4966232	0	1
CD	65	.0923077	.2917125	0	1

All the correlation coefficients >+/- 0.24 are statistically significant (non-directional) at 0.05 level. Most of the statistically significant coefficients are either low or moderately high, and very few coefficients are >0.60. Since RP and EX are one and the same, the correlation coefficient is 1.

Table A4.13: Correlation Coefficients of the Variables

```
. correlate RR RI RP NP PA AG EB WE AS IN EX ED NF GF NM WM ME GS GD CA SE GV CD
(obs=65)
```

	RR	RI	RP	NP	PA	AG	EB	WE	AS	IN
RR	1.0000									
RI	0.1965	1.0000								
RP	0.1496	0.2322	1.0000							
NP	0.2624	0.8516	0.2097	1.0000						
PA	0.7061	-0.0039	0.3550	0.0428	1.0000					
AG	0.1411	0.4131	0.1889	0.4630	0.2023	1.0000				
EB	0.0086	0.0623	0.4165	0.0104	0.3309	0.3705	1.0000			
WE	0.1332	-0.1078	0.2655	-0.0161	0.2746	0.0717	0.4276	1.0000		
AS	0.0005	0.2191	0.5337	0.3229	0.0132	0.0272	0.0368	0.0924	1.0000	
IN	0.2226	0.1248	0.5978	0.0768	0.4524	0.2694	0.6508	0.3890	-0.0575	1.0000
EX	0.1496	0.2322	1.0000	0.2097	0.3550	0.1889	0.4165	0.2655	0.5337	0.5978
ED	0.2515	0.2239	0.5556	0.1088	0.3634	0.2272	0.4642	0.4149	0.1402	0.7392
NF	-0.0063	-0.1878	-0.4820	-0.1390	-0.2093	-0.3063	-0.4334	-0.3424	-0.1047	-0.6458
GF	-0.0653	0.2243	0.5139	0.1866	0.1378	0.2998	0.4901	0.2092	0.1663	0.6121
NM	-0.2072	-0.0564	-0.2378	-0.2235	-0.1707	0.0077	0.0305	0.0848	-0.1391	-0.2225
WM	0.2670	-0.0688	0.4433	-0.0158	0.2931	-0.0450	0.2176	0.1169	0.2011	0.3444
ME	-0.0190	-0.0249	0.3718	0.0572	0.0935	-0.1873	0.0179	0.2209	0.2869	0.1348
GS	-0.0783	0.1593	0.1849	0.1193	0.0827	0.2480	0.4797	0.4076	-0.0379	0.4557
GD	-0.0715	-0.0428	-0.3089	-0.0889	-0.1521	-0.0152	-0.4102	-0.2769	0.1088	-0.5566
CA	0.2103	0.8109	0.1974	0.9869	-0.0130	0.4224	-0.0107	-0.0148	0.3341	0.0366
SE	0.3443	-0.0836	0.0939	0.1730	0.3169	0.0474	-0.1173	0.1503	0.3896	-0.0326
GV	-0.1518	-0.0640	0.4079	-0.1456	0.0766	0.1920	0.6846	0.2158	0.0099	0.6773
CD	0.5470	-0.0173	0.1252	-0.0065	0.5587	0.0980	0.0228	-0.0095	-0.1016	0.2563

	EX	ED	NF	GF	NM	WM	ME	GS	GD	CA	SE	GV	CD
EX	1.0000												
ED	0.5556	1.0000											
NF	-0.4820	-0.5887	1.0000										
GF	0.5139	0.4299	-0.8129	1.0000									
NM	-0.2378	-0.2387	0.1291	-0.1657	1.0000								
WM	0.4433	0.3057	-0.1409	0.2320	-0.4910	1.0000							
ME	0.3718	0.0296	-0.0075	0.0354	-0.1140	0.1696	1.0000						
GS	0.1849	0.2433	-0.2470	0.4195	-0.0260	0.0625	-0.0415	1.0000					
GD	-0.3089	-0.2770	0.3215	-0.4285	0.2041	-0.1708	-0.1353	-0.5101	1.0000				
CA	0.1974	0.0541	-0.0959	0.1537	-0.2170	-0.0386	0.0820	0.0890	-0.0964	1.0000			
SE	0.0939	-0.0196	0.0558	-0.0483	-0.2827	0.0996	0.1907	-0.0686	0.0594	0.2217	1.0000		
GV	0.4079	0.3929	-0.6170	0.6938	-0.0765	0.2044	-0.0147	0.5195	-0.4943	-0.1653	-0.1407	1.0000	
CD	0.1252	0.3140	0.0336	-0.2049	-0.1736	0.1799	-0.0019	-0.2440	0.0177	-0.0445	0.1881	-0.2688	1.0000

The results of stepwise regression analysis for regression equation 6.1 (dependent variable is RI) are given in Table A4.14. The regression model is statistically significant as revealed by the F value, and it has a high explanatory power of more than 78% as indicated by the adjusted R^2 value. There is no multicollinearity problem among the selected explanatory variables as none of the VIF values is more than 1.4. The model selected only five of the 18 explanatory variables, namely, CA, SE, ED, WE and NM, and rejected the remaining 13 variables. A description on each of them is in order.

Table A4.14: Variables influencing R&D Investment Expenditure of TBIs: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pe(.05): regress RI AG EB WE AS IN EX ED NM WM NF GF ME GS GD CA SE GV CD
                      begin with empty model
p = 0.0000 <  0.0500  adding  CA
p = 0.0001 <  0.0500  adding  SE
p = 0.0081 <  0.0500  adding  ED
p = 0.0236 <  0.0500  adding  WE
p = 0.0143 <  0.0500  adding  NM

      Source |       SS       df       MS              Number of obs =      65
-------------+------------------------------           F(  5,    59) =   47.56
       Model |  9.2815e+17     5  1.8563e+17           Prob > F      =  0.0000
    Residual |  2.3027e+17    59  3.9028e+15           R-squared     =  0.8012
-------------+------------------------------           Adj R-squared =  0.7844
       Total |  1.1584e+18    64  1.8100e+16           Root MSE      =  6.2e+07

------------------------------------------------------------------------------
          RI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          CA |   440257.2   30548.71    14.41   0.000     379129.4      501385
          SE |  -714655.1   235887.7    -3.03   0.004     -1186665   -242644.8
          ED |   7.93e+07   1.82e+07     4.34   0.000     4.28e+07    1.16e+08
          WE |  -2.61e+07    8682130    -3.01   0.004    -4.35e+07    -8764196
          NM |   4.52e+07   1.79e+07     2.52   0.014      9376467    8.11e+07
       _cons |   2.20e+07   2.58e+07     0.86   0.396    -2.95e+07    7.36e+07
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
          ED |      1.39    0.721321
          WE |      1.35    0.740307
          NM |      1.28    0.779722
          SE |      1.21    0.827150
          CA |      1.08    0.922978
-------------+----------------------
    Mean VIF |      1.26
```

The TBIs which had more cumulative admissions (CA) but less successful exits (SE) have resorted to more R&D investment expenditure (RI). Such TBIs had exclusive external networks (ED) of their own, and provided need based mentoring (NM) to their incubatees. The CEOs of such TBIs did not have previous industry/start-up experience (WE). These results indicate that the TBIs with CEOs who are technology graduates but have no previous experience, have established external networks (perhaps to compensate their lack of experience) which enable them to provide need based mentoring and admit a larger number of incubatees, which would necessitate more R&D investments towards the formation of start-ups. This is in contrast to the TBIs with CEOs who are technology graduates but have industry/start-up experience, but no external networks and provide monthly mentoring for a lesser number of cumulatively admitted incubatees, which successfully exit faster.

The results of stepwise regression analysis for equation number 6.2 (for the dependent variable (RP), number of R&D personnel) are given in Table A4.15. The F value is significant indicating the statistical significance of the overall model, and it has a high explanatory power of more than 67% as reflected in the value of adjusted R^2. The VIF values indicate that there is no multicollinearity problem among the selected explanatory variables. The model selected only two of the 17 independent variables, namely, IN and AS, and thus rejected the remaining 15 variables. The results are described as follows.

The number of R&D personnel employed by the TBIs are largely determined by the extent of infrastructure and the number of administrative staff members employed and nothing else. In other words, the characteristics of neither the TBI and its CEOs nor the incubation process had any influence on the number of R&D personnel (RP) employed. Those TBIs which had specialized laboratory, machinery and equipment invariably had more number of administrative staff, on the one hand, and more number of in-house experts in the form of R&D personnel to nurture start-ups. From another perspective, it can also be inferred that TBIs that have managed to create good R&D infrastructure will attract R&D personnel to their TBI. In the absence of infrastructure, there will be no role for the qualified R&D personnel in the TBIs other than to provide mentoring support to incubating startups.

Table A4.15: Variables influencing R&D Personnel of TBIs: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pe(.05): regress RP AG EB WE AS IN ED NM WM NF GF ME GS GD CA SE GV CD
                      begin with empty model
p = 0.0000 <  0.0500  adding  IN
p = 0.0000 <  0.0500  adding  AS
```

Source	SS	df	MS
Model	408.548788	2	204.274394
Residual	191.297366	62	3.08544138
Total	599.846154	64	9.37259615

Number of obs	65
F(2, 62)	66.21
Prob > F	0.0000
R-squared	0.6811
Adj R-squared	0.6708
Root MSE	1.7565

RP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
IN	.9559079	.1089043	8.78	0.000	.7382114	1.173604
AS	.5324915	.0671206	7.93	0.000	.3983194	.6666637
_cons	-3.045313	.5230224	-5.82	0.000	-4.09082	-1.999806

```
. vif
```

Variable	VIF	1/VIF
AS	1.00	0.996693
IN	1.00	0.996693
Mean VIF	1.00	

The results of stepwise regression analysis for the dependent variable viz., number of new products/services (NP) (equation number 6.3) are given in Table A4.16. The overall model is statistically significant as revealed by the F value, and it has a very high explanatory power of almost 98% as reflected in the adjusted R^2 value. There is no multicollinearity problem as indicated by the VIF values for the selected explanatory variables. The model selected only four of the 18 independent variables, namely, CA, ED, SE and AG, and thus rejected the remaining 14 variables. The description on the results is in order.

Table A4.16: Variables influencing New Products/Services from TBIs: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pe(.05): regress NP AG EB WE AS IN EX ED NM WM NF GF ME GS GD CA SE GV CD
                     begin with empty model
p = 0.0000 <  0.0500  adding  CA
p = 0.0053 <  0.0500  adding  ED
p = 0.0177 <  0.0500  adding  SE
p = 0.0424 <  0.0500  adding  AG
```

Source	SS	df	MS
Model	6352879.82	4	1588219.96
Residual	126507.715	60	2108.46192
Total	6479387.54	64	101240.43

Number of obs	=	65
F(4, 60)	=	753.26
Prob > F	=	0.0000
R-squared	=	0.9805
Adj R-squared	=	0.9792
Root MSE	=	45.918

NP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CA	1.167581	.0244328	47.79	0.000	1.118708	1.216454
ED	28.76591	11.71384	2.46	0.017	5.334739	52.19707
SE	-.3894508	.1619666	-2.40	0.019	-.7134323	-.0654694
AG	2.733385	1.317751	2.07	0.042	.0974909	5.369278
_cons	-17.61139	10.99815	-1.60	0.115	-39.61096	4.388184

. vif

Variable	VIF	1/VIF
AG	1.29	0.778073
CA	1.28	0.779501
ED	1.06	0.945838
SE	1.06	0.947828
Mean VIF	1.17	

The older TBIs (AG) which accounted for a larger number of cumulative admissions (CA) but lesser number of successful exits (SE) and had exclusive external networks, were able to produce a higher number of new products/services (NP) relative to TBIs which are younger and accounted for a lesser number of cumulative admissions but a higher number of exits and had no exclusive external networks. This implies that those TBIs which have a longer operational experience with exclusive external networks and accommodate more number of incubatees which undergo the incubation process for a longer period of time (and therefore, lesser number of successful exits) will have a higher number of new products/services.

The stepwise regression analysis results for equation number 6.4 where the dependent variable is the number of patent application submissions (PA) are shown in Table A4.17. The model is statistically significant and the explanatory power of the model is almost 45% as revealed by the adjusted R^2 value. The VIF values reflected the absence of multicollinearity problem among the selected explanatory variables. The model selected three of the 18 independent variables, which are statistically significant, namely, CD, IN and SE and thus rejected the remaining 13 variables.

The results reveal that those TBIs which had corporate (industry) sponsorship (CD) and had more infrastructure (IN) and experienced more successful exits (SE) accounted for a higher number of patent application submissions (PA). The TBIs led by industry (mostly accelerators/incubators) which had better specialized infrastructure, which also experienced more time-bound successful exits, have gone for more patent application submissions relative to non-industry (private-promoted) TBIs (mostly co-working spaces) which had less/no specialized infrastructure and experienced less successful exits. This is understandable given the fact that industry is always keen to protect its intellectual property generated through the incubated start-ups in their TBIs relative to the rest. Since we could not obtain data on the number of patents obtained as against the number of patent applications submitted, it is not possible to throw light on the quality of patent applications submitted by these TBIs.

Table A4.17: Variables influencing Patent Application Submissions from TBIs: Results of Stepwise Multiple Regression Analysis

