Transitions in Information Systems Development: SME's Issues and Challenges

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Abstract: Organizations experience external pressures such as changing technologies and faster time-to-market, which drive them to make changes. We can refer to these changes as transitions. The organizations that use cloud infrastructure leverage faster application availability at reduced cost and pay-per-usage of features advantages to reduce their total cost of ownership (TCO). TCO manifests as external pressure on organizations that develop on-premises software applications. To stay competitive, these organizations either need to migrate their applications to the cloud or change their existing on-premises software application. This paper considers the latter of bringing changes for a successful transition. The software application development involves social and technical aspects, and change must include both these aspects. To examine the change as a phenomenon, we need to examine it in its settings, and a case-study method is best suited. The selected case is a Small and Medium Enterprise (SME) with on-premises application development in human capital management. The findings indicate that agility is necessary to stay competitive. For agility, across different stages of its value chain, associated contexts come into play, which requires appropriate social and technical changes and not necessarily migrate to cloud-based development. To reduce TCO, a change in the form of adopting open-source technologies is a necessity. Further, for the changed on-premises application to provide competitiveness, apart from managing prevalent external pressures, the organization must manage debt, which comprises technical and social changes.

1 INTRODUCTION

Cloud-based information technology (IT), since its inception, developed and matured to provide a range of services, systems, applications, and mobile computing services. These provide savings to an organization's upfront capital expenses (Attaran et al., 2019), seen in government scenarios (Jones et al., 2019). Cloud infrastructure providers' elastic increase of resources meets peak-load capacity, faster implementation, self-provisioning, and easier access. They contend that outsourcing these services outweighs internal operating costs; however, these require careful evaluation (Brabra et al., 2018). Brabra et al., (2018) contend that especially for organizations that use their resources and host them on their premises[1], to compete effectively, they need to manage the total cost of ownership (TCO). TCO decides the price, considered prominent by the marketplace. Apart from cost rationalization, external pressures drive competitiveness. These are changing technologies (security, architecture, virtualization, visualization, and so forth), societal trends (institutional change, globalization, privatization, and so forth), human elements (privacy, identity, access, trust, confidentiality, and so forth), and local government regulations (Kompella, 2017). The external pressures are a source of a trigger to bring changes, i.e., transitions. This paper examines changes by considering information systems development. In doing so, include information management, development methodology, requirements engineering (RE), and a range of

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[1] The organization develops the application using web technologies and hosts it in its datacentre, accessible to users over the Internet. As compared to cloud infrastructure services, its datacentre provides limited elasticity of storage, computing resources, and self-provisioning to the users. In this paper, the author refers to such hosted applications as on-premises and applications that use cloud infrastructure as cloud based.

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customers under consideration. Apart from these, interaction, complexity, collaboration, risk management, cooperation, and workforce ratio (personnel in development and operations) are necessary during information systems development.

We can use multi-level perspective (MLP) and analyze information systems development and its response to external pressures. Kompella (2017) examined it for E-Governance. MLP conceptualizes the system in three levels, where external pressures act at macro and niche-innovations at micro-levels. At the intermediate level meso, organizations select niche-innovations from the micro-level, shape their organizational systems better to adapt their IT systems to the external pressures. This shaping and selection logic decides their ICT innovations adoption, in turn, their transition success.

The application development factors comprising upstream (architecture and RE), downstream (software development methodology and deployment), and organizational (interaction and complexity, tools used, culture, growth plans, and so forth) span the entire value chain decide the shaping and selection logic and TCO. Therefore, we need to identify appropriate factors for a significant TCO reduction and make necessary social and technical changes along the entire value chain. The changes are not bereft of challenges and based on the improvements attempted and the stage in the value chain associated contexts coming into play. Nevertheless, the changes apart from improving their value chain and TCO improve the TCO of organizations' using their products/services.

This paper considers the entire value chain of a Small and Medium Enterprise (SME). The SME attempted to transition from Business Process Outsourcing (BPO) on-premises applications' software development. The transition demanded considerable changes to its existing architecture, technology, and development process.

