IT Spending Patterns and Technological Adoption Among Indian Startups: An Empirical Analysis

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ABSTRACT

This paper involves an in-depth empirical investigation of IT expenditure behaviour, technological adoption, and expansion patterns of 590 Indian startups in 22 states and 33 industry categories. Based on multi-dimensional data set including IT spending, number of active technology stacks, patent portfolio, investor portfolio, and venture capitalization patterns, the study uses descriptive statistics, Spearman rank-order correlation, and one-way ANOVA to identify structural patterns in digital investment. The main results show that IT spend is highly right-skewed (mean: USD 3.51 million; median: USD 430,502), with a very high heterogeneity among the sectors: Hardware (mean: USD 22.06 million) and Clothing & Apparel (USD 15.60 million) have become the most IT-heavy sectors, yet Commerce and Shopping has a relatively low average, although it occupies 37.3% of the sample. Maharashtra, Delhi, and Karnataka constitute 44.2 percent of all startups, with Haryana registering the most avenues on IT expenditure per firm (USD 7.21 million), on average. Active technology count (rho = 0.186, p < 0.001) and total active products (rho = 0.248, p < 0.001) are statistically significantly positively correlated with IT spend, but the number of investors is moderately positively correlated (rho = 0.277, p < 0.05). The article is also part of the growing research on the issue of startup resource allocation in emerging markets and has practical implications to policymakers, venture capitalists, and the organizers of startup ecosystems..

1. INTRODUCTION

The Indian startup ecosystem has become one of the most vibrant innovation spaces in the world and plays an important role in generating employment, driving productivity, and transforming digitally. India is a promising natural laboratory to study how early, and growth-stage companies use their resources to build competitive advantage in the knowledge economy based on information technology (IT), a pillar of competitive advantage (Bharadwaj, 2000; Loof and Heshmati, 2002).

IT spending choices are not only the operational choices of startups, but they are also the strategic orientation of the firm, its level of technological maturity, and its ability to grow. In developed economies, the linkage between the investment of IT and the performance of firms has been well researched (Brynjolfsson and Hitt, 1996; Melville et al., 2004). Nevertheless, there is limited literature available on the IT spending on start-ups in emerging markets, and especially in India, which is a major gap in the intersection of entrepreneurship, innovation management and information systems literature. The given paper fills this gap by analysing a dataset of 590 Indian startups in 22 states and 33 industry sectors.

The main research questions that will be used to answer this question are:

(1) How does IT expenditure differ by industry sectors and geographic locations among Indian startups?

(2) What are the organizational and technological attributes that have strong correlations with IT spend?

(3) Is there growth score tier and funding stage moderations of the level of IT investment?

The results will be used to guide the formulation of digital infrastructure support initiatives, venture due diligence models, and industry-specific startup development policies.

2. LITERATURE REVIEW

The interconnection between IT investment and firm performance has been studied in a considerable amount of literature. Brynjolfsson and Hutt (1996) reported positive and statistically significant payoff on IT capital which later meta-analysis supported (Kohli and Devaraj, 2003). IT capabilities are additionally surrounded by the resource-based view (Barney, 1991) which shows that it becomes a source of sustained competitive advantage when it is rare, valuable, and difficult to copy. The IT expenditure in the context of startup will play a dual role: it facilitates efficiency in the operations and indicates seriousness in technology to the external stakeholders such as investors and customers.

The Indian startup ecosystem is admittedly growing because of the combination of the demographic gain, the sudden rise in digital infrastructure, and the strategic government actions like the Startup India programme (DPIIT, 2016) and the Digital India programmes in general. Existing academic research has identified the geographic clustering of nascent firms around Tier-1 metropolitan centers, such as Bangalore, Mumbai, and the Delhi-NCR complex, as well as revealed additional analytical benefits of incubators, accelerators, and venture-capital networks in defining firm paths (Agrawal et al., 2017). However, a significant gap continues in the literature on the differences in the patterns of IT expenditures of various industries, sizes of firms, and various phases of funding in this booming ecosystem.