```
. . stepwise, pe(.05): regress PA AG EB WE AS IN EX ED NM WM NF GF ME GS GD CA SE GV CD
                      begin with empty model
p = 0.0000 <  0.0500  adding  CD
p = 0.0016 <  0.0500  adding  IN
p = 0.0109 <  0.0500  adding  SE
```

Source	SS	df	MS
Model	7462.07863	3	2487.35954
Residual	8283.52137	61	135.795432
Total	15745.6	64	246.025

Number of obs =	65
F(3, 61) =	18.32
Prob > F =	0.0000
R-squared =	0.4739
Adj R-squared =	0.4480
Root MSE =	11.653

PA	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CD	22.66263	5.276125	4.30	0.000	12.11236	33.21289
IN	2.738214	.7489235	3.66	0.001	1.240649	4.235779
SE	.1073462	.0408931	2.63	0.011	.0255754	.1891169
_cons	-7.036744	3.205084	-2.20	0.032	-13.44571	-.6277822

. vif

Variable	VIF	1/VIF
CD	1.12	0.895705
IN	1.08	0.927565
SE	1.04	0.957636
Mean VIF	1.08	

Finally, what matters is the total revenue (TR) generated by the TBIs, and its influential variables. The results of stepwise regression analysis for equation number 6.5 are presented in Table A4.18. The regression model is statistically significant as reflected in the F value, and adjusted R2 revealed that the model explained more than 33% of the overall variation in the dependent variable (TR). The VIF values indicated that there is no multicollinearity between the chosen explanatory variables of the model. The model chose only two of the 18 explanatory variables, namely, CD and SE, and thus rejected the remaining 16 variables.

The two statistically significant variables are two of the three variables which explained the variation in the number of patent application submissions in the previous model (equation number 6.4). This would imply that both corporate sponsorship (CD) and successful exits (SE) do matter not only for patent application submission but also for revenue generation. Those TBIs which are sponsored by the industry and which have experienced a higher number of successful exits are able to generate a higher total revenue relative to the TBIs which are non-industry (private) sponsored, and which have experienced lesser number of successful exits. The influence of corporate sponsorship indicates that for revenue growth of a startup, and its transformation into a large enterprise, market access is very crucial. Corporate accelerators are seen to be providing this crucial support for the incumbent startups to increase revenues and thus also facilitate exit from their incubation successfully.

But, at the same time, it is pertinent to ascertain what kind of influence R&D investments (RI), R&D personnel (RP), number of new products/services generated (NP), and number of successful exits (SE) experienced by the TBIs have on its total revenue (TR). Therefore, we carried out stepwise (forward selection) multiple regression for equation number 6.6. The results are given in Table A4.19. The model is statistically significant and it has a higher explanatory power (almost 54% as revealed by the adjusted R^2) compared to the model of equation number 6.5 (results given in Table A4.18). There is no multicollinearity problem between the two explanatory variables as revealed by the VIF values. The model selected two variables, viz., PA and NP, and rejected two other variables (RP and RI) out of the four independent variables. The results bring out that more than the R&D inputs of manpower and investments, it is the new products/services generated through the incubatees and the patent application submission which significantly influence the total revenue generated by the TBIs.

Table A4.18: Variables influencing the Total Revenue of TBIs: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pe(.05): regress RR AG EB WE AS IN EX ED NM WM NF GF ME GS GD CA SE GV CD
                      begin with empty model
p = 0.0000 <  0.0500  adding  CD
p = 0.0185 <  0.0500  adding  SE
```

Source	SS	df	MS
Model	2.8343e+18	2	1.4171e+18
Residual	5.0475e+18	62	8.1412e+16
Total	7.8818e+18	64	1.2315e+17

Number of obs	= 65
F(2, 62)	= 17.41
Prob > F	= 0.0000
R-squared	= 0.3596
Adj R-squared	= 0.3389
Root MSE	= 2.9e+08

RR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CD	6.01e+08	1.24e+08	4.83	0.000	3.53e+08	8.50e+08
SE	2412764	997635.2	2.42	0.019	418520	4407009
_cons	-6670401	4.12e+07	-0.16	0.872	-8.90e+07	7.57e+07

```
. vif
```

Variable	VIF	1/VIF
CD	1.04	0.964625
SE	1.04	0.964625
Mean VIF	1.04	

This is understandable because R&D investments and R&D personnel play a more crucial role in the formation of start-ups enabling them to generate new products/services and even patent application submissions for their eventual successful exits. Given this, it is the new products/services generated by the incubating start-ups which would contribute to the generation of revenue. Further, when incubating start-ups submit their patent applications (prior to their exits), it would act as a signal to the prospective customers/market about the 'superior quality' or 'innovativeness' of new products/services generated, which would further help them to capture a larger market early for the generation of more revenue. Given this, generating more number of new products/services as well as application submission for patents, through their incubatees could be an appropriate strategy for TBIs for increasing total revenue generation.

Table A4.19: Influence of R&D Inputs, New Products/Services & Patent Applications on the Total Revenue of TBIs: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pe(.05): regress RR RI RP PA NP
                      begin with empty model
p = 0.0000 <  0.0500  adding  PA
p = 0.0081 <  0.0500  adding  NP
```

Source	SS	df	MS
Model	4.3557e+18	2	2.1779e+18
Residual	3.5261e+18	62	5.6872e+16
Total	7.8818e+18	64	1.2315e+17

Number of obs	= 65
F(2, 62)	= 38.29
Prob > F	= 0.0000
R-squared	= 0.5526
Adj R-squared	= 0.5382
Root MSE	= 2.4e+08

RR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PA	1.56e+07	1902251	8.19	0.000	1.18e+07	1.94e+07
NP	256508.6	93773.57	2.74	0.008	69057.88	443959.3
_cons	-5.01e+07	3.46e+07	-1.45	0.152	-1.19e+08	1.90e+07

```
. vif
```

Variable	VIF	1/VIF
NP	1.00	0.998167
PA	1.00	0.998167
Mean VIF	1.00	

Appendix 4.4: Statistical Analysis and Inferences related to Chapter 7

A4.4.1 TBI based Start-Ups: Determinants of their R&D Contributions

To answer these research questions, we used the following dependent variables, TBI wise:

- RI: The value of R&D investment expenditure (as of 2016/17) for research question 7.1,
- RP: Number of R&D personnel (as of 2016/17) for research question 7.2,
- NP: Number of new products/services (as of 2016/17) for research question 7.3,
- PA: Whether an application for patents has been submitted or not (Yes or No) for research question 7.4,
- RR: Total sales revenue (for 2016/17) generated from the sale of new products/services for research questions 7.5 and 7.6.

The explanatory variables used for eliciting answers for research questions from 7.1, 7.2, 7.3, 7.4, 7.5 and 7.6 are as follows:

- AG: Start-up age in number of years (as of 2016/17);
- FA: Age of CEOs in years (at the time of creation of the start-up)
- EB: Education background of CEOs (1=STEM graduates; 2=STEM PGs; & 3=STEM doctorates);
- IE: Industry experience of CEOs (in number of years);
- SE: Prior start-up experience of CEOs (in number of years);
- ID: Incubation duration in months;
- IN: Infrastructure of TBI (1=common hardware + software; 2= 1 + soft infra; 3= 1+2+unique hardware; 4=1+2+3+business or tech mentors; 5= 1+2+3+both business and tech mentors; 6=1+2+3+4+5+external networks);

- AS: Number of Administrative staff members in the TBI;
- EX: Number of in-house experts in the TBI;
- ED: Dummy variable for the presence of external networks of TBIs (1=yes and 0=no);
- NF = Dummy variable (1=No funding support from the TBIs and 0 for others);
- GF = Dummy variable (1=Government sponsored seed funds from the TBIs and 0 for others);
- NM = Dummy variable (1=Need based mentoring support from the TBIs and 0 for others);
- WM = Dummy variable (1=Weekly mentoring from the TBIs and 0 for others);
- SD: Dummy variable (1=graduated start-ups and 0=incubating start-ups.

The explanatory variables for research question 7.6, in addition, are the dependent variables for the first four research questions, namely, R&D expenditure (RI), R&D personnel (RP), number of new products/services (NP), and dummy variable for application submission of patents (PA). For research question numbers 7.1, 7.2, 7.3, 7.5, and 7.6, we developed multiple regression equations and for research question number 7.4, since the dependent variable is binary, we have developed a logistic regression equation. The respective multiple/logistic regression models are as follows:

$$RI=b0+b1AG+b2FA+b3EB+b4IE+b5SE+b6ID+b7IN+b8AS+b9EX+b10ED+b11NF+b12GF+b13NM+b14WM+b15SD \quad \text{---- (7.1)}$$

$$RP= b0+b1AG+b2FA+b3EB+b4IE+b5SE+b6ID+b7IN+b8AS+b9EX+b10ED+b11NF+b12GF+b13NM+b14WM+b15SD \quad \text{---- (7.2)}$$

$$NP= b0+b1AG+b2FA+b3EB+b4IE+b5SE+b6ID+b7IN+b8AS+b9EX+b10ED+b11NF+b12GF+b13NM+b14WM+b15SD \quad \text{---- (7.3)}$$

$$Ln[p/(1p)] = b0+b1AG+b2FA+b3EB+b4IE+b5SE+b6ID+b7IN+b8AS+b9EX+b10ED+b11NF+b12GF+b13NM+b14WM+b15SD \quad \text{---- (7.4)}$$

Where p represents the probability of an event (patent application submission), b0 is the y-intercept, and each independent variable's association with the outcome (log odds) is indicated by the coefficients b1 to b14. In effect, we are trying to model the probability that an event (submitting patent application) is a result of a linear combination of variables as indicated in the equation above.

RR= b0+b1AG+b2FA+b3EB+b4IE+b5SE+b6ID+b7IN+b8AS+b9EX+b10ED+b11NF+b12GF+ b13NM+b14WM+b15SD ---- (7.5)

RR= b0+b1AG+b2FA+b3EB+b4IE+b5SE+b6ID+b7IN+b8AS+b9EX+b10ED+b11NF+b12GF+ b13NM+b14WM+b15SD+b16RI+b17RP+b18NP+b19PA ---- (7.6)

The descriptive statistics of the variables are given in Table A4.20, and the correlation coefficients between the variables are presented in Table A4.21.

Table A4.20: Descriptive Statistics of the Variables

```
. summarize RR RI RP NP PA AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
```

Variable	Obs	Mean	Std. Dev.	Min	Max
RR	107	1445467	2984430	0	2.00e+07
RI	107	1880280	2925810	100000	2.00e+07
RP	107	4.028037	3.057493	1	15
NP	107	1.018692	.7521204	0	3
PA	107	.4299065	.4973922	0	1
AG	107	3.579439	2.347369	0	12
FA	107	35.96262	9.293866	19	56
EB	107	1.831776	.7331244	1	3
IE	107	11.13084	8.809123	0	33
SE	107	2.261682	4.195879	0	25
ID	107	24.42991	17.37821	3	84
IN	107	3.700935	2.029104	1	6
AS	107	3.392523	3.366755	1	17
EX	107	2.542056	3.239731	0	18
ED	107	.5046729	.502331	0	1
NF	107	.6074766	.4906101	0	1
GF	107	.2897196	.4557669	0	1
NM	107	.5981308	.492583	0	1
WM	107	.1308411	.3388135	0	1
SD	107	.3925234	.4906101	0	1

Table A4.21: Correlation Coefficients of the Variables