The paper's composition is as follows - the next section discusses the factors that drive organizations to use cloud-based applications. Section 3 discusses the social and technical aspects that help examine the changes to effect successful transitions and form the paper's theoretical basis. The subsequent section discusses the research methodology. Section 5 examines the selected organization's social and technical changes, followed by section 6, which contrasts the approach and subsequent steps. Finally, the last section concludes the paper with its limitations and directions for future work.

2 LITERATURE REVIEW

The on-premises application development organizations compete with cloud-based application development organizations. Therefore, reasons for cloud transition and adoption can provide insight into necessary on-premises changes. The period of on-premises changes selected for this study is 2015-16; therefore, during 2005-2016, gathered information on cloud transitions and adoption.

Transition to cloud emphasizes security, privacy, reliability, sharing, hybrid cloud, and collaboration (Phaphoom et al., 2015) and (Senyo et al., 2018). In scenarios where service delivery efficiency, effectiveness, and cost are required, cloud-adoption improved UK public sector service delivery (Jones et al., 2019). We can infer that by including other aspects, we can enhance cloud adoption. Better adoption was noted by considering organizational policies around security and standardization (Lin and Chen, 2012), the full context of the environment, and performance trade-offs while implementing encryption security features (Chang et al., 2016). We can summarize that decision to adopt cloud requires addressing diverse managerial and technical aspects.

The transition from on-premises to cloud-based requires decisions on technological acceptance and trajectory, business models, absorptive capacity, flexibility in operations (Kranz et al., 2016). As organizations connect with the environment, can improve knowledge management (Palacios-Marqués et al., 2015), and usage can improve collaboration and communication (Chang et al., 2016). Therefore, as organizational capabilities and applications work in tandem, they can improve their operational flexibility, service delivery effectiveness and efficiency, and sensitivity to upstream and downstream processes. In other words, whether it is a cloud or on-premises application, it is essential to be responsive to both upstream and downstream processes.

The requirements determine the value, but architecture decides the cost, schedule, and the extent to which software adapts to later requirement changes (Boehm, 2000). A dynamic, flexible, and responsive RE can develop sensitivity into both the upstream and downstream activities. When upstream and downstream processes have the right social and technical changes, RE's sensitivity turns into agility. In doing so, can effectively manage the transition of information systems development. This study considers all these, and the next section discusses the theoretical underpinnings necessary to bring agility in software development and deployment.

3 THEORETICAL PERSPECTIVE

The value chain for a software development organization comprises upstream and downstream processes. The architecture and RE are upstream, while downstream is software development. Both the processes decide the organization's TCO. In their endeavour to respond to external pressures, eventually reduce TCO, they rearchitect monolithic to modular and transition from waterfall to iterative methodology. In doing so, make associated cultural changes. This paper examines the extent to which architecture displays software product lines (SPL) characteristics such as multiple cores and varying features, reuse of assets, and modularity. It also examines the extent to which downstream processes assist in exhibiting SPL characteristics. The subsequent subsections discuss the key underpinnings necessary to examine SPL characteristics.

Product Architecture and Requirements Engineering. The modular and integrative architectures play a decisive role in managing technological changes and delivering innovative products/services. When organizations stay competitive, play on cost reduction, which can result in technology not evolving. On the contrary, when they use continuous innovation and incorporate the latest technologies into their final product, it results in a dynamic, flexible, and evolving product architecture. Park (2014) suggests that modular architectures help develop a platform that encourages reuse at a large-scale with multiple cores and varying features—thereby enabling us to focus on cost and platform leadership and strive for market supremacy and leadership. An architecture-centric development attempted in other industries before finding useful in software is SPL. (Hohl et al., 2017) contend that it emphasizes meeting three key requirements 1) architectural design of new applications in product lines, 2) development of reusable core assets to develop new product lines, and 3) permit analysis to assess the impact, especially on cost, time-to-market, maintainability, large-scale productivity gains, and use of human resources to sustain unprecedented growth. As suggested by Hohl et al., (2017), we can attempt SPL by following proactive development of reusable components (assets developed upfront are heavyweight), reactively (acquire assets on time during production), use distinct organization teams to develop reusable assets, usage of reusable assets.

