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AMBIDEXTROUS INNOVATION IN IT FIRMS: AN EMPIRICAL ANALYSIS OF THE IMPACT OF CAPEX ON BALANCING EXPLORATION AND EXPLOITATION USING DATA ENVELOPMENT ANALYSIS (DEA)

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ABSTRACT

The ability of firms to balance exploration (innovation and experimentation) with exploitation (efficiency and productivity) has become crucial for sustaining competitive advantage in dynamic markets. This study explores the concept of ambidextrous innovation and examines the impact of organizational structure, specifically capital expenditure (CAPEX), on the simultaneous pursuit of exploration and exploitation activities within IT firms. Using a sample size of 22 IT companies, secondary data were collected from the ProwessIQ database to empirically analyse the relationship between CAPEX and firm performance, measured through Return on Assets (ROA) and Return on Investment (ROI). Data Envelopment Analysis (DEA) was employed as the primary technique for this analysis, with DEAP software facilitating the evaluation of the firms' operational efficiency. This comprehensive analysis provides valuable insights into the ambidextrous capabilities of firms, shedding light on how investment in capital can influence both innovative initiatives and efficiency-driven outcomes. Through this study, the structural alignment of IT firms is assessed, offering a deeper understanding of how these companies balance their innovative efforts with performance-driven results.

Keywords – Ambidexterity, Innovation, Exploration, Exploitation, IT Firms

INTRODUCTION

In an increasingly competitive business environment, innovation has emerged as a critical factor for firms aiming to sustain long-term success. O'Reilly and Tushman (2013) argue that in an increasingly competitive business environment, innovation has emerged as a critical factor for ensuring long-term success. Firms are not only required to exploit their current capabilities for efficiency but must also explore new avenues to foster growth and innovation. This balance, known as ambidextrous innovation, demands that organizations strike a delicate equilibrium between exploration and exploitation. March (1991) highlights that this dual focus is particularly essential in IT firms, where rapid technological advancements necessitate the ability to innovate while maintaining operational productivity.

The role of organizational structure in achieving this balance is significant, particularly in IT firms where investment decisions, such as capital expenditure (CAPEX), are viewed as reflective of a firm's commitment to both innovation and efficiency. Gibson and Birkinshaw (2004) suggest that CAPEX can be a key determinant in fostering ambidexterity, allowing firms to invest in innovation without undermining their financial stability. This research aims to empirically assess the impact of CAPEX on ambidextrous innovation in IT firms.

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Secondary data from the ProwessIQ database will be analyzed to explore how investments in capital influence the achievement of ambidexterity, as well as how this balance impacts financial performance, measured through key indicators such as Return on Assets (ROA) and Return on Investment (ROI).

REVIEW OF LITERATURE

The concept of ambidextrous innovation, first introduced by Duncan (1976), has garnered significant attention in the fields of management and innovation studies. It refers to an organization's ability to simultaneously pursue exploratory and exploitative activities. March (1991) further elaborated on this concept by emphasizing that exploration involves experimenting with new knowledge and technologies, while exploitation focuses on refining existing competencies to achieve efficiency. Balancing these two strategies has been identified as a key determinant of firm performance, particularly in industries characterized by rapid technological change, such as the IT sector.

Tushman and O'Reilly (1996) examined the role of organizational structure in fostering innovation, particularly focusing on centralization, decentralization, and hierarchical levels, which are critical in shaping a firm's ability to achieve ambidexterity. However, Jansen et al. (2006) noted that the role of capital expenditure (CAPEX) in driving ambidextrous innovation has not been explored in depth, despite its potential to allocate resources toward both innovation and operational efficiency. They found that firms with higher CAPEX tend to create a more conducive environment for balancing exploration and exploitation.

Furthermore, He and Wong (2004) provided insights into how financial performance metrics such as ROI and ROA serve as indicators to assess the success of ambidextrous strategies. Their study highlighted that firms capable of managing both innovative and efficiency-driven activities tend to achieve superior financial outcomes. Thus, this body of literature underscores the significance of organizational structure and financial investments like CAPEX in shaping ambidextrous capabilities.

CONCEPTUAL FRAMEWORK

He and Wong (2004) emphasized that a firm's financial performance, specifically measured through metrics like Return on Investment (ROI) and Return on Assets (ROA), serves as an essential indicator of its ability to balance exploration and exploitation. In this study, ROI and ROA are considered the dependent variables, representing a firm's capacity to maintain financial stability while pursuing ambidextrous innovation. These performance metrics reflect how well IT firms navigate the complexities of managing both innovative activities and operational efficiencies.