```
. correlate RR RI RP NP PA AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
(obs=107)
```

	RR	RI	RP	NP	PA	AG	FA	EB	IE	SE	ID	IN	AS	EX	ED	NF	GF	NM	WM	SD
RR	1.0000																			
RI	0.6457	1.0000																		
RP	0.4909	0.6434	1.0000																	
NP	0.2782	0.4126	0.4018	1.0000																
PA	0.2950	0.3549	0.3146	0.2053	1.0000															
AG	0.0693	0.1250	0.2869	0.4587	0.1159	1.0000														
FA	0.1243	0.2804	0.2935	0.1580	0.0811	0.0775	1.0000													
EB	0.0642	0.2650	0.1705	0.2111	0.3813	0.1723	0.2428	1.0000												
IE	0.1213	0.2218	0.1769	0.0644	0.1356	-0.0074	0.7631	0.0546	1.0000											
SE	0.0738	0.1275	0.2226	-0.0554	0.2575	-0.0706	0.3108	0.0098	0.2942	1.0000										
ID	0.0221	0.0941	0.1198	0.3379	0.1574	0.6719	-0.0176	0.2427	-0.0480	-0.0397	1.0000									
IN	0.1169	0.2856	0.2447	0.2262	0.2875	0.0902	0.2650	0.3844	0.1484	0.0292	0.0690	1.0000								
AS	-0.0468	0.0649	-0.0341	0.0045	-0.2313	-0.0207	0.0870	-0.1565	0.0313	0.0371	-0.0876	-0.0710	1.0000							
EX	0.0384	0.2145	0.1851	0.1739	-0.0465	0.1134	0.2971	0.0785	0.2132	-0.0015	0.0099	0.5372	0.4811	1.0000						
ED	0.2442	0.2826	0.2364	0.2744	0.2184	0.0377	0.1981	0.1559	0.1459	0.1292	-0.0316	0.7788	0.0714	0.4680	1.0000					
NF	-0.1533	-0.2342	-0.1561	-0.2356	-0.1911	-0.1365	-0.2143	-0.2902	-0.0677	0.0550	-0.1172	-0.6402	-0.0601	-0.3931	-0.5667	1.0000				
GF	-0.0434	0.1363	0.0957	0.1217	0.1112	0.1061	0.2587	0.3166	0.0645	-0.0696	0.1687	0.6046	0.1281	0.4421	0.3855	-0.7945	1.0000			
NM	-0.2648	-0.1397	-0.1052	-0.0305	-0.0968	0.1135	-0.1393	0.0723	-0.1889	-0.0331	0.0005	-0.2063	-0.1258	-0.1401	-0.2402	0.1219	-0.1488	1.0000		
WM	0.1254	0.3057	0.1695	0.1014	0.0549	-0.0962	0.2742	-0.0625	0.1981	0.1150	-0.0849	0.3731	0.1944	0.3989	0.3290	-0.1422	0.2409	-0.4733	1.0000	
SD	0.2078	0.0396	0.1876	0.3379	0.0365	0.3085	0.0984	-0.0245	0.1190	-0.0733	0.0840	-0.0136	0.0086	0.0904	-0.0075	-0.0201	-0.0071	-0.0047	-0.0281	1.0000

All the correlation coefficients >+/- 0.18 are statistically significant (non-directional) at 0.05 level. Most of the statistically significant coefficients are either low or moderately high, and very few coefficients are >0.50. Particularly, not many of the variables have a significant correlation with the five dependent variables, namely, RI, RP, NP, PA and RR. We have carried out stepwise backward elimination multiple regression analyses for equation numbers 7.1, 7.2, 7.3, 7.5 and 7.6 whereas stepwise backward elimination logistic regression analysis for equation number 7.4. The results of the stepwise multiple regression analysis for equation number 7.1 is given in Table A4.22.

Table A4.22: Variables influencing R&D Investment Expenditure of Start-Ups: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.05): regress RI AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
                      begin with full model
p = 0.9680 >= 0.0500  removing EX
p = 0.9296 >= 0.0500  removing SD
p = 0.8798 >= 0.0500  removing IN
p = 0.8777 >= 0.0500  removing NM
p = 0.7490 >= 0.0500  removing FA
p = 0.7867 >= 0.0500  removing ID
p = 0.6290 >= 0.0500  removing ED
p = 0.5677 >= 0.0500  removing SE
p = 0.4783 >= 0.0500  removing AS
p = 0.2623 >= 0.0500  removing AG
p = 0.1183 >= 0.0500  removing IE
```

Source	SS	df	MS
Model	2.0205e+14	4	5.0512e+13
Residual	7.0535e+14	102	6.9152e+12
Total	9.0740e+14	106	8.5604e+12

Number of obs =	107
F(4, 102) =	7.30
Prob > F =	0.0000
R-squared =	0.2227
Adj R-squared =	0.1922
Root MSE =	2.6e+06

RI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
WM	3026755	787910.6	3.84	0.000	1463938	4589572
NF	-2138167	861681.1	-2.48	0.015	-3847307	-429026.2
EB	1138364	372109.8	3.06	0.003	400285.6	1876442
GF	-2075880	959621.2	-2.16	0.033	-3979284	-172475.6
_cons	1299339	1042303	1.25	0.215	-768063.4	3366741

. vif

Variable	VIF	1/VIF
GF	2.93	0.341048
NF	2.74	0.365035
EB	1.14	0.876602
WM	1.09	0.915430
Mean VIF	1.98	

The regression model is statistically significant as revealed by the F value, but it has a low explanatory power of just about 19% as indicated by the adjusted R^2 value. The model selected only four of the 15 explanatory variables, namely, EB, WM, NF and GF, and rejected the rest. It is significant to note that while NF and GF influenced R&D investment negatively, EB and WM influenced it positively. There is no multicollinearity problem among the selected explanatory variables as the vif values of all the variables turned out to be less than 3, which is lower than the threshold value of 10 (Hair, et.al., 2007). A description on each of these is in order.

The educational qualification of the Start-Up CEOs is a significant positive influencer of start-up R&D investments implying that more qualified start-up CEOs have incurred more R&D investments relative to less qualified CEOs. Further, start-ups which have received weekly mentoring services have invested more than start-ups which have received monthly mentoring services. Finally, start-ups which have received corporate funding [relative to either government funding (GF) or no funding (NF)] have invested more in R&D. All this implies that start-up CEOs who are more qualified and received mentoring services on a weekly basis, supported by corporate funding have incurred more R&D investment expenditure than the rest.

Given this, what variables influence the employment of R&D personnel in a start-up is the next relevant issue. The results of stepwise regression analysis are presented in Table A4.23. The regression model as reflected in the F value is statistically significant, and the model has a low explanatory power as the model explained just about 14% of the variation in the dependent variable (RP). The model rejected 13 of the 15 explanatory variables and retained the remaining two variables, namely, AG and FA. There is no multicollinearity problem between the selected two explanatory variables as the vif value of both the variables is just 1.01, which is lower than the threshold value of 10 (Hair, e.al., 2007).

Table A4.23: Variables influencing R&D Personnel employed in Start-Ups: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.05): regress RP AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
                      begin with full model
p = 0.8659 >= 0.0500  removing IN
p = 0.6423 >= 0.0500  removing NF
p = 0.5582 >= 0.0500  removing WM
p = 0.4629 >= 0.0500  removing GF
p = 0.5072 >= 0.0500  removing EB
p = 0.4440 >= 0.0500  removing EX
p = 0.4262 >= 0.0500  removing ID
p = 0.3842 >= 0.0500  removing AS
p = 0.4085 >= 0.0500  removing NM
p = 0.4304 >= 0.0500  removing IE
p = 0.2472 >= 0.0500  removing SD
p = 0.0856 >= 0.0500  removing SE
p = 0.0504 >= 0.0500  removing ED
```

Source	SS	df	MS
Model	154.924305	2	77.4621526
Residual	835.991583	104	8.0383806
Total	990.915888	106	9.34826309

Number of obs	= 107
F(2, 104)	= 9.64
Prob > F	= 0.0001
R-squared	= 0.1563
Adj R-squared	= 0.1401
Root MSE	= 2.8352

RP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AG	.3461233	.1176684	2.94	0.004	.1127825	.579464
FA	.0897837	.0297197	3.02	0.003	.0308484	.148719
_cons	-.4397465	1.151104	-0.38	0.703	-2.722429	1.842935

```
. vif
```

Variable	VIF	1/VIF
AG	1.01	0.993987
FA	1.01	0.993987
Mean VIF	1.01	

It is the age of the start-up as well as the age of the founder CEO which mattered for the R&D personnel employed by start-ups. With experience, both start-ups and its CEOs gain knowledge, external networks, understand the market and competition better and thereby the ways and means of developing a firm and accordingly, resort to recruitment of R&D personnel. When compared with older CEOs, younger CEOs might lack both experience and social networks. Start-ups facing severer competition and uncertainty can ill-afford inefficiency and may need to be equipped with older CEOs, who are more experienced, have more skills, better judgment and more social networks. This assumes special significance in an emerging economy like India where start-up growth and its ecosystem are a recent phenomenon, unlike a developed economy.

Given this, it is important to know the determinants of generation of new products/services in start-ups. The stepwise regression analysis results for equation number 7.3 are presented in Table A4.24. The stepwise regression model eliminated 12 of the 15 explanatory variables and thus retained three variables, namely, AG, ED and SD. The three statistically significant variables, all of which have a positive influence on the generation of new products/services, explained more than 30% of the variation in the dependent variables. The model is statistically significant as reflected in the F value of the model. The three statistically significant variables have no multicollinearity as revealed by their vif values (which ranged from a high of 1.11 to a low of 1.00), which are much lower than the threshold value of 10.

The age of start-ups, the graduated start-ups and the exclusive external networks of TBIs enabled the start-ups to produce more new products/services relative to the younger ones, particularly the incubatees, where TBIs did not have exclusive external networks. Start-ups with age gain experience, knowledge, skills and networks, particularly in TBIs which have exclusive external networks, which prove useful even after their graduation. On the contrary, those younger incubating ones lack of all of these, and therefore they are unlikely to have generated more new products/services. In fact, it is with the objective of generating new products/services that prospective start-ups join TBIs, and they stand to gain as they acquire knowledge and experience over time, which will be further strengthened by TBIs, which have exclusive external networks.

Table A4.24: Variables influencing New Products/Services generated by Start-Ups: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.05): regress NP AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
                      begin with full model
p = 0.9975 >= 0.0500  removing AS
p = 0.9709 >= 0.0500  removing EX
p = 0.7403 >= 0.0500  removing NM
p = 0.5068 >= 0.0500  removing IE
p = 0.4862 >= 0.0500  removing FA
p = 0.4233 >= 0.0500  removing SE
p = 0.4021 >= 0.0500  removing IN
p = 0.2432 >= 0.0500  removing ID
p = 0.2327 >= 0.0500  removing NF
p = 0.4140 >= 0.0500  removing GF
p = 0.3610 >= 0.0500  removing WM
p = 0.1628 >= 0.0500  removing EB
```

Source	SS	df	MS
Model	19.2723893	3	6.42412978
Residual	40.6902275	103	.395050752
Total	59.9626168	106	.565685064

Number of obs =	107
F(3, 103) =	16.26
Prob > F =	0.0000
R-squared =	0.3214
Adj R-squared =	0.3016
Root MSE =	.62853

NP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AG	.1218098	.0273652	4.45	0.000	.0675374	.1760821
ED	.3919539	.1216411	3.22	0.002	.1507075	.6332002
SD	.3411493	.1308418	2.61	0.010	.0816554	.6006432
_cons	.2509633	.127298	1.97	0.051	-.0015021	.5034288

. vif

Variable	VIF	1/VIF
AG	1.11	0.903209
SD	1.11	0.904442
ED	1.00	0.998175
Mean VIF	1.07	

It is the willingness and ability of a start-up to convert a new product/service into a patent which would reflect on the level of innovativeness of a generated new product/service. Since we could not obtain data on the number of patents won by each of the start-ups, we have only gathered data on whether they have submitted an application seeking a patent for the new products/services produced. Since the variable is binary (1=yes and 0=no), we have carried out stepwise backward elimination logistic regression based on equation number 7.4 (Table A4.25). The model is statistically valid, and it retained five explanatory variables, after eliminating 10 of the 15 explanatory variables.

Table A4.25: Variables influencing Patent Application submission by Start-Ups: Results of Stepwise Logistic Regression Analysis

```
. stepwise, pr(.05): logit PA AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
                     begin with full model
p = 0.9580 >= 0.0500  removing ED
p = 0.8577 >= 0.0500  removing ID
p = 0.6053 >= 0.0500  removing GF
p = 0.5654 >= 0.0500  removing SD
p = 0.4464 >= 0.0500  removing WM
p = 0.4214 >= 0.0500  removing NF
p = 0.3947 >= 0.0500  removing AS
p = 0.2848 >= 0.0500  removing NM
p = 0.3157 >= 0.0500  removing AG
p = 0.0639 >= 0.0500  removing EX

Logistic regression                               Number of obs   =        107
                                                  LR chi2(5)      =      33.54
                                                  Prob > chi2     =     0.0000
Log likelihood = -56.342218                       Pseudo R2       =     0.2294
```

PA	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
IN	.2527154	.1268796	1.99	0.046	.0040359	.5013949
FA	-.1043919	.0433629	-2.41	0.016	-.1893817	-.0194021
EB	1.335914	.3821808	3.50	0.000	.5868532	2.084975
IE	.0873812	.0439825	1.99	0.047	.0011771	.1735853
SE	.1748872	.0670875	2.61	0.009	.043398	.3063764
_cons	-1.314909	1.113611	-1.18	0.238	-3.497547	.8677282

While the age of start-up CEOs has a negative influence, TBI infrastructure, education background, industry experience and previous start-up experience of the start-up CEOs have a positive influence on patent application submissions. Whether a start-up has to go for a patent application submission or not is largely a decision to be taken by the CEO of a start-up. However, that would also be influenced by the infrastructural support extended by a TBI in terms of information, technology mentoring, legal counseling, etc. Given this, younger CEOs who are more qualified and have both more prior-industry and more prior-start-up experience are likely to go for patent application submission relative to older CEOs, who are less qualified, and have less industry and start-up experience previously.