As organizations focus on developing products based on SPL, they need to manage both market-oriented and technical input. Bashroush et al., (2017) suggest that product management can manage both market-oriented and technical inputs. Product management performs functions such as positioning the product, aligning corporate strategy and the products, marketing instruments (product, price, place, and promotion), and communication with sales, customers, and suppliers. When managing market-oriented and technical input, product management needs to focus on market-driven product development (MDPD). As in MDPD, unlike bespoke development, a single customer does not decide its features. Dzamashvili Fogelström et al., (2010) suggested that the market investigation and business intelligence need to accomplish RE's elicitation phase. In the endeavor to meet customer's wants-and-needs, the product management needs to balance different requirement types, the trade-off between technology-push (future needs) and market-pull (existing customer needs), and release planning (triaging and prioritizing diverse initial requirements). The scope of the release and its evolution must reflect in the upstream activities such as corporate strategy, sales, revenue, market growth, and ability to create and maintain a flexible architecture. When the upstream and downstream activities align, the scope evolves and contributes to multiple product releases leading to a product and organization's success. Notwithstanding, we need to consider development teams' capabilities to refactor, update, and correct after-the-fact activities. After-the-fact activities include defects, involuntary (scope creep) and voluntary (change in assumption), missing of requirements, and so forth.

Agility in Software Development and Deployment. The faster time-to-market and responsiveness are reasons organizations adopt the Agile methodology (Agile, 2001). Dzamashvili Fogelström et al., (2010) contend that Agile methods (Agile, 2001) are bespoke and unsuitable for MDPD. To develop products for mass customers, Dzamashvili Fogelström et al., (2010) suggest that ASD requires a considerable amount of tweaking to 1) accommodate heterogeneous communities, 2) to consider long-term product maintainability, 3) associated architectural changes, 4) update release plan to include features that address time-to-market, 5) understanding of the value and 6) assumptions about requirements. Using continuous integration (CI) and continuous deployment (CD), we can further improve upstream and downstream orchestration. Fitzgerald and Stol

(2017) researched the transition from CI to CD and suggested a holistic view of business, development, operations, and innovativeness. Organizations have avenues to choose and orchestrate their upstream and downstream activities that require appropriate social and technical changes. The chosen avenues and the appropriate changes influence their products/services and their successful competition in the marketplace, thereby, their transition.

4 RESEARCH METHODOLOGY

The organizational changes as responses to external pressures need to reduce TCO and influence its entire value chain, thereby assisting in staying competitive. Therefore, the selected organization needs to provide the required dynamics and complexities at different stages of its value chain. The study's scope examines the transitions in information systems development; hence, a single case-study, as mentioned by Yin (2009), is appropriate. The selected organization is COMP-XLL (real name is made anonymous). The JSP-based application (technology), acquisitions, cost per payslip, managed services, architecture as shown in Figure 1, and footprint (9 million annual payslips for 400 customers spread across 17 countries) provided the required dynamics and complexities. The study objects are the departments of COMP-XLL involved in application development. The analysis unit is the groups involved in application development, associated processes, products, and technology.

The author worked as an observer in COMP-XLL from 01/2015 till 08/2016 and provided inputs for their transition plans. The author conducted fieldwork close to the study objects and involved respondents who were decision-makers during software development and at various customer engagement stages from response-to-proposal to end-user acceptance. It involved gathering information around COMP-XLL's approach to transitioning and the finalization of the plan. It involved various avenues such as semi-structured interviews, technical reports, archives, records, meetings, media reports, and written sources. Data collection from diverse information sources helped achieve construct validity. The purposive sampling assisted in selecting respondents for the semi-structured interview. It ensured that respondents represent at least one business unit, and no business unit is left unrepresented; moreover, it ensured that respondents are at various business units. The respondents involved COMP-XLL's leadership team consisting of the Chairperson, chief Technology, human resources, sales and marketing, operations, and finance officers. The interviewee respondents extended to directors, architects, senior managers, and managers from the technology, operations, and human resources departments. The author spent around seven to nine months gathering information.