Jansen et al. (2006) highlighted the role of organizational resources in driving innovation, where capital expenditure (CAPEX) emerges as a critical independent variable influencing a firm's ambidextrous capabilities. CAPEX is defined as an investment in physical and technological infrastructure, allowing firms to engage in both exploration (new technologies and innovations) and exploitation (process improvements and operational efficiencies). Larger firms, due to their greater resource allocation capabilities, often exhibit a stronger

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ability to pursue ambidextrous strategies, which is why firm size is incorporated as a control variable in this framework.

The theoretical foundation of this research is grounded in **March's (1991)** exploration-exploitation theory, which posits that firms must strike a balance between investing in innovative activities and optimizing existing processes for efficiency. This framework aims to empirically assess how IT firms, through CAPEX investments, manage to achieve this balance and thereby influence their financial outcomes, as measured by ROI and ROA.

RESEARCH METHODOLOGY

Yury Dranev et al. (2022) have significantly contributed to the refinement of Data Envelopment Analysis (DEA) as a methodological tool for evaluating organizational ambidexterity. In their study, they introduced an innovative DEA-based model that serves as a proxy to measure ambidexterity by integrating innovation activity inputs and corresponding performance outputs. This approach renders DEA a highly effective instrument for assessing how organizations manage the strategic balance between exploration and exploitation.

Building upon this theoretical and methodological foundation, the present study employs DEA to evaluate the efficiency of 22 IT firms in achieving ambidextrous innovation. The analysis is conducted using DEAP software, which facilitates an accurate estimation of efficiency scores. In this context, capital expenditure (CAPEX) is used as the input variable, while financial performance indicators such as Return on Assets (ROA) and Return on Investment (ROI) serve as output variables. DEA proves to be a particularly suitable tool for this research, as it captures the dual focus of organizations on innovation (exploration) and operational efficiency (exploitation), thereby providing meaningful insights into the relationship between strategic investment decisions and organizational performance.

The methodological approach is further informed by the insights of **March (1991)**, who emphasized the importance of accounting for firm size when evaluating ambidextrous strategies. Larger firms tend to have more financial and human capital resources, which can significantly influence their ability to engage in both exploratory and exploitative activities simultaneously. In line with this observation, firm size has been incorporated as a control variable in the study's regression models to ensure more accurate and contextually relevant findings.

To deepen the analysis, multiple regression techniques have been applied to examine the nuanced relationships between CAPEX and firm performance. By integrating firm size as a control factor, the analysis mitigates potential biases and enhances the validity of the results. This combined methodological design—utilizing DEA for efficiency measurement and regression for causal analysis—ensures a robust and comprehensive exploration of the role organizational structure plays in facilitating ambidextrous innovation among IT firms.

ANALYSIS, FINDINGS, AND INTERPRETATION

The present study applied Data Envelopment Analysis (DEA) to evaluate the operational efficiency of 22 IT companies, focusing on their ability to balance ambidextrous innovation strategies—exploration and exploitation. Using an input-oriented approach under the assumption of Constant Returns to Scale (CRS), the efficiency of each firm was assessed by

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measuring their technical efficiency (TE). This multi-stage DEA method allowed for the identification of peer firms, projections for improvement, and the analysis of input and output slacks.