Ultimately what matters for start-ups is the generation of revenue, and therefore, it is important to ascertain what variables influence them. The stepwise regression analysis results for equation number 7.5 are given in Table A4.26. The regression model contained four of the 15 explanatory variables, after eliminating 11 of them. The model is statistically significant (as indicated by the F value) and the four explanatory variables together explained almost 18% of the variation in Total Revenue, as revealed by the adjusted R squared value.

Table A4.26: Variables influencing Total Revenue generated by Start-Ups: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.05): regress RR AG FA EB IE SE ID IN AS EX ED NF GF NM WM SD
                      begin with full model
p = 0.9972 >= 0.0500  removing AG
p = 0.9340 >= 0.0500  removing EX
p = 0.8015 >= 0.0500  removing ID
p = 0.7710 >= 0.0500  removing SE
p = 0.7742 >= 0.0500  removing IE
p = 0.5507 >= 0.0500  removing WM
p = 0.4515 >= 0.0500  removing AS
p = 0.4815 >= 0.0500  removing FA
p = 0.3920 >= 0.0500  removing IN
p = 0.2649 >= 0.0500  removing EB
p = 0.2366 >= 0.0500  removing ED

      Source |       SS       df       MS              Number of obs =     107
-------------+------------------------------           F(  4,   102) =    6.74
       Model |  1.9732e+14     4  4.9329e+13           Prob > F      =  0.0001
    Residual |  7.4681e+14   102  7.3216e+12           R-squared     =  0.2090
-------------+------------------------------           Adj R-squared =  0.1780
       Total |  9.4412e+14   106  8.9068e+12           Root MSE      =  2.7e+06

------------------------------------------------------------------------------
          RR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          SD |    1174992   536196.6     2.19   0.031     111448.4     2238535
          GF |   -3108049   953884.4    -3.26   0.002     -5000074    -1216024
          NM |   -1662875   539573.8    -3.08   0.003     -2733118   -592633.2
          NF |   -2999364   882991.8    -3.40   0.001     -4750774    -1247954
       _cons |    4701379   918609.9     5.12   0.000      2879321     6523437
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
          GF |      2.74    0.365447
          NF |      2.72    0.368057
          NM |      1.02    0.977780
          SD |      1.00    0.998115
-------------+----------------------
    Mean VIF |      1.87
```

While Government funding (GF) and No funding (NF) (with respect to Corporate funding), and need based mentoring (with respect to Monthly mentoring) have a negative influence, graduation (SD) has a positive influence on total revenue. All this implies that, graduated start-ups who have received corporate funding, and structured monthly mentoring have generated more total revenue in 2016/17 relative to those incubating start-ups, which have received need based mentoring and received either no funding or government funding.

However, what is more relevant for revenue generation is the R&D investment, R&D personnel employed, new products/services generated, patent application submissions, and the graduation of start-ups, in addition to the variables considered above. Therefore, it is important to examine how significant each of these variables and what influence do they have on total revenue generation. Accordingly, we carried out stepwise multiple regression analysis for equation number 7.6, and the results are presented in Table A4.27. The model is statistically significant as given by the F value, and it has a moderately high explanatory power of more than 51% as revealed by the adjusted R squared value. The model rejected 14 variables and retained five of the 19 explanatory variables, namely, RI, NF, GF, NM and SD. The problem of multicollinearity does not exists as the vif values for all the five variables ranged from a low of 1.00 to a high of 2.84, which are much lower than the threshold value of 10.

The results reconfirmed the results obtained from the previous regression analysis, after adding R&D investment as another variable influencing total revenue of start-ups. Thus, it is the start-ups which have received corporate funding with monthly mentoring support in the TBIs and then graduated and invested more in R&D capital expenditure (but not R&D personnel, new products/services and patent application submissions), which contributed to the total revenue generation of start-ups.

Table A4.27: Variables influencing Total Revenue generated by Start-Ups: Results of Stepwise Multiple Regression Analysis

```
. stepwise, pr(.05): regress RR RI RP NP PA SD AG FA EB IE SE ID IN AS EX ED NF GF NM WM
                      begin with full model
p = 0.8693 >= 0.0500  removing ID
p = 0.8665 >= 0.0500  removing EX
p = 0.6706 >= 0.0500  removing AG
p = 0.6486 >= 0.0500  removing SE
p = 0.6072 >= 0.0500  removing FA
p = 0.5422 >= 0.0500  removing EB
p = 0.6349 >= 0.0500  removing PA
p = 0.3715 >= 0.0500  removing RP
p = 0.3291 >= 0.0500  removing IE
p = 0.2592 >= 0.0500  removing NP
p = 0.1752 >= 0.0500  removing WM
p = 0.1082 >= 0.0500  removing ED
p = 0.2245 >= 0.0500  removing IN
p = 0.2284 >= 0.0500  removing AS

      Source |       SS       df       MS              Number of obs =     107
-------------+------------------------------           F(  5,   101) =   23.28
       Model |  5.0547e+14     5  1.0109e+14           Prob > F      =  0.0000
    Residual |  4.3866e+14   101  4.3431e+12           R-squared     =  0.5354
-------------+------------------------------           Adj R-squared =  0.5124
       Total |  9.4412e+14   106  8.9068e+12           Root MSE      =  2.1e+06