While firming up the transition plan, the COMP-XLL team referred to technical reports and other relevant reports related to database, development environment, automation tools, and so forth and formed part of the fieldwork. The notes were the output of the fieldwork, which provided material for open and axial coding. The output of open and axial coding was categories and patterns mapped to constructs in the section' Theoretical perspective.' The coding and mapping assisted in achieving triangulation. This exercise resulted in specific expressions to develop explanations for causal effect relationships, thereby, internal validity. The case findings are from a single case of on-premises application; therefore, the findings' external validity applies to similar organizations.

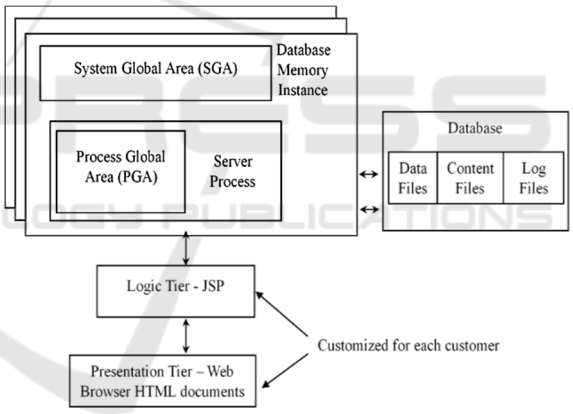

Figure 1: Current application architecture along with database and its instances. Source (Oracle, 2015).

5 ANALYSIS

5.1 Existing Operations and Workplace Culture

The selected organization wants to transition from providing BPO services to a technology-based and provide offerings comprising products/services. It requires changes at social and technical levels. It also requires changes to the underlying approaches to RE, such as from bespoke to MDPD. To compete in the marketplace, COMP-XLL redefined its business

direction; the following statement from Chairperson summarizes COMP-XLL's direction

"*Organization to fast transition from HCM BPO to a technology-centric one.*" – The Chairperson of COMP-XLL.

The author conducted qualitative research immediately after the COMP-XLL took over from the MNC before initiating the social and technical changes. The remaining of this subsection highlights the operating dynamics using excerpts gathered during the semi-structured interview.

The teams' sales, product management, and operations performed requirements elicitation while the technology team used waterfall-based software development. The technology team focused on support activities; due to changing priorities, it focused more on support activities and not revenue-generating activities.

The sales and operations teams gathered requirements, but the lack of effective RE complicated the inter-departmental operational dynamics. The subsequent part of this section highlights the inter-departmental operational dynamics with quotes from the interviewees.

"*The backbone of operations is technology. Without technology support, we cannot meet our targets.*" – An operations manager and part of the leadership team.

"*Infrastructure and software applications invariably fail during peak loads and happens every year; moreover, the technology team does not address issues immediately.*" – A manager of the operations team.

"*We need the technology team to participate in customer conference calls and provide reasons when the operations team deliverables get delayed*." – A manager of the operations team.

"*Operations team does not communicate clearly during the requirements gathering phase and user acceptance testing; they make noise when customers complain*." – A manager of the technology team.

"*While committing enhancements with customers, we require the technology team to participate; they frequently display their unwillingness*." – A manager of the operations team.

Apart from the above, managing and engaging human resources also added to the operational dynamics. The following remark from managers in the technology and human resources team summarizes the dynamics.

"*A consistent policy in the recruitment of resources is missing, sometimes, contractors onboard, in three months, the cost becomes a key component resulting in the release of the new contractors. We only ended up training them on our products*." – A manager of the technology team.