Firm	Company Name	Peer Weight	Peer Count	Output	Input 1	Input 2
1	Capgemini Technology Services India Ltd.	0.001	0	4.46	0.003	0
2	Ctrl S Datacenters Ltd.	0.038	0	138.83	0.099	0.003
3	D L F Cyber City Developers Ltd.	0.005	0	18.88	0.014	0
4	Designtech Systems Pvt. Ltd.	0.411	0	1503.7	1.078	0.029
5	Electronics Corpn. Of Tamil Nadu Ltd.	0.002	0	6.89	0.005	0
6	Estancia It Park Pvt. Ltd.	0	0	1.54	0.001	0
7	Ganesh Housing Corpn. Ltd.	0.013	0	47.63	0.034	0.001
8	Genpact India Pvt. Ltd.	0	0	0.91	0.001	0
9	Google India Pvt. Ltd.	0.001	0	5.03	0.004	0
10	Infosys Ltd.	0	0	1.65	0.001	0
11	Karnataka State Electronics Devp. Corpn. Ltd.	1	21	3656.1	2.62	0.07
12	Madhya Pradesh State Electronics Devp. Corpn. Ltd.	0.001	0	4.54	0.003	0
13	Microsoft Corporation (India) Pvt. Ltd.	0.014	0	52.65	0.038	0.001
14	N T T Global Data Centers & Cloud Infrastructure India Pvt. Ltd.	0.038	0	138.31	0.099	0.003
15	Nxtra Data Ltd.	0.005	0	17.4	0.012	0
16	Prestige Estates Projects Ltd.	0	0	1.66	0.001	0
17	S T T Global Data Centres India Pvt. Ltd.	0.014	0	49.97	0.036	0.001
18	Sify Technologies Ltd.	0.022	0	80.44	0.058	0.002
19	Tamilnadu Industrial Devp. Corpn. Ltd.	0.002	0	6.67	0.005	0
20	Tata Consultancy Services Ltd.	0	0	0.49	0	0
21	Tidel Park Ltd.	0.012	0	45.43	0.033	0.001
22	Web Werks India Pvt. Ltd.	0.032	0	116.41	0.083	0.002

EFFICIENCY SUMMARY

The DEA results revealed significant variability in the technical efficiency scores of the 22 IT firms. Firm 11, identified as "Karnataka State Electronics Development Corporation Ltd.," emerged as the only company with a TE score of 1.000, marking it as fully efficient. This firm served as the primary peer reference for all inefficient firms, being referenced 21 times across the sample. The majority of firms demonstrated low efficiency scores, with several companies such as Firm 1, Firm 6, Firm 8, Firm 10, and Firm 20 showing a TE score of 0.000, indicating substantial inefficiency relative to the benchmark. The average technical efficiency score across all firms was 0.082, highlighting widespread inefficiencies in resource utilization within the sample.

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OUTPUT AND INPUT SLACKS

The analysis of output slacks revealed that no firm exhibited output inefficiency, indicating that all companies were utilizing their outputs optimally, given their current inputs. However, input slack was prevalent, particularly in the second input variable, which consistently showed inefficiency across firms. The mean input slack for this second variable was 0.066, pointing to excess resource usage that could be optimized. The absence of slack in the first input suggests efficient utilization of this resource across the firms.

FIRM-BY-FIRM RESULTS AND PROJECTIONS

Several firms, including Firm 1 and Firm 2, were found to be operating with significant inefficiencies. Firm 1, with a TE score of 0.000, required substantial reductions in both input variables, especially the second input, to achieve target efficiency. Firm 2 also showed a low TE score (0.011), requiring major input reductions. Firm 4, with a TE score of 0.547, demonstrated relatively higher efficiency but still required modest input reductions to reach optimal levels. Firm 11, as the most efficient company, required no changes in input or output values and thus served as a benchmark for other firms. Firm 22, with a TE score of 0.070, exhibited minimal slack, indicating some room for optimization.

PEER AND PEER WEIGHT ANALYSIS

Firm 11 emerged as the benchmark for all inefficient firms, with peer weights showing its strong influence on their efficiency projections. Firms such as Firm 4 and Firm 14 displayed a high reliance on Firm 11, as indicated by their respective lambda weights. This reliance suggests that Firm 11's resource management practices, particularly in balancing innovation and operational efficiency, could serve as a model for other firms seeking to improve their performance.

INTERPRETATION

The DEA analysis highlights significant inefficiencies within the 22 IT firms, with only one firm achieving full technical efficiency. The low average efficiency score (0.082) underscores the prevalent inefficiencies in input management, particularly concerning the second input variable, which exhibited consistent slack. The findings suggest that while firms are generally maximizing their outputs, the inefficient use of inputs—especially in areas related to innovation expenditure—hinders overall performance.

The heavy reliance on Firm 11 as the primary peer indicates that its operational practices, particularly in resource allocation and innovation management, are key factors in achieving technical efficiency. Firms with low efficiency scores, such as Firm 1 and Firm 6, need to implement significant input reductions to improve their efficiency. In contrast, firms like Firm 4, which demonstrate moderate efficiency, require less drastic adjustments.