------------------------------------------------------------------------------
          RR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          RI |   .6065214   .0720058     8.42   0.000     .4636812    .7493615
          NM |   -1227911   418770.5    -2.93   0.004     -2058639   -397182.5
          NF |   -1775950   695408.5    -2.55   0.012     -3155453   -396446.4
          GF |   -2523163   737946.6    -3.42   0.001     -3987051    -1059276
          SD |    1062501   413189.3     2.57   0.012     242844.9     1882158
       _cons |    2432290   757053.9     3.21   0.002     930498.2     3934081
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
          NF |      2.84    0.352002
          GF |      2.76    0.362211
          RI |      1.08    0.923146
          NM |      1.04    0.962912
          SD |      1.00    0.997072
-------------+----------------------
    Mean VIF |      1.75
```

Appendix 5: Directory of Accelerators, Incubators and Co-working spaces in Bangalore, Chennai and Hyderabad

Introduction

The Department of Science & Technology (DST) has been compiling information on the addresses of Research & Development (R&D) institutions in the country since 1978 for conducting National level survey on resources (both financial and human) deployed on R&D activities. The present Directory is an initial and exploratory centralization of information on the 189 TBIs in the form of Phone no. /Fax no. / Email /Website.

The term TBI, used in this Directory refers to either a business incubator or a start-up accelerator or a co-working space which can be either private or Government funded unit. The Organizations under various classifications mentioned above are not homogeneous and are of varied sizes in terms of infrastructure, facilities and research inputs like manpower and expenditure etc. deployed on S&T activities. They are also not homogeneous in terms of research outputs such as patent grants, sales revenue generated out of new products and services, the number of new products and services created etc.

Organization of the Directory

The information in this Directory has been arranged city-wise and listing has been made based on the type of TBIs (accelerators, business incubators, or co-working spaces) within the city. This Directory has been divided into nine parts. Part I to Part III contains the information regarding the TBIs operating out of Bangalore with Part I detailing the information on the incubators, Part II detailing the listing of information on the accelerators and Part III presenting the information on the co-working spaces.

In similar fashion, Part IV to Part VI contains the information regarding the TBIs operating out of Chennai with Part IV detailing the information on the incubators, Part V detailing the listing of information on the accelerators and Part VI presenting the information on the co-working spaces. Part VII to Part IX contains the information regarding the TBIs operating out of Hyderabad with

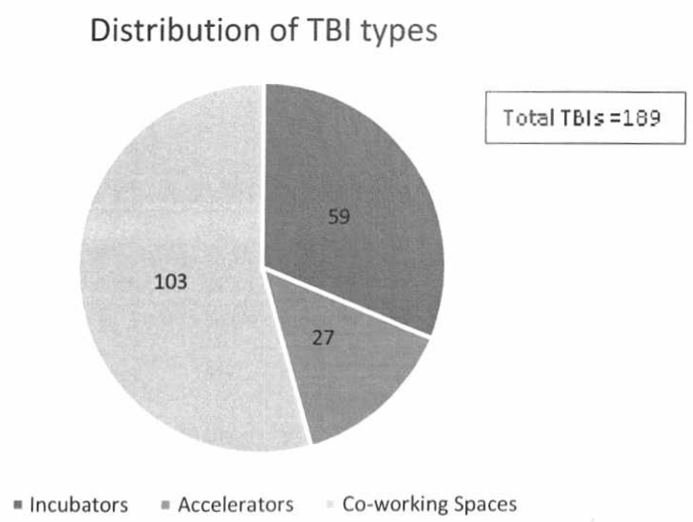
Part VII detailing the information on the incubators, Part VIII detailing the listing of information on the accelerators and Part IX presenting the information on the co-working spaces.

AN OVERVIEW

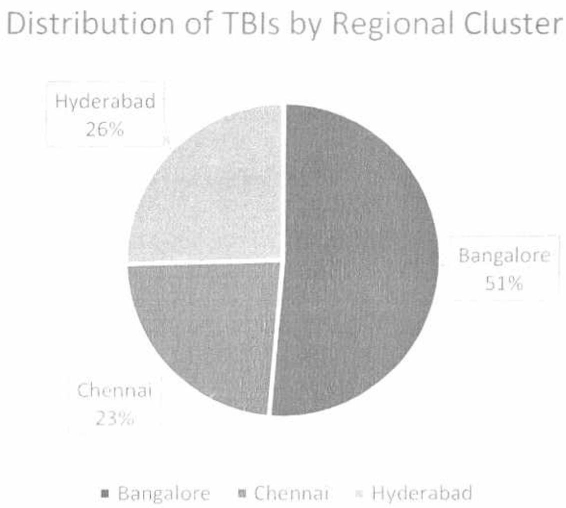
The Directory contains contact details of 189 TBIs operating across Bangalore, Chennai and Hyderabad. Bangalore has the maximum number of TBIs among the cities, with 97 TBIs (51%) being located in the city. This is followed by Hyderabad, which is host to 48 TBIs (26%) and Chennai that is home to 44 TBIs (23%) respectively. In case of the type of TBIs, the co-working spaces constitute the majority, with 103 (55%) being classified in this category. This is followed by incubators with 59 (31%) and accelerators with 27 (14%) being classified in their respective categories.

Summary Statistics of the TBIs curated for the Directory as of January 2018

TBI type	Bangalore	Chennai	Hyderabad	Total
Incubators	34	11	14	59
Accelerators	18	1	8	27
Co-working Spaces	45	32	26	103
Total	97	44	48	189

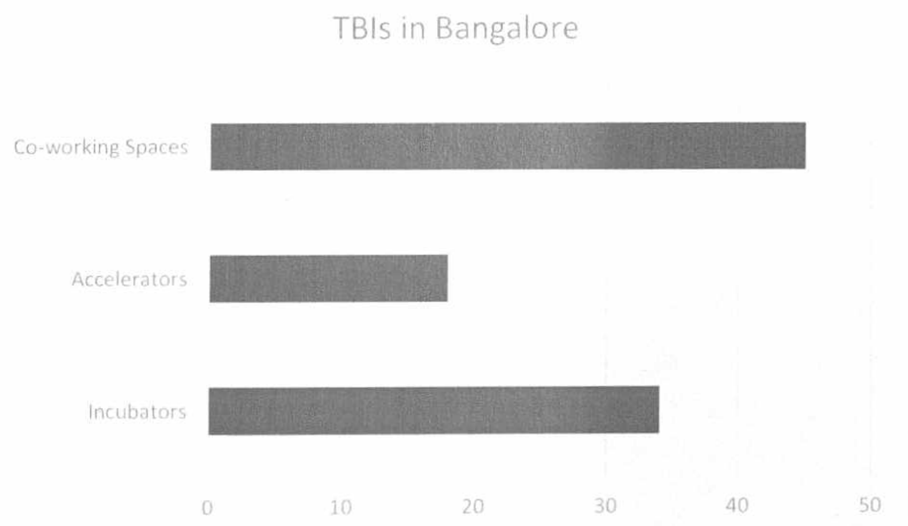


Note: The chart depicts status as on January 2018



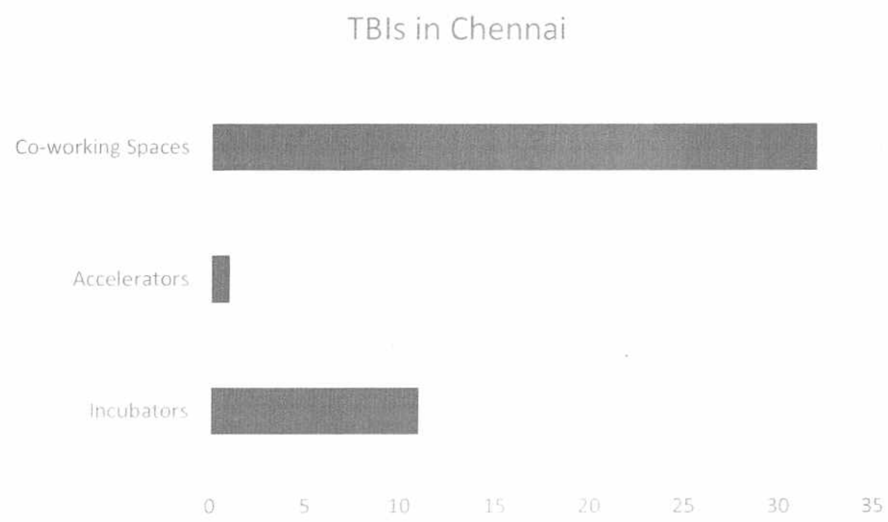
Note: The chart depicts status as on January 2018

Within Bangalore, out of the total 97 TBIs, 45 co-working spaces (46%) constitute the majority, followed by incubators represented by 34 entities (35%) and lastly by accelerators that constitute 18 entities (19%) respectively.



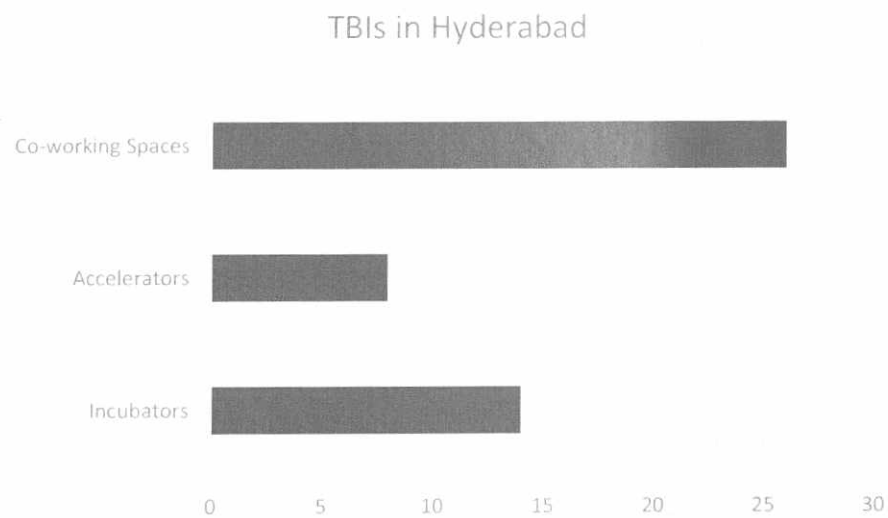
Note: The chart depicts status as on January 2018

In Chennai, 32 out of the 44 TBIs are co-working spaces (73%), followed by 11 incubators (25%) and 1 accelerator (2%) respectively.



Note: The chart depicts status as on January 2018

In Hyderabad, 26 co-working spaces (54%) form the majority of the TBIs, followed by 14 incubators (29%) and 8 accelerators (17%) respectively.



Note: The chart depicts status as on January 2018

Part – I: List of Incubators in Bangalore as on January 2018

Sl #	Name of Entity	Location
1	Bangalore Bioinnovation Center	Bangalore Bioinnovation Centre Bangalore Helix Biotech Park Electronics City Phase 1 Bangalore – 560 100 E mail: info@bioinnovationcentre.com Ph: +91 9483717532
2	buoyanci	#47, Byrasandra Main Rd, 1st Block East, 1st Block, Jaya Nagar East, Jayanagar, Bengaluru, Karnataka 560011 Phone: 098450 12560 Email id : info.buoyanci@gmail.com
3	C-CAMP	Centre for Cellular and Molecular Platforms NCBS-TIFR Campus, GKVK Post, Bellary Road, Bangalore 560065, India Telephone No: +91 80 67185100 Fax No: +91 80 2363 6662 Email: ccamp@ccamp.res.in
4	Composites Technology Park	BSM Extension, Kengeri Satellite Town, Bengaluru, Karnataka 560060 Phone: 080 6599 7605 Email id : drgopal@blr.vsnl.net.in
5	DERBI Foundation TBI	Dayananda Sagar University, 2nd Floor, Block 1,, Kudlu Gate, Hongasandra Village, Hosur Road,, Bengaluru, Karnataka 560068 Mail to: info@derbifoundation.com Phone: 080 4909 2961

6	Ehealth-TBI	A-Block, PIXEL Park, PES School of Engineering, 1 KM Before Electronics City, Hosur Road (NH-7), Bangalore - 560 100 Email: ehealthtbi@mail2business.com , contactus@ehealthtbi.in Telephone: 080-25743600
7	Excubator Consulting Private Limited	#758, 3rd & 4th Floor, 19th Main, Dollar Scheme Colony, HSR Layout, Sector 2, Bangalore, India – 560102 Phone : +91 80 41647830 Email id : contact@excubator.org
8	Global Incubation Services (GINSERV)	CA Site No:1, Behind Hotel Leela Palace, HAL 3rd Stage, 560008, HAL 2nd Stage, Kodihalli, Bengaluru, Karnataka 560017, India Phone: 080 2520 0916 Email: vinod@ginserv.in
9	GOK - NASSCOM 10000 Startups Warehouse	Lower Ground Floor, DD3, Diamond District ISRO Colony, Domlur, Bengaluru, Karnataka 560008 Email: kritika@nasscom.org Phone: 080 4169 3924
10	GOK NASSCOM – IAMAI Mobile 10X Incubator	Lower Ground Floor, DD3, Diamond District ISRO Colony, Domlur, Bengaluru, Karnataka 560008 Email: kritika@nasscom.org Phone: 080 4169 3924

11	GOK – Incubator for Tech Start-ups (GIFTS)	Lower Ground Floor, DD3, Diamond District ISRO Colony, Domlur, Bengaluru, Karnataka 560008 Email: kritika@nasscom.org Phone: 080 4169 3924
12	Green Bubbles	Green Bubbles Startup Services Pvt. Ltd., #L165, 1st Floor, Sri Gayathri Complex, HSR Layout Sector 6, Outer Ring Road Service Lane, Bangalore - 560 102 Ph: +91 80 3301 3359 contactus@greenbubbles.in
13	IIIT- Bangalore	26/C, Electronics City, Hosur Road, Bangalore - 560100 Phone: +91 80 4140 7777/ 2852 7627 Fax: +91 80 4140 7704 Email id : startup@iiitb.org
14	Incuabtion Center-IBAB	Institute of Bioinformatics and Applied Biotechnology Biotech Park Electronics City Phase I Bengaluru 560 100 India Tel: 080-285 289 00, 080-285 289 01, 080-285 289 02 Fax: 080-285 289 04
15	INDAVEST IT SERVICES(INDIA) PRIVATE LIMITED	660/1, 2nd Floor, Akshaya Building, 100 Feet Road, Indiranagar, Bangalore, Karnataka 560038 IN Email ID: rajavardhan@sipbooks.com Phone : +91 80 41483223, +91 80 25214126, +91 97395 89282

16	Khosla Labs	#18/2A, GRS Towers, Second Floor Above Spencer's HyperMart Sarjapur Road Bangalore 560103 Email id : contact@khoslalabs.com Phone : +91 80 46661029
17	kStart	Kstart Unit 02-01 & 27, Second Floor Ascendas Park Square Mall ITPB, Whitefield Road Bangalore, Karnataka 560 066 Phone : +91 080-67733000 Email : team@kstartcapital.com Fax : 080-67733050
18	M.S. Engineering College	Navarathna Agrahara, Sadahalli P.O., Off Bengaluru International Airport, Bengaluru - 562 110, Karnataka, INDIA Phone: +91 80 3252 9575 / +91 80 3252 9939 Email id : principal@msec.ac.in
19	MS Ramaiah Institute of Technology	Ramaiah Institute of Technology MSR Nagar, MSRIT Post Bangalore, PIN- 560 054 Karnataka INDIA Phone : +91-80-23600822/23606939 Email id : principal@msrit.edu
20	NSRCEL,IIMB	NSRCEL, Indian Institute of Management Bangalore, Bannerghatta Road, Sundar Ram Shetty Nagar, Bilekahalli, Bengaluru, Karnataka 560076 Phone : +91-80-26993701 Email id : nsrcel@iimb.ernet.in

21	National Design Business Incubator	B-112, Rajajinagar Industrial Estate Bengaluru - 560 044 F:+91-80-2340 8200 E:admin.ndbi.b@nid.edu
22	Nitte Meenakshi Institute of Technology	Nitte Meenakshi Institute of Technology, P.O. Box 6429, Yelahanka, Bangalore 560064. Ph: 080-22167800 E-mail: principal@nmit.ac.in
23	PES Institute of Technology	100 Feet Ring Road, BSK III Stage, Bangalore-560085 +91 80 26721983, +91 80 26722108
24	R V College of Engineering	Sri. A.V.S. Murthy Hon. Secretary, Rastreeya Sikshana Samithi Trust [RSST] Phone: 91-080-2656 2386 /2656 1777 Fax: 91-080-26568290
25	SeedFund	Lone Star, First Floor, #33, Promenade Road, Frazer Town, Bangalore 560 005 Phone: (+91) 80 41502412
26	Shirdi Sai Engineering College	Saileo Nagar, Samandhur(PO) Anekal ,Bangalore- 562106 Karnataka Email : info@ssec.ac.in Phone : 8110-7830221/7840631/32

27	Society for Innovation and Development	Innovation Centre Indian Institute of Science Campus Bangalore-560 012 Email id : office@sid.iisc.ernet.in Phone : 91 - 080 - 23442779
28	Srijan Capital	Sri Sai Complex, 1st Floor Pampa Extension, Hebbal Kempapura Bangalore - 24 Email id : ravi@srijancapital.com
29	Syndicate	#81/37, 2nd Floor, The Hulkul, Lavelle Road, Bengaluru, Karnataka 560002 Phone: 077607 00077 Email id : kmani@thesyndicate.tech
30	TATA ELXSI incub@TE	ITPB Road, Whitefield Bangalore 560048 India Phone : +91 80 2297 9123 info@tataelxsi.com
31	TBI- International Centre for Innovation	Prof. Dr. Paul C. Salins Vice Chairman, INCITE Technology Transfer and Entrepreneurship (IN-CITE) Narayana Hrudayalaya Hospitals, No.258/A, Bommasandra Industrial Area, Bangalore-560 099 Phone: 080-22142229 Fax: 080-22142228
32	Technovate Innovations	No. L-142, 5th Avenue, 5th Main, 6th Cross, HSR Layout Bangalore Bangalore KA 560102 IN Email id : v.rajendran@i2india.in P: +91 804-653-4800