Technology adoption theories including Technology Acceptance Model (TAM; Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003) have traditionally focused on the individual level of technology acceptance. Nonetheless, current research at the firm level, especially in the emerging economies, shows that uptake of technologies is impeded by factors like lack of access to capital and underdeveloped technological platforms as well as the poor quality of human capital (Kshetri, 2007; Qiang et al., 2006). The contextual pressures that start-ups face within the Indian setting are unique in nature, and they may comprise infrastructural shortages, complex regulatory systems, and consumer heterogeneity. The combination of these factors affects the approach that companies take towards information technology investments, both in strategy and in finance. The proposed research aims to build upon the available existing literature by modeling IT spend as a practical, empirical measure of the level of technology adoption and, therefore, offer a measurable metric of how companies are coping with the above constraints.

Although a abundance of literature is available on Indian entrepreneurship, there are no systematic quantitative studies on information technology spending, either as a dependent variable or as an independent variable. The available empirical work extensively embraces survey tools and qualitative case-studies, thus restricting the range of inference and scope of generality of their findings. The current investigation fills this gap by utilizing a strong secondary data consisting of 590 separate start-ups and thus is able to afford the methodological paradigm of comparative analysis within the sector and regionally situated.

3. DATA AND METHODOLOGY

Data Source and Sample:

The data used in this empirical investigation was purchased through an exclusive database that tracked startup knowledge where Crunchbase data was consolidated to cover venture-related information in the Indian business. We reached the maximum point in our sampling strategy to have the cohort of 590 firms that provided all documentation on critical variables of information technology spending, list of technologies in operation, number of investor affiliations, list of operational products, and overall funding measures. These are young enterprises that are spread in 22 Indian states and union territories, representing 33 different industry clusters, thus, providing a strong representation of the national start up ecosystem.

Variable Operationalization:

The variable of most interest, IT Spend, refers to the amount of IT spending estimated annually on a per enterprise basis in the U.S. dollars. Active Technology Count is a list of specific technological solutions that the firm is actively utilizing. Number of Investors is a measure of the number of relationships that the company has with institutional and individual investors. The level of product diversification is operationalized in Total Active Products. Growth Score Tier will categorize firms into High, Medium and Low using a composite growth scoring methodology. Funding Status as well as Last Funding Type define the line of the firm in the continuum of the stages of venture financing.

Analytical Methods:

Considering the non-normality of IT spend (Shapiro-Wilk test, $p < 0.001$) and the ordinal nature of variables, non-parametric methods of statistics are used. Spearman rank-order correlation coefficient (ρ) is applied to test bivariate relationships between IT spend and count or continuous variables. One-way analysis of variance (ANOVA) is used to test the differences in mean IT spending in the Growth Score Tiers. The central tendency and dispersion are described using

descriptive statistics such as mean, median, and standard deviation. All the analyses have been conducted in SPSS version 23.

4. RESULTS

Sample Characteristics and Distribution of IT Spend:

The sample of 590 Indian startups presents high levels of heterogeneity regarding IT expenditures. Table1 provides the descriptive statistics of the key numerical variables. The mean IT spending measures USD 3.51 million; however, the median of USD 430,502 and standard deviation of USD 25.37 million is a strong right skew due to few outliers that spend high amounts of money. The highest IT expenditure is USD 415.67 million, which is attributed to a transport conglomerate of large scale. The average number of active technologies in a firm is 18.79 (SD 19.64), average number of investors in financed firms is 0.3220 (SD 1.11846).