"*Services from the human resources department are only for recruitment, onboarding, and on special occasions, we connect with employees*." – A manager of the human resources team.

The COMP-XLL based its transition plans on payroll and non-payroll classifications of HCM space and Everest Group's assessments by Basak et al., (2014) and (2015). Basak et al., 2015) placed COMP-XLL in the second category of the three-group classification in their assessment. They forecasted payroll operations, especially multi-country, to grow at 20% and reach US $1.2 BN. On non-payroll, Basak et al., (2014) placed COMP-XLL in the first category of the three-group classification. Both to stay ahead of the competition and gain market share suggested a wide spectrum of product offerings, mobility, analytics, and dashboard. The next subsection discusses the transition activities of COMP-XLL.

5.2 Modified Product Architecture and Associated Workplace Mechanisms

Oracle, specifically for the cloud, launched database version 12c with CDB and PDB. COMP-XLL modified its architecture to include container database (CDB) and pluggable databases (PDB). Their architectural changes focused on displaying the SPL characteristics. Figures 2 and 3 depict the CDB, PDB, and modularity of their modified architecture. In pursuit of their modularity, COMP-XLL followed a phased approach, as depicted in Table 1. The modularity assisted COMP-XLL in combining products that complement one another and form product families. These are 1) payroll, 2) benefits management, 3) strategic human resource management, and 4) workforce administration. A phased approach was also the approach to expand its market share. The first phase contained payroll, while the second phase focused on combining the second phase components of Table 1 with product families. To address evolving release scope, bespoke development, and reduced turnaround time, it relied on DevOps, Agile methodology, and changes to its horizontal organization structure. COMP-XLL used DevOps principles suggested by Bang et al., (2013) and the digital competence framework of Vieru et al., (2015). It relied on principles- feature orientation and reactive development based on expert judgment.

These principles required imbibing new methods such as collaboration, teamwork, and reduction of

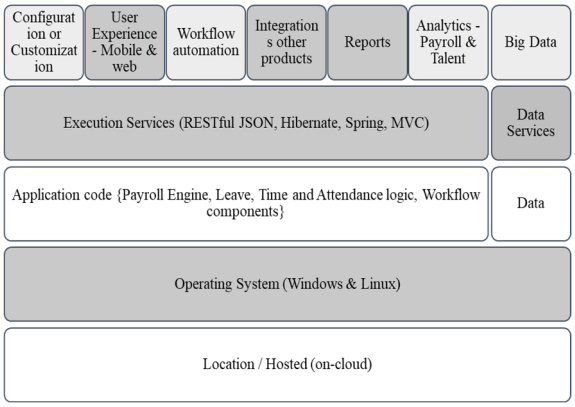

Figure 2: Application, platform, and associated components. Platform components in two phases are in shades of grey.

isomorphic teams and displayed these. However, there were instances where it struggled to display advanced Agile constructs such as shared decision-making, shared mental models, and self-managing teams.

In the second phase, while expanding market share expansion, the emphasis shifts towards release content instead of evolving release plan. The social changes necessary for advanced constructs of Agile methodology further increase the complexity.

The TCO reduction changes comprised retaining resources in the department, using automation to reduce the data setup activities (or preparation time) and the application setup time, and depicted in Tables 2 and 3. They extended automation for testing and continuous integration with Selenium[2] and Jenkins,[3] respectively. This orchestration enabled them to automate repetitive tasks, reduce turnaround time and restrict manual intervention to monitor and raise alarms and address exceptions.

Table 1: Platforms Product Components and the phases.

Phase	Components	Remarks
First	user experience, reports, and integrations	User experience for mobile and web, while integrations are for external products
Second	workflow automation, configuration/ customization, Big Data, and analytics	It requires equal consideration of technical and marketing inputs.

[2] Selenium is used to automate web applications testing and web-based administration tasks.
[3] Jenkins is an open-source continuous integration tool written in Java.
[4] HRMS (Human Resource Management System).