33	Villgro	638, 7th Cross, 11th Main, Indirananagar, Bangalore – 560038 Phone : +91-80-41631523 Email id : info@villgro.org
34	WinTrans	# 334/28, 14th Cross Road,2nd Block, Jayanagar,Bengaluru, Karnataka 560011. Phone : +91 80 26572912 Email id : team@wintrans.co.in

Part – II: List of Accelerators in Bangalore as on January 2018

Sl #	Name of Entity	Location
1	Appy Hours	Head Office- Bangalore Appiness Interactive Pvt. Ltd. #414, 1st Floor,1st C Cross, 7th Block, Koramangala Bangalore - 560095 Phone : +91 80 41483788,+91 80 40980959 Email id : info@appinessworld.com
2	Axilor Ventures	15th Cross Rd, KR Layout, JP Nagar VI Phase, KR Layout, JP Nagar Phase 6, JP Nagar, Bengaluru, Karnataka 560078 Email id : accelerator@axilor.com Phone : 080 4925 2400
3	Brigade Real Estate Accelerator Program (REAP)	Brigade Gateway Campus, 26/1, Dr. Rajkumar Road, Malleswaram - Rajajinagar, Bangalore 560 055, India Email id : info@brigadereap.com Phone : 098451 79424
4	Catalyst SG-GSC Accelerator	10th floor, Voyager Building, ITPB Whitefield Road Bangalore, Karnataka 560066 India
5	Cisco LaunchPad	Cessna Business Park, KadubeesanahalliVarthurHobli, SarjapurMarathalli ORR BANGALORE, KARNATAKA 560 103 INDIA Email id : ind-innovation@cisco.com
6	Citrix Startup Accelerator	Prestige Dynasty, 33, Ulsoor Road, Yellappa Garden, Sivanchetti Gardens, YellappaChetty Layout, Bengaluru, Karnataka 560042 Phone: 080 3954 1000

7	GSF Accelerator	GSF, 505 Oxford Towers, 4th Floor 139, Old Airport Rd. Opp. Leela Palace Behind Maruthi Towers Bangalore, Karnataka – 560 071 Email id : pingus@gsfindia.com
8	Kyron Accelerator	Kyron Global, No. 164, 9th Cross, 1st Stage, Indira Nagar, Bangalore 560038. Phone : +91-80-41172134/135 E-Mail : sowmya.Keshava@kyronglobal.com
9	Microsoft Accelerator	Microsoft Ventures JNR City Center 30, Raja Rammohan Roy Road Bangalore – 560001 Email id: msvindia@microsoft.com Phone : +91 (80) 66586000
10	Netapp Excellerator	NetApp Bangalore Campus, ITPL Main Road, Hoodi, Bengaluru 560048 India Email: EV@netapp.com Tel: +91 80 61103000 Fax: +91 80 6616-6016
11	Oracle Cloud Accelerator Program	Prestige Tech Park, Marathahalli Outer Ring Road, Kadubeesanahalli Bangalore, India Phone : +1 800-392-2999 Email id : oraclesca_ww@oracle.com
12	Prime Venture Partners	Ground Floor, Alpha Block, Sigma Technology Park, Varthur Road, Phase 2,Whitefield, Bengaluru, Karnataka 560066 Phone: 078030 74662
13	Revvx	#536, 2nd Floor, Opposite Embassy Golf Links, Dell Office, 100 ft Inner Ring Road, Domlur, Bangalore 560034

		Email id : contact@revvx.com Phone : +91 9008511002
14	SAP Startup Studio	#138, EPIP Zone, Whitefield, Bengaluru, Karnataka 560066 Phone: 080 4329 4444
15	Shell Make the Future	Shell India Markets Pvt Ltd RMZ Ecoworld Campus 4A & 4B, SarjapurMarathahalli, Outer Ring Road Bangalore 560 103 Karnataka - India Phone : +91 80 4677 3333
16	Target Accelerator Program	Gregg W. Steinhafel Center, Manyata Embassy Business Park, SEZ Unit, Rachenahalli&Nagwara Village, Outer Ring Road, Bangalore, 560 045
17	Tlabs	TLabs Bangalore, 6th Floor, Salarpuria Tower, Hosur Main Road, Bengaluru, Karnataka - 560095 Email id : tlabs@tlabs.in Phone: 080 2550 1311
18	Thought Factory	Thought Factory, 2nd Floor, Tower D, Diamond District, Old Airport Road, Domlur, Bangalore - 560008 Email id : thoughtfactory@axisbank.com

Part – III: List of Co-working spaces in Bangalore as on January 2018

Sl #	Name of Entity	Location
1	Awfis	7th Floor, H.M. Vibha Tower, Hosur Main Road, Koramangala, Bangalore - 560029 Phone : +91 93412 21048, +91 73384 69219 Email id : vishal.bhardwaj@awfis.com
2	Bangalore Alpha Lab	1316/C, 9th Cross, JP Nagar 2nd Phase Bangalore 560078 Email id : bangalorealphalab@gmail.com Phone : +91 93412 12569
3	Bangalore Coworking Hub	2124,Behind Leela Palace Rd, HAL 3rd Stage, Kodihalli, Bengaluru, Karnataka 560008 Phone: 086382 68507
4	Bhive workspace	L-148, 5th Main, Sector 6, HSR Layout, Bangalore, Karnataka- 560102 (next to Madhuram Restaurant) Phone: 080888 22364 Email: sales@bhiveworkspace.com
5	Breathing Room	L-, 148, 5th Main Rd, Sector 6, HSR Layout, Bengaluru, Karnataka 560102 Phone : +91 84 52 037275 Email : hey@breathingroom.co
6	Church Street Social	46/1, Cobalt Building, Church Street, Bengaluru, Karnataka 560001 Phone: 080 4171 3016
7	Cohub India	Adress: #164,1st Cross, 1st Stage,Sanjaynagar, RMV II STAGE ,Bangalore E-mail:hello@cohub.in

8	Common Desk	1st Floor, 271, 14th Cross, Opp. Indiranagar Park, Near Motto Adda / Indiranagar metro station, Indiranagar, Bengaluru – 560038, Karnataka, India. Phone: +91 9611189911 Email: nudge@commondesk.in
9	Commune Coworks	139, First Cross Road, V Block, A Cross Road, Koramangala, Bengaluru, Karnataka 560095 Phine : 8880500175 Email : info@communecoworks.com
10	Construkt- Startup Hostel	#3097A, 6th A main, 13th cross, 2nd stage Indiranagar, Bangalore- 560038 command@construkt.me
11	CoWork247	1. WHITEFIELD - 6th floor, Gamma building, Sigma Technology Park, SH 35, Phase 2, Whitefield, Bengaluru-66 2. KR PURAM - 1st AA Cross, 201/202, 2nd Main, Kasturinagar, Main Road, Bangalore-43 3. INDIRA NAGAR - House No.264/265, 18th E Main, Hal 2 nd Stage, Bangalore 560008 Email id : hello@co.life Phone : +91 88846 00247
12	Cowork Café	COWORKCAFE, #28, OPP KANUA RESTAURANT, BEHIND BATA SHOWROOM, KAIKONDRAHALLI, BANGALORE - 560035 Phone : 808 884 4623 Email id : contact@coworkcafe.in
13	CoWorkIndia	#5, 14th Main Road, 15th Cross Rd, HSR Layout, Bengaluru, Karnataka 560102 Phone: 077601 51525 Email: sales@coworkindia.com
14	CoWrks	The Millenia Tower 'C' Plaza Level, Murphy Road, Ulsoor, Bangalore - 560 008, India. Phone : +91 88800 00220 Email id : communication@cowrks.com

15	Evoma biosphere	#14, BHATTARAHALLI, OLD MADRAS ROAD, BESIDES PASHMINA WATER FRONT, K R PURAM, BANGALORE-560049 Email id : inquiries@evoma.com Phone : +91 80 4190 3000
16	Fetchpod	Sneed Technologies Private Limited, First Floor, #1&2, Krishna Reddy Layout, Domalur, Bangalore - 560 071. Phone : +91 80 4098 60 60 Email : hello@sneed.in
17	GoodWorksCOWORK	4th Floor, Akshay Tech Park, Plot No. 72 & 73, EPIP Zone, Whitefield, Bangalore – 560066, India Phone: +91-8088707700 Email: contact@goodworklabs.com
18	Hacklab.in	4th Floor, CJR Arcade, Marathahalli - Sarjapur Outer Ring Rd, Bellandur, Bengaluru, Karnataka 560103 Email id : admin@hacklab.in Phone : +91-9538069129
19	Hustle	1. Hustle CoworkIndranagar Ixora Suits Building No.19, 9th Main, Indiranagar 1st Stage, Bangalore- 560038 Call: 9818819266 info@hustlecowork.com

20	Incubex	Coronet greens commercial complex 9/2, 2nd floor, above big bazaar sarjapur main road bengaluru - 560102 Landline: 91 80 41302180 Mobile: 91 9980862404 Email id : incubex.juststartup@gmail.com
21	Innvo8	#3, 20 Main Rd, Koramangala Industrial Layout, Koramangala, Bengaluru, Karnataka 560034 Phone: 099994 66688
22	IShareSpace	4th Floor, Prestige Towers, Residency Road, Shanthala Nagar, adjacent to Ritz Carlton, Bengaluru - 560025 Phone : +91 80-67699700/+91 9731993407 Email id : info@isharespace.com
23	IXORA COWORK	Sneed Technologies Private Limited, First Floor, #1&2, Krishna Reddy Layout, Domalur, Bangalore - 560 071. Phone : +91 80 4098 60 60 Email : hello@sneed.in
24	Jaaga Startup	5/1, Penthouse 01, 6th Floor, Rich Homes Apartment, Richmond Road, Bengaluru, Karnataka 560025 Phone:074119 67890 Email id : startup@jaaga.in
25	Let's START	# 205, 3rd Floor, SA Arcade, 24th Main, J P Nagar 5th Phase Bangalore - 560078 Phone : +91-9916175969 , +91 9902015240 Email : shashidhargj@lets-start.in, letsstart@lets-start.in
26	NextSpace	2nd Floor,, 780, 19th Main Rd, 1st Sector, HSR Layout, Bengaluru, Karnataka 560102 Phone: 083176 70586

27	NovelGroup	1. BTM Branch: Ground Floor, #10, 100 Feet Ring Road BTM Layout 1st Stage, Bangalore 560 068 2. Hosur Road Branch: 1st Floor, #46/4 GB Palya Hosur Main Road, Bangalore 560 068 3. Off-Richmond Road Branch: G Floor, #57, 13th Cross, Gajendra Nagar Baldwin Road, Bangalore 560 030 4. Off MG Road Branch: 8/2, Diagonally opp. to 1MG Mall Ulsoor Road, Off MG Road, Bangalore 560 008
28	Numa	Bengaluru, 46/1, 5th Floor, Church Street, Bengaluru, Karnataka Phone : Phone: 91-080-2656 2386 /2656 17
29	QkrDesk	JK HOUSE, #499 AmarJyothi Layout, 8th Main Road, Domlur 1 Stage, Bengaluru, Karnataka 560071 Phone: 080 6562 1005
30	QUEST	Raheja Towers, Level 10, 26-27 Mahatma Gandhi Road Place, Bengaluru, Karnataka 560001 Phone: 090660 20806

31	Regus	1. CBD Level 9 Raheja Towers, 26-27 Mahatma Gandhi Road, Bangalore, 560 001 2. The Estate, 8th Floor, Dickenson Road, Bangalore, 560042 3. Unit No 2201, 22nd Floor, World Trade Centre, Brigade Gateway Campus, RajajinagarExtn, Malleshwaram(W), Bangalore, 560055 4. RMZ Infinity, 1st floor, in Tower D, Municipal No. 3, Old Madras Road, Benniganahalli village, KrishnarajpuramHobli, Bangalore, 560016 5. Ground Floor, Beech, E-1 Manyata Embassy Business Park, Outer Ring Road, Nagawara, Karnataka, Bangalore, 560045 6. 1st & 2nd Floor IBIS Hotel, 26/1 Hosur Road, Bommanahalli, Karnataka, Bangalore, 560068 7. Embassy Tech Square, 1st floor, Tower Delta, Block B, Kadubeesanahalli Village, VarthurHobli, East Taluk, Bangalore 8. 2nd Floor, Prestige Omega, No. 104 EPIP Zone, Whitefield, Bangalore, 560066
32	Silicon Buisiness space	#156. 27th cross, 6th Block Jayanagar, Bangalore Email id : info@businessspace.co.in 91 080 41313200 Phone : +91 9916499990 +91 9986899994
33	Smart Spaces	#164, 8th Main Road, 2nd Block, Jaya Nagar East, Jayanagar, Bengaluru, Karnataka 560011 Phone: 096196 25196
34	Social Offline	46/1, Cobalt Building, Church Street, Bengaluru, Karnataka 560001 Phone: 080 4171 3016 Email id : hello@socialoffline.in

35	Solo Cubes	Sai Complex Museum Rd Haridevpur, Shanthala Nagar, Ashok Nagar Bengaluru, Karnataka 560001 PHONE : +91-9243498344 EMAIL : support@solocubes.com
36	Space Whiz	1. Jayanagar 2. RMV Extension 3. Srinivas Nagar 4. Sadashiv Nagar 5. Residency Road 6. Ganaga Nagar Phone : +91 90225 57557 Email : info@spacewhiz.com
37	Startup Cafe	#6, Above Airtel, Next to Maharaja Hotel, 80ft Road, Koramangala 4th Block Bangalore, India Phone : 099721 93005 Email id : contact@startupcafeindia.com
38	StartupHuts	2nd & 3rd Floor, #108, Opposite Corner House, 27th Main Road, Sector 2, HSR Layout, Bangalore-560102 Phone : 966 300 3001 Email id : info@startuphuts.com
39	Starttopia	Vinir Tower, No 6, BTM Layout, 100ft Main Road Bangalore, India Phone : 7899922033/9448342964 Email id : info@starttopia.com
40	TechHub	Prestige Blue Chip, No. 9 Hosur Road, Nr. Dairy Circle Bangalore 560 019 India Phone : 098866 07534 Email id : hello@techhub.com
41	TRINITY	#26 / A, 1st Floor, Patel Rama Reddy Road, Krishna Reddy Layout, Domlur, Bengaluru – 560071. Phone : +91 99003 19580 +91 99807 68689 Email : info@trinitycoworkingspace.in

42	Work-Adda	98/1 MMR Plaza, Above DCB Bank, Jakkasandra Bangalore, India Phone : 098860 51931 Email id : hello@workadda.biz