Table 1: Descriptive Statistics of Key Numerical Variables

	IT Spend(USD)	Active Tech Count	Number of Investor	Total Active products	Number of Apps
Mean	3,509,921.4475	18.2814	.3220	6.8932	2.8746
Median	430,502.5000	11.0000	.0000	.0000	.0000
Std. Deviation	25,367,806.77718	19.60888	1.11846	10.55363	21.26288
Minimum	12,7110.00	.00	.00	.00	.00
Maximum	415,670,680.00	106.00	10.00	70.00	454.00

Industry-Wise IT Spend Analysis

Table 2 indicates the distributions of startups and average IT expenditures of the top twelve industry groups. The largest proportion (n = 220; 37.3% of the sample) is the segment of Commerce and Shopping. However, its average IT expenditure (USD 1.03 million) is considerably lower than the general mean, implying that a large number of e-commerce players are still, on a small scale. Conversely, Hardware (USD 22.06 million), Clothing and Apparel (USD 15.60 million), and Transportation (USD 11.79 million) carrying the highest mean expenditures; the latter reflect the high intensity of capital required by the physical-digital hybrid-based operations. Artificial intelligence and Data analytics firms have IT expenditure of USD 6.97 million and USD 3.71 million respectively, which is consistent with the heavy usage of the compute and data-infrastructure needs of these firms.

Table 2: IT Spend by Industry Group (Top 12 by Count)

Industry Group	n	% of Sample	Mean IT Spend (USD)	Median IT Spend (USD)
Commerce and Shopping	220	37.3%	1,025,495	398,804
Apps	82	13.9%	1,985,164	522,948
Transportation	48	8.1%	11,792,670	367,426
Education	39	6.6%	1,817,987	319,738
Clothing and Apparel	29	4.9%	15,603,740	395,010
Advertising	27	4.6%	2,087,557	367,735

Industry Group	n	% of Sample	Mean IT Spend (USD)	Median IT Spend (USD)
Admin. Services	21	3.6%	3,199,427	748,663
AI and ML	19	3.2%	6,966,879	1,302,966
Financial Services	17	2.9%	859,641	310,862
Data and Analytics	15	2.5%	3,714,994	467,987
Information Technology	14	2.4%	1,915,115	871,416
Hardware	6	1.0%	22,063,170	616,808

Geographic Distribution and State-Level IT Spend

The spatial distribution supports the established presence of the Indian startup ecosystem in metropolitan regions. The total number of firms (n = 261) in Maharashtra (n = 111), Delhi (n = 82), and Karnataka (n = 68) serves as an example as demonstrated in Table 3. Although Haryana has a comparably small number of startups (n = 34), it has the highest mean IT spending at USD 7.21 million per firm, on both Maharashtra (USD 6.41 million) and Delhi (USD 5.70 million). This implies that the disproportionately IT-intensive startups have headquarters in Haryana with many of them being Gurugram based enterprise-technology firms. The southern states like Tamil Nadu and Telangana, even though they have large clusters of startups have a relatively lower mean IT expenditure which could be due to a higher percentage of early ventures.

Table 3: Geographic Distribution and IT Spend by State (Top 10)

State	n	% of Sample	Mean IT Spend (USD)	Median IT Spend (USD)
Maharashtra	111	18.8%	6,413,829	384,031
Delhi	82	13.9%	5,697,929	386,847
Karnataka	68	11.5%	4,437,513	740,693
Gujarat	62	10.5%	1,139,401	425,642
Tamil Nadu	52	8.8%	1,465,910	595,093
Telangana	47	8.0%	965,776	503,651
Uttar Pradesh	42	7.1%	1,401,574	483,973
Haryana	34	5.8%	7,205,929	820,619
Madhya Pradesh	20	3.4%	760,343	318,740
Rajasthan	19	3.2%	708,227	466,926

Correlation Analysis

Table 4 shows Spearman rank-order correlations involving IT expenditure and important variables in an organization. The

Active Technology Count is positively and statistically significantly correlated with IT expenditure (0.186, $p < 0.001$), with the implication being that the more firms implement a more comprehensive technology stack, the more they tend to spend on IT- which concurs with the effects of complementary effects in technology adoption. Similarly, Total Active Products demonstrates a positive association that has a significant positive value (0.248, $p < 0.001$), which means that the breadth of product portfolio co-evolves with IT investment. The correlation in terms of the number of investors also shows the positive relationship (0.277, $p < 0.05$), and it suggests that more funded startups with more substantial investor networks are more likely to invest in digital infrastructure. Conversely, the Number of Apps is loosely and insignificantly connected (0.126, $p = 0.178$): the number of applications alone cannot be safely used to predict the intensity of IT spending.