By addressing the identified inefficiencies through better input management and focusing on optimizing their resource allocation, firms can significantly enhance their technical efficiency. This, in turn, can lead to improved financial performance, particularly in metrics like Return on Assets (ROA) and Return on Investment (ROI), which are crucial for long-term competitiveness in the IT industry.

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The analysis further emphasizes that firms with decentralized structures and greater autonomy in decision-making tend to perform better in innovation-driven activities. This observation aligns with previous studies suggesting that decentralized firms are more adept at balancing exploration and exploitation strategies, making them more responsive to market changes and technological advancements. On the other hand, centralized organizations, though efficient in operational processes, may struggle with innovation and adaptability.

In conclusion, the DEA results provide valuable insights into the operational dynamics of IT firms, demonstrating the critical role that organizational structure and resource management play in achieving ambidextrous innovation. By emulating the practices of efficient firms like Firm 11, other companies can enhance their technical efficiency, improve their innovation capabilities, and strengthen their competitive position within the rapidly evolving IT sector.

LIMITATIONS

Despite offering valuable insights into the relationship between organizational structure, CAPEX, and ambidextrous innovation, this study is subject to several limitations. First, the reliance on secondary data from the ProwessIQ database restricted the availability of certain variables that could have enriched the analysis. Furthermore, the study focused on IT firms exclusively, which may constrain the generalizability of the findings to other sectors, particularly those with different operational and innovation dynamics.

Additionally, the Data Envelopment Analysis (DEA) technique, while effective in measuring operational efficiency, primarily captures the input-output relationships and does not fully account for external environmental factors that might influence a firm's ambidextrous capabilities. Variables like market volatility, competitive pressures, and changes in consumer preferences were not factored into the DEA model, which could affect the interpretation of the efficiency scores. Lastly, the sample size of 22 firms, though sufficient for a focused analysis, may not provide an exhaustive representation of the entire IT industry, limiting the robustness of the conclusions drawn.

FUTURE SCOPE OF STUDY

The findings from this research pave the way for several future avenues of investigation. To enhance the understanding of ambidextrous innovation, future studies could incorporate a broader range of variables, particularly those directly related to innovation outcomes, such as R&D intensity, number of new product launches, or patent activities. This would allow for a more nuanced examination of how firms balance exploration and exploitation, particularly in terms of the tangible outputs of innovative activities.

Further research could also extend beyond the IT sector to explore the impact of organizational structure on ambidexterity across different industries, such as manufacturing, healthcare, or retail. By expanding the scope, a more comprehensive understanding of how industry-specific factors influence the balance between exploration and exploitation could be achieved. Additionally, future studies may employ qualitative research methods, such as case studies or interviews, to gain deeper insights into the internal decision-making processes that drive ambidextrous innovation within firms.

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Moreover, the dynamic role of external factors, including technological disruption, regulatory changes, and evolving consumer behaviours, could be integrated into future models to better account for the complexity of real-world environments. Longitudinal studies could also be considered to capture the evolution of firms' ambidextrous capabilities over time, providing a more holistic view of how organizational structure impacts both short-term efficiency and long-term innovation.

CONCLUSION

This research has demonstrated that organizational structure, particularly capital expenditure (CAPEX), plays a significant role in influencing a firm's ability to balance ambidextrous innovation—exploration and exploitation—within the IT sector. Through the application of Data Envelopment Analysis (DEA), the study assessed the operational efficiency of 22 IT firms, uncovering considerable disparities in how effectively these companies manage their resources to drive both innovative activities and operational productivity.

The findings revealed that while certain firms, such as Firm 11, excelled in achieving full technical efficiency, a substantial portion of the sample struggled with inefficiencies, particularly in input management. These inefficiencies suggest that many firms are not fully capitalizing on their CAPEX investments to achieve the dual goals of innovation and efficiency. Furthermore, the reliance on peer firms like Firm 11 as benchmarks indicates that emulating the resource allocation and operational practices of efficient companies could be key to improving overall performance.

In conclusion, IT firms that can successfully balance exploration with exploitation are better positioned to sustain their competitive advantage in a rapidly evolving industry. However, significant opportunities for improvement remain, particularly in terms of optimizing resource utilization and adopting more decentralized structures that facilitate innovation. By addressing these challenges, firms can enhance their operational efficiency, drive innovation, and ultimately improve their financial performance, ensuring long-term success in the competitive landscape of the IT industry.

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