43	Workbench Projects	Halasuru Metro Station, Old Madras Road, Gupta Layout, Halasuru, Bengaluru, Karnataka 560008 Phone: 096630 90123 Pavan Kumar +91-9663090123 info@workbenchprojects.com
44	Work Shaala	N R Tower, 3rd Floor, 19th Main, 17th Cross Sector 4 HSR Layout, Bengaluru, Karnataka 560102 Phone: +91 9916 477 048 Phone: +91 80 64512555 E-Mail: contact@workshaala.com
45	91springboard	4th Floor, Salarpuria Tower -1, No. 22, Industrial Layout, Landmark: Forum Mall, Hosur Road, Koramangala, Bengaluru, Karnataka 560095 Phone: 090154 19191 Email: joinus@91springboard.com

Part IV: List of Incubators in Chennai as on January 2018

Sl #	Name of Entity	Location
1	Anna University TBI	Dr. S. Meenakshisundaram Business Manager Technology Business Incubator Centre for Biotechnology, Anna University , Chennai - 600025 Tel: 044 22350772, 98403 48173 Fax: 044 22350299 Email: meenakshi@annauniv.edu
2	Healthcare Technology Innovation Centre	Address: 3E, 3rd Floor, IIT Madras Research Park, Kanagam Road, Taramani, Chennai, Tamil Nadu 600113 Phone: 044 6646 9830 webmanager.dbt@nic.in
3	IIT Madras Incubation Cell (IITM-IC)	Module 2, D Block, Third Floor Phase II, IIT Madras Research Park Kanagam Road, Taramani Chennai - 600113, Tamil Nadu, India Email: office@incubation.iitm.ac.in Tel (O): 91 (0) 44 6646 9869
4	Sathyabama University-Technology Business Incubator (SU-TBI)	Dr. B. Sheela Rani, Vice Chancellor Email: kavi_sheela@yahoo.com Jeppiaar Nagar, Rajiv Gandhi Salai Chennai 600119, Tamil Nadu Phone:044-24503308, Fax: 044-24500646

5	SKR Engineering College	Address: Nazarathpet, (1.5 Kms from Poonamallee) Poonamallee, Chennai - 600 123 Phone: 044-26494205, 26273380 Email: admin@skrenggcollege.org
6	SPEC-TBI	The Project Manager Technology business Incubator St.Peter's Engineering College Avadi, Chennai – 600 054, Tamilnadu, India. Phone Phone:044 – 26557020 Fax Mobile: 91-9444933742 Email: info@spectbi.com
7	Rural Technology & Business Incubator	Module #6, I Floor IITM Research Park,Kanagam Road, Taramani Chennai - 600113 Phone : +91 44 66469872 Email : info@rtbi.in
8	Technology Business Incubator/ EDC	SSN College of Engineering Old Mahabalipuram Road Kalavakkam – 603 110 Tamil Nadu, India Phone: +91 44 27469700 Telefax: +91 44 27469772 Email: info@ssn.edu.in

9	The Startup Center	The Startup Centre Old No. 26, New No. 8, 1st Seaward Road, Valmiki Nagar, Thiruvanmiyur, Chennai 600 041 +91 (44) 39922601 hello@thestartupcentre.com
10	UOM-TBI	Dr. G. Gangi Reddy Managing Director Technology Business Incubator University of Madras, Dr.A L M PGIBMS, Sekkizhar Campus Chennai - 600 113 Phone : +91 44 2454 0038 Fax : +91 44 2454 0039 Email : tbi_unom@yahoo.com
11	Vel Tech –Technology Incubator	Vel Tech Technology Incubator No 42, Vel Tech Road, Avadi, Chennai – 600 062 Tamil Nadu Phone : 044 26840605 Fax : 044 26840605 E-mail : veltech@vsnl.com, presidentoffice@veltechuniv.edu.in Mobile : 9600040254 / 9940024007

Part V: List of Accelerators in Chennai as on January 2018

Sl #	Name of Entity	Location
1	Villgro	Chief Executive Officer Villgro Innovations Foundation III Floor, IITM Research Park, Kanagam Road, Taramani (Behind TIDEL Park), Chennai 600 113 Ph; 044 66630400 Email: info@villgro.org

Part VI: List of Co-working spaces in Chennai as on January 2018

Sl #	Name of Entity	Location
1	Adyar Coworking Space	No.5, LB Road, 1st Cross Street, Near Olympic cards and HDFC bank in LB road Indira Nagar Chennai
2	Airloyal	Address :56/21, Giriguja Enclave, 1st floor, 1st Avenue Shastrhi Nagar, Adyar, Chennai Phone :9840889955 Email :sheik@airloyal.com
3	Axis Business Centre	Address :No. 27, Vellalar Street, 4th Floor, Adambakkam Chennai Email :ayaz@axisconsultancy.co.in Phone :08939999806
4	Chennai Olympia	2nd floor, ALTIUS, Olympia Technology Park, 1 - SIDCO Industrial Estate Guindy Chennai Phone : + 91 44 4299 4299, 1800 209 4949
5	Chennai, Prince Infocity II	Prince Infocity II, Unit No. 1, 1st Floor, 283/3 & 283/4, Rajiv Gandhi Salai (OMR) Perungudi Chennai Phone :1800 209 4949 | + 91 22 4026 0000

5	Co working space	Address :#29,TNGO colony,West Karikalan St Adambakkam Chennai Phone :9962277324 Email :admn.apex@gmail.com
6	Dimension Coworking Space	83/14 Arcot Road Vadapalani Chennai Email :seshukarthick@dimensionsco.com Phone : 9962257775
7	Doxa Business Centre - OMR Chennai	#11, RatthaTek Towers GF, Rajiv Gandhi Salai OMR, Thoraipakkam, Chennai 600 097. (Landmark: Opp. Sangeetha Hotel) Office: +91 44 4927 5555 Emailid : contact@doxa.co.in
8	Hanu Reddy Business Center	Hanu Reddy Realty Business Centre No:14, 1st Street, Wallace Garden, Nungambakkam, Chennai-600006. Telephone:+91 44 43999555 E-mail: info@hrrbc.com
9	iKeva	Level 2, Agnitio Tech Park, Kandanchavadi, Perungudi, OMR, Near Rajiv Gandhi Salai Chennai, 600 096 91 44 6602 3299 91 44 6602 3290 contact@ikeva.com

10	IVS	Shyam Phone :9840473663 Address :3-F, 3rd Floor ,Gee Gee Emerald,151,Village Road Nungambakkam Chennai Email :shyam@ivsupport.com
11	Janus Info Park	Janus Info Park 10 Palandi Amman Kovil Street Adambakkam, Chennai - 600088 Tel: +91 9514400400 / 9514 200200 Contact: janusinfopark@gmail.com
12	Karya Space	78/132, Dr. RadhakrishnanSalai, Mylapore Chennai, Tamil Nadu 600004 India 098840 86725 Email id : cowork@karyaspace.com
13	MLS Business Centres	4 Venkatnarayana Road, T.Nagar Chennai Email : enquiries@mls-india.in Phone :044-6665 9003 / 3915 9003
14	New Version Studios	Srikanth Phone :9566034444 Address :#5, 45th Street, Thillai Ganga Nagar, Chennai 61, 1440 Sqft, Chennai Thillai Ganga Nagar Chennai Email :srikanthkarthikeyan@hotmail.com
15	Opennovus Sharing Office Space	Ramamoorthy Avenue Sakthi Nagar Porur Chennai

16	Pixel Soft	Murali Phone :9841618155 Address :No 6A, 2nd Floor, 2nd Main Road, Mahalaxmi Nagar Adambakkam Chennai Email :pixelmurali@gmail.com
17	Regus	1. Prince InfoChennai II, Unit No. 1, 1st Floor, 283/3 & 283/4, Rajiv Gandhi Salai (OMR), Perungudi, Chennai, 600 096 2. Samson Towers, 8th Floor at Pantheon Road, and Casa Major Road, Block No.31, Egmore Village, Chennai, 600 008 3. KRM Plaza, South Tower, 8th Floor, No.2, Harrington Road, Chetpet, Chennai, 600031 4. Level 6, Chennai Citi Centre 10/11, Dr.RadhakrishnanSalai, Chennai, 600 004 5. 'Amara Sri", situated at Old No.313, New No.455, Block No.75, 7th Floor, Anna Salai, Teynampet, Chennai, 600018 6. 3rd Floor, Shyamala Tower, No. 136, Arcot Road, Saligramam, Chennai 7. 2nd floor, ALTIUS, Olympia Technology Park, 1 - SIDCO Industrial Estate, Guindy, Chennai, 600 032 8. Olympia Platina, 9th Floor, Plot Nos.33-B, South Phase, Guindy Industrial Estate, Guindy, Chennai, 600 032 9. RMZ Milenia Business Park, Phase 2, Campus 4B, 6th Floor, Unit 602A, No 143, Dr. M.G.R Road, (North VeeranamSalai), Kadanchavady, Perungudi, Chennai, 600 096
18	Rhytha Shared Office	Muthukumar Prakasam Phone :9840702274 Address :2/268, 1st Floor, 1st Main Road Mogappair Chennai Email :mk@rhytha.com

19	Skietech	Suresh Phone :9003023620 Address : No:47,Nerkundram padhaiVadapalani Chennai Email :suresh@skietech.in
20	Sharing Based Office Space	Arun Phone :9884848198 Address :jones road Saidapet Chennai Email :yes3info@gmail.co
21	Sharing Based Office Space-Adambakkam	Vijay Phone :9790888830 Address :Near St.Thomas Mount Railway station, Next to GUINDY, Land Mark Behind NGO Colony Bus DepoAdambakkam Chennai Email :vijay.babu008@gmail.com
22	Shared Workspace for Startup Business	PRAKASH Phone :9500501421 Address :625, Surya Complex, Thousand Lights Anna Salai Chennai Email :prakash@launchpd.com
23	Shared Workspace-Naganullar	Sivathanu Phone :919840378332 Address :Plot 2, Iyyappanager, Duraiswamy garden, Nanganullar Chennai Email :siva@neelsoftware.com
24	Spaces	SPACES EXPRESS AVENUE EA Chambers Tower II, No.49/50L, Whites Road Royapettah, Chennai, Tamil Nadu 600002, India Phone: 1800 209 4141 Email: reception.expressavenue@spacesworks.com

25	Spaceterior	SanthoshYelchur Phone :9841412384 Address :84E/7, Sampoorna Avenue Kodambakkam Chennai Email :yelsanthosh@gmail.com
26	Stone sketch solutions pvt. ltd.	AkashPurohit Phone :9840389826 Address :2 east karikalan second street Adambakkam Chennai Email :akashpurohit6@gmail.com
27	SwaStart	28 KR Ramasamy Nagar Velachery Main Road Chennai 600 042 INDIA Diagonally opposite The Westin Hotel Call: +9144 4201 4700 or +91 8939 414 717 Email: hello@swagene.com
28	TheWorks@ OMR	Old Mahabalipuram Rd Tirumalai Nagar, Perungudi Chennai, Tamil Nadu 600096 +919677052094
29	Vatika Business Center	Vatika Business Centre, Prestige Polygon, 3rd Floor, 471 Anna Salai, Mount Road, Teynampet Chennai Email :vbc@vatikagroup.com Phone :1800-3000-3773
30	WorkHub	Ayaz Mohammad Phone :8939999806 Address :No. 27, Vellalar Street, Adambakkam Chennai Email :ayaz@axisconsultancy.co.in
31	Workspace	VIDHYA Phone :04442030161 Address :21/16, Cenotaph Road, 1st Street Teynampet Chennai Email :info@icubeprojects.com
32	#MyOffice	Basker N Phone :9840364961 Address :3-A, 3rd Floor ,Gee Gee Emerald,151,Village Road Nungambakkam Chennai Email :natesanbasker@gmail.com

Part VII – List of Incubators in Hyderabad as on January 2018

Sl #	Name of Entity	Location
1	Association of Lady Entrepreneurs of India(ALEAP)	Survey No.342, ALEAP Industrial Estate, Near PragathiNagar,Kukatpally Hyderabad 500072,A.P, India Tel: +91-7036666421,7036666422 email id : aleap93@gmail.com
2	ARCI Technology Incubator	Balapur P.O., Hyderabad - 500005,Telangana, India. EPABX : 0091 - 040 - 2445 2200 Fax : 0091 - 040 - 2444 2699 info@arci.res.in
3	Birla Institute of Technology and Science, BITS-Pilani	1. Prof. Arya Kumar Coordinator,Chief, Entrepreneurship Development & IPR Unit, BITS Pilani, 333 031 Rajasthan Tel: +91-1596-51-5257 Fax: 91 01596 244183 Email: aryakumar@pilani.bits-pilani.ac.in 2. Dr. Anu Gupta Program Manager, TBI@BITS EEE Group BITS PilaniPilani 333031 Phone: +91-1596-51-5280 Fax: 91 01596 244183 Email: anug@pilani.bits-pilani.ac.in

4	Business Incubator-Indus Entrepreneurs(TiE)	C/o P. S. Sreekanth, Head, TiE-Hyderabad, Investment Director, Hyderabad Angels, Hyderabad
5	Dlabs	AC2 Level 1, Indian School of Business Gachibowli, Hyderabad - 5000032 Phone: +91 40 2318 7291 Email: CIE@isb.edu
6	International Institute of Information Technology (IIIT-H)	Gachibowli, Hyderabad Phone: 040 6653 1000 Email : contact@iiith.org
7	Instill.motion	5th floor, Plot No.29, Road No.76, Opp. Mahaa TV Office, Jubilee Hills, Hyderabad - 500033 contact@instillmotion.net
8	J.N.T.U.H. College of Engineering	Co-ordinator, Entrepreneurship Development Cell Mechanical Engineering Block JNTH Kukatpally,Hyderabad, Telangana PIN : 500085. Tel/ Fax : +91-40-2305 2650 (Direct); Phone:23158661 Ext: 4560 e-mail id: edc.jntuh@jntuh.ac.in
9	Life Science Incubator (LSI)	IKP Knowledge Park Genome Valley Turkapally, Shamirpet Medchal-Malkajgiri District Hyderabad-500 101 Telangana India T: +91 (40) 23480006 / 23480090 F: +91 (40) 42018082 email id : info@ikpknowledgepark.com