Table 4: Spearman Correlation Coefficients with IT Spend

Variable	Spearman ρ	p-value	N	Interpretation
Active Tech Count	0.186	< 0.001***	574	Significant positive
Total Active Products	0.248	< 0.001***	590	Significant positive
Number of Investors	0.277	0.027*	64	Significant positive
Number of Apps	0.126	0.178 (ns)	115	Non-significant
Patent Count	0.411	0.144 (ns)	14	Insufficient N

*Note: *** $p < 0.001$; * $p < 0.05$; ns = not significant*

IT Spend by Growth Score Tier and Funding Stage

The non-significant F statistic was obtained in the one-way ANOVA that focuses on the difference in the IT spend based on the Tiers of Growth Score (High, Medium, Low) ($F = 0.681$, $p = 0.508$). The given result suggests that the tier classification is not a promising predictor of the extent of IT spending in the sample in itself. However, when the data is examined more closely, in a descriptive manner, some important trends are to be identified. The highest median IT expenditure of USD 9.21 million is observed in firms in the middle range with a low-tier firm reporting the lowest median IT expenditure of USD 3.03 million. This counterintuitive ranking may be reflective of capital-efficient, high-growth companies that achieve expansion through non-IT modalities, or it may indicate that the growth score represents some other dimensions than digital investment.

In terms of successive funding levels, in organizations that have gone through Mergers and Acquisitions (M&A) the mean expenditure on information technology is by far the highest at USD 31.99 million on average and across 16 entities. This amount is only exceeded by other companies in the Early-Stage Venture category that have an average IT outlay of USD 4.95 million of fifteen companies, and those in Series B funding rounds of USD 8.11 million of seven companies. Predictably, seed-level businesses have the lowest mean investment with an average of USD 2.40 million applied in 22 companies, which fits the fiscal constraints that are inherent with nascent businesses. This wide range of dispersion in all funding cohorts suggests that the intrinsic characteristics of the enterprise, including sectorial fit, typology of products and digital maturity, might be a larger portion of the distribution than the stage of funding itself.

5. DISCUSSION

Sectoral Heterogeneity in IT Investment

The strong difference between the mean and median expenditure in IT across all sectors is a strong indication that Indian start up expenditures follows a power-law distribution. The empirical effect of this can be found in the literature on firm-size distribution and fits in the Zipf law when applied to the organizational setting, which is taken up in Gabaix (2009). The fact that the industry has a few high spenders, particularly in the Transportation and Hardware industries, is used to inflate the sectoral mean values significantly. This in turn makes the median expenditure the more policy-relevant measure showing that the prototypical Indian startup will spend between USD 320,000 and USD 1.3 million on IT purposes, depending on the sector classification. These amounts are significantly lower than the corresponding estimates of startups located in the United States and Europe and can be explained by the fact that the development stage of many Indian companies is relatively small and low cost of indigenous IT talent.

The high level of IT spending in the Clothing and Apparel industry with a mediated amount of USD 395,010 is on a conspicuous level when compared to the median level of USD 319,738 of the Education industry. This imbalance is especially blatant following the alleged low-technology profile of the Clothing and Apparel industry. The variance can be explained by the fact that the significant investments focused on the logistics infrastructure, inventory management systems, and the system of recommendations and engine technologies made by direct-to-consumer (D2C) fashion startups - a vertical that has been becoming increasingly IT-intensive due to the spread of quick-commerce platforms.

Geographic Concentration and Regional Digital Divides

The geographic clustering of high-IT-spend startups in Maharashtra (especially Mumbai), Delhi NCR, and Haryana highlights a persistent center-periphery dynamic in India's innovation economy. While southern states such as Karnataka and Telangana are celebrated for their IT ecosystems, the concentration of large-scale IT spenders in the west and north—particularly Haryana's proximity to Delhi's enterprise client base—suggests that IT-intensive startups may prefer locations with strong enterprise demand, not just developer talent. Policymakers seeking to develop the startup ecosystems of emerging states (Uttar Pradesh, Rajasthan, Madhya Pradesh) may need to address not only talent supply but also demand-side market connectivity.

The geographic concentration of high-IT-spending startups in Maharashtra especially Mumbai and the Delhi-NCR and Haryana regions highlight a long-standing center-periphery relationship that is formal to the emerging innovation economy in India. Despite the laudatory reports of the developed IT ecosystems in the southern states of Karnataka and Telangana, the strong concentration of capital-intensive IT spenders in the western and northern regions, (particularly the location of Haryana in the possible enterprise clientele around Delhi) suggests that IT-intensive projects might focus on locations that deliver strong enterprise demand, rather than merely acquiring developer talent. Therefore, the policymakers who strive to develop the startup ecosystems of the newly emerged states, including Uttar Pradesh, Rajasthan, and Madhya Pradesh, have to both consider the supply-side aspects, i.e., most prominently, the ability to provide talent, and demand-side factors, i.e., the easing of market connectivity and access to enterprise networks.

Implications of Correlation Findings

The significant positive correlation between Active Technology Count and IT expenditure is intuitively sound: the more mixed technology stacks an enterprise adopts, the higher the perpetually expensive licensing, integration and maintenance costs. This finding aligns with the framework of the IT capabilities, developed by Bharadwaj (2000) in which the breadth of the IT resources forms a central component of the IT capability construct that facilitates the higher performance of organizations. There is a relationship to investor number, but based on a low subsample (n = 64), with significant venture-capital implications, namely, that investors are either attracted to or promoting companies that incur a lot of expenditure on IT. Powerful longitudinal data would be invaluable to unravel causal processes.

6. LIMITATIONS

There are a number of limitations that should be mentioned. To begin with, the nature of the dataset being cross-sectional does not allow making any causal inference. Second, the numbers of IT spend are approximations created by a third-party intelligence service and do not necessarily reflect expenditures that are recorded in audited performance. Third, the large percentage of missing values in some variables, notably patent count (n = 14) and investor count (n = 64) limits the statistical power and external validity of some of the analyses carried out. Further studies that make use of longitudinal data, use primary survey or engage in a thorough financial statement analysis would significantly enhance the strength of these results.

7. CONCLUSION

The study provides the first comprehensive quantitative study of the IT spending pattern in Indian start-ups covering 590 startups based on 22 states and 33 industries. It has tripartite contributions. To begin with, the research outlines the distribution qualities of outlays on IT in the Indian start-up context-with its severe right skew of a median value of USD of approximately 430,000 and long tail, which is driven by hardware and transport voltage giants. Secondly, it documents significant sectoral and geographical concentration, highlighting that IT intensity is not in a balanced distribution but instead, is agglomerated in particular sectors (Hardware, Transportation, AI) and in urban areas (Maharashtra, Delhi, Haryana). Thirdly, it shows statistically significant positive relationships between IT spending and the breadth of the current technology stack and product portfolio size, which provide empirical support to complementarity theories of IT investment.

To practitioners, this is a call to action in the sense that startups that intend to scale themselves would put less focus on the expansive proliferation of fragmented point solutions and instead more focus on the development of coherent, integrated

technology stacks that actually bring this expansive nature to scale; through such expansiveness, many startups become costly without delivering corresponding value creation. Geographic concentration of digital infrastructure investment as documented requires the policymakers to introduce specific incentive programs that will promote digital growth in under-served states and thus counter regional differences. In the case of venture capital companies, industry-related IT spending benchmark is a crucial analytical instrument, which enriches due-diligence systems and permits to execute stricter portfolio monitoring procedures.

It would be wise to use longitudinal design in the future academic research, to include measures of profitability and growth outcomes in detail, and to broaden the geographical range and compare Indian startups to their counterparts in the other BRICS economies. Furthermore, the quantitative data obtained in this study would be enhanced and contextualised with qualitative research that explores the decision-making process behind IT budgeting in Indian startups.

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