10	National Academy of Agricultural Research Management (NAARM)	Dr. R. Kalpana Sastry DIRECTOR Rajendranagar,Hyderabad 500030,Telangana, India 091-40-24581300/333 091-40-24015912 Email id : director.naarm.ernet.in
11	Progress Incubator	18 iLabs Centre, Building 3, Inorbit Mall Road, Madhapur, Hyderabad, Telangana 500081 Email : ravi@startuphyderabad.com Phone : 040 4048 4444
12	Technology Business Incubator-UOH	1. Prof. V. VenkataRamana Co-ordinator, TBI-UoH & Professor, School of Management Studies Tel. 040-23135002 Mobile: 09440482232 Fax. 040-2301191 E-mail: vvrms@uohyd.ernet.in vedulla@hotmail.com 2. Dr. B.S. Rama Krishna Administrative Co-ordinator, TBI-UoH Tel. 040-23137551 Mobile 09885040914 Fax. 040-23011091 E-mail: admintbi@uohyd.ernet.in dr.ramakrishna@gmail.com
13	T-Hub	IIIT-H Campus, Gachibowli, Hyderabad, Telangana 500032 sharma.as@t-hub.co.in Ph No. : 040-11111111
14	Wavelabs	Plot No. 7, Jubilee Enclave, Opp. Hitex Entrance, Hitech City, Hyderabad-500081 Call : 040 23542944 info@wavelabs.in

Part VIII – List of Accelerators in Hyderabad as on January 2018

Sl #	Name of Entity	Location
1	Aavishkaar	International Institute of Information Technology (IIIT-H), Gachibowli, Hyderabad Phone: 040 6653 1000 Email : contact@iiith.org
2	Business Accelerator-Indus Entrepreneurs(TiE)	C/o P. S. Sreekanth, Head, TiE-Hyderabad, Investment Director, Hyderabad Angels, Hyderabad
3	Catalyzer Startup Accelerator	2nd Floor, Plot # 309 Walden's Path, Road Number 78 Jubilee Hills, Hyderabad, Telangana 500033 info@catalyzer.co
4	SPARK10	SPARK10, ESCI Campus, Old Bombay Road, Gachibowli, Hyderabad, Telangana 500032, INDIA +91 40 64441919 email id : info@spark10.com
5	UPTEC IDEALABS	Plot #31, 4th Floor, Leeven Heights, Jubilee enclave, Hitec City, Hyderabad, Telangana 500081 +91 98484-48538 info@uptecidealabs.com
6	Utthishta	2ND FLOOR, CENTRUM COMMERCIAL COMPLEX PHASE 182,KPHB COLONY, KUKATPALLY HYDERABAD Kurnool TG 500072 IN email id : ramakrishna@utthishta.com

7	Wavelabs	Plot No. 7, Jubilee Enclave, Opp. Hitex Entrance, Hitech City, Hyderabad- 500081 Call : 040 23542944 info@wavelabs.in
8	50k Accelerator	Plot No. 7, Jubilee Enclave, Opp. Hitex Entrance, Hitech City, Hyderabad- 500081 Call 040 23542944 info@wavelabs.in

Part IX: List of Co-working spaces in Hyderabad as on January 2018

Sl #	Name of Entity	Location
1	Attapur	Chary Phone :9160992704 Address :4-6-155/A Attapur Hyderabad Email :kbchari81@gmail.com
2	Autonetic	Prity Phone :9394304971 Address :Hitech City, OppRahejaMindspace Hi-Tech City Hyderabad Email :prity.r@gmail.com
3	B2B Sales & Marketing	1st Floor, Above More Supermarket, Main Road S.R. Nagar Vengal Rao Nagar Hyderabad
4	CoKarma	309, Liberty Plaza 3-6-365, Himayat Nagar Hyderabad +91 99 89 016041 dropin@cokarma.in
5	Collab House	66A, 3rd Floor, Above Syndicate Bank Road No. 70, Journalist Colony Jubilee Hills Hyderabad 500 033 Phone : +91 9985258603 Email : hello@collab.hous
6	Co.Lab.Orate	103, New Mark House, Patrika Nagar, HiTechCIty Main Road, Hyderabad, Telangana India - 500033 09985190006/04/02 admin@colaborate.in

7	Cowork Zone	100 feet Road, HitecCity,Hyderabad Call 093910 35140 info@coworkzone.in
8	Fireminds	SUJAIN Phone :88866629987 Address :Road no 9 ,Shantiniketan Colony, Secunderabad, Telangana 500026, India, Mahindra Hills Rd, hyderabadGachibowli Hyderabad Email :fireminds91@gmail.com
9	HatchStation	19/3RT, Prakash Nagar, Begumpet, Hyderabad - 500016 +91 90325 90328 hatchstation@gmail.com
10	Ideapolis	Sekhar Phone :8500985110 Address :202, Siri Arcade, Opp.Bio-Diversity Park, GachibowliGachibowli Hyderabad Email :ideapolis.in@gmail.com
11	iHub	Phone : +91-9652419892 Address :iHub Jubilee Hills 4th Floor, Tirumala Mansion Plot 120, Kavuri Hills, Phase – I Jubilee Hills Hyderabad Email :hello@ihubhyd.com
12	iKeva	iKeva, Road no.10, Banjara Hills Hyderabad Call 040 4646 4889 contact@ikeva.com
13	IT INCUBATOR	VineelaJayant Address :Opposite Shopper's Stop Begumpet Hyderabad Email :vineelajayant@gmail.com

14	Krishe Sapphire	Phone : 1800 209 4949, + 91 22 4026 0000 Address :7th Floor, South Wing, Krishe Sapphire, Hitec City Main Road, Madhapur Village, 88, Serilingampally Mandal, Ranga Reddy District Madhapur Hyderabad
15	Mid-Town	Address :1st Floor Mid Town Plaza, Road No 1 Banjara Hills Hyderabad Phone : +91 40 4433 4433, 1800 209 4949
16	Mindspace	Phone : +91 40 4033 9900 Address :Level 7, Maximus Towers, Building 2A, Mindspace Complex, Hi-Tech City Hyderabad
17	OurHub	Plot no 909, Ayappa Society, Madhapur Hyderabad Call 090327 62521 vivek@startups.in
18	Raccord Space Sharing	Afroz Phone :09000198939 Address :6-3-347/1/N, 1st Floor, NV Plaza, Model House Lane, Dwarakapuri colony, Punjagutta, Hyderabad Punjagutta Hyderabad Email :Mdafroz99@gmail.com
19	Regus	Manjeera Trinity Corporate, Plot No S2, Survey No.1050 Unit No. 810 & 811, Kukatpally, JNTU Road, Ranga Reddy District, Telangana State, Hyderabad, 500072 Call:1800 209 4949
20	Rent A Desk	Babukhan Rasheed Plaza, Plot # 682, 5th Floor, Road # 36, Jubilee Hills, Hyderabad +91 98 85 421400 info@rentadesk.in

21	Sorokasoft India Private Limited	Phone : 91-40-65793268, 9866319178 (HR, F&A), 9866699781(Customer Support & Business Development) Address :LSPC Mansion, H.No: 3-201, HIG, Lane Opposite Lakshmi SBI Homes, HUDA, Mayuri Nagar Miyapur Hyderabad Email :info@sorokasoft.com
22	Teetos Business Centre	4th floor, Shri Prashanti Sai Towers, Plot No. 68, Nagarjuna Hills, Road No .1 Banjara Hills, Near Punjagutta, Hyderabad - 500081, Telangana, India +91 40 66778788 / 89 info@teetos.com
23	The Valley	8-2-351/GG6, Road no. 3 ,banjarahills Hyderabad Call 080087 99756 sharjeelsidd808@gmail.com
24	Unispace Business Center	Office No: 303 & 305, Plot No: 32-34 & 39-41, KTC Illumination Image Hospital Road, Gaffoor Nagar, Madhapur Hyderabad - 500 081. 9100080011 info@unispacebc.com
25	Vatika Business Center	Phone : 1800-3000-3773 ,+91-40-4431 1103 Address :NSL ICON 3rd Floor, NSL-ICON Plot No. 1-4 Road No. 12, Banjara Hills Hyderabad Email :vbc@vatikagroup.com
26	91 SpringBoard	Plot No-44, Phase I Kavuri Hills Hyderabad 500033 Phone: +91-9015419191 Email: joinus@91springboard.com

Appendix 6: Summary of Proceedings of the Workshop on TBIs and their contributions to National R&D Efforts

A workshop titled "TBIs and their contributions to National R&D Efforts" was held on 6th July 2018 at the Department of Management Studies, Indian Institute of Science, Bangalore, in connection with this R&D Project sponsored by NSTMIS, DST, Government of India, New Delhi. The primary objectives of this workshop was to disseminate the findings and outcomes of the project to a curated audience of 40 people that comprised of LPAC members of this project, academicians, stakeholders of the entrepreneurial ecosystem which included entrepreneurs, CEOs of the TBIs, incubating and graduated startups at the TBIs, selected respondents to the project among others.

The workshop began at 9:30 AM, with Prof. M. H. Bala Subrahmanya, Principal Investigator of the project welcoming the delegates and LPAC members. As part of the inaugural ceremony, Dr. A. N. Rai, Director, CHORD, DST, Govt. of India provided insight into the context and importance of the Research Project to the delegates. Dr. Parveen Arora, Advisor and Head, CHORD, DST, Govt. of India explained to the delegates on how this project was conceived, and how it fits to the overall R&D related monitoring programs conducted by the Govt. of India under the supervision of his division. Dr. Prahlada Ramarao, Chairman of the LPAC addressed the delegates and provided his insights on this emerging field of TBIs, and how they could be vehicles of new R&D outputs and innovation for our country. Prof. Parthasarathy Ramachandran delivered the Vote of Thanks for the Inaugural Ceremony, and concluded the first session of the workshop.

Prof. M. H. Bala Subrahmanya then provided a deep dive on the various aspects of the research project, primarily sharing the outputs, inferences, analysis and observations from the data collected during the course of the project work. The delegates and LPAC members provided their inputs and feedback on the presentation, which was noted by the project team for rectification/clarification.

During the afternoon, two panel discussions were held, involving four experts in each panel. The first panel deliberated upon the differences and similarities between Accelerators, Business Incubators and Co-working spaces as an institutional mechanism for start-up creation. This panel was moderated by Prof. S. Rajagopalan, Head of IIIT Bangalore Innovation Centre. Dr. Lakshmi Jagannathan, COO of DERBI Foundation Incubator in Bangalore, Dr. Prahlada, Chairman of LPAC, Mr. V. Rajaram, CEO of the Veltech TBI, Chennai were the panelists. The second panel was moderated by Mr. Lokesh V of Innomantra Consulting, with Dr. Gayatri Saberwal, Dean (Academic Affairs), IBAB, Bangalore, Dr. Ramakrishna, Co-ordinator of University of Hyderabad TBI, Dr. Ravikumar M V, Advisor to Indo-Korea Science and Technology Center, Bangalore being the panelists.

Key takeaways from the workshop are presented as below:

1. There is a need for further research on many different aspects related to TBIs – such as
    a. how are the TBIs helping reduce the mortality rate of startups (micro details),
    b. would pre-incubation help the TBIs in generating a robust pipeline of healthy start-ups,

c. would co-incubation (two or more TBIs collaborating with each other and supporting the same startup to meet its diverse needs) help overcome the initial challenges of the incubating startups etc.

2. Among the TBIs that are operating well, the aspect of leadership and vision at each of these TBIs also needs to be probed and ascertained if they impact the R&D inputs and outputs generated.
3. Patents and patenting activity of incubating startups may not be a very good measure of R&D outputs, since the startups in the very initial stages would focus their energies on getting the product and market fit, as against getting distracted in managing their IP.
4. Can the Government further refine their policy support based on sectors that have different innovation intensity was another input provided by the delegates of the workshop. For example, in emerging areas such as Nano-science, IoT, Artificial Intelligence and Machine Learning, should the Government come up with specific policies to support these sectors was debated.
5. Modes, mechanisms and approaches to sustain TBIs operationally, after the cessation of Government grants were discussed. CEOs of TBIs who were part of the delegates explained how they are currently trying to address this aspect and shared some approaches that have worked for them.

The workshop concluded at 4:30 PM with a note of thanks to all the LPAC members and delegates who participated.