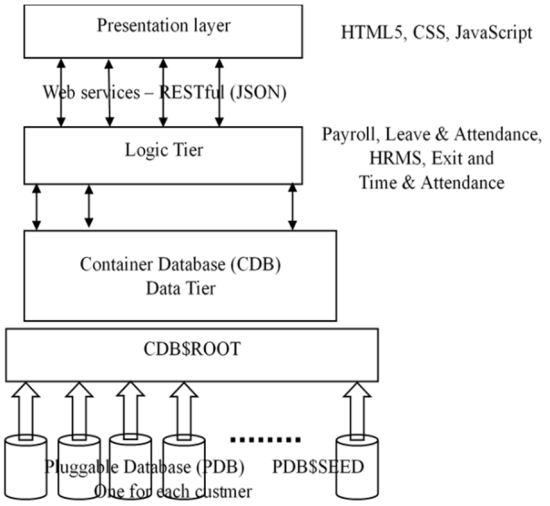

Figure 3: A diagrammatic sketch of the application & multitenant database architecture.

Table 2: Key business unit contributions for $ 1 cost.

Business Unit	%	# of people	Remarks
Operations	0.38	400	Perform managed services include setup and migration.
Sales & Product Management	0.2	30	Sales; solutions to customer problems
Technology	0.13	80	Develop products, change requests, and corrections
Real Estate	0.13	10	Administration
IT Infrastructure	0.10	10	Network and other activities
EBIT	0.06		

Table 3: Software Applications and preparation time.

Application (preparation time)	Time in days	
	Config	Migrate
Payroll (20-30)	10-15	10-15
HRMS[4] (35-45)	15-20	20-25
PMS[5] and LMS[6] (10-15)	5-7	5-8
L&A[7] and T&A[8] (30-35)	15-20	10-15
Exit Management (10-15)	4-7	6-8

[5] PMS (Performance Management System)
[6] LMS (Learning Management System)
[7] L & A (Leave and Attendance).
[8] T & A (Time and Attendance)

6 DISCUSSIONS

Organizations face external pressures and reasons for transitions. With the advent of cloud infrastructure services, on-premises organizations weigh their transition options. The options are the cost of acquisition, existing customer base, prospective customers they foresee, and the architectural components. The aspect porting of their existing data and applications and resilience displayed by their new application like its predecessor further challenge their transitions. We can use MLP to conceptualize the transitions and analyze challenges and the resulting agility. It requires examining the shaping and selection logics followed at the meso and micro-levels, this paper's focus. The paper's scope examined the challenges when an SME wants to modify its application and its development according to the shaping and selection logic.

Acquiring applications and venturing into a new business or customer segment is a strategy widely followed by organizations. Nevertheless, to continue meeting customer wants-and-needs and achieving the desired agility and TCO reduction, organizations must include the entire value-chain in their shaping and selection logic. The value chain involves upstream and downstream processes and specific to organizations. For example, multiple providers' cloud infrastructure requires new computing architectures and changes to data center centralization and services if applications adopt cloud systems on the multi-layered framework of current security technologies (Chang et al., 2016). Organizations need to reconcile their shaping and selection logic with their transition timelines which are, invariably, of long duration. The reconciliation involves retaining market share, accommodating scope changes and associated roadmap changes. One approach is continuous or 'block planning.'

Before this transition, COMP-XLL never performed any transition of magnitude and scale presented in this paper. So, they worked out a phased approach (or roadmap). The first phase considered the duration required to internalize the organization's changes and prioritize components that are prerequisites for the subsequent phases. It aimed to harness the fallout agility of its first phase in the subsequent phases. As presented in this paper, the debt need not be technical alone and involves social and influences shaping and selection logic. So, if organizations do not respond to external pressures and the debt, they can accumulate debt, which results in reduced agility and impacts their roadmap. COMP-XLL, in its subsequent phases, wants to combine product lines with MDPD. It may also necessitate 'block planning' and develop a roadmap based on external pressures, frequently refactor debt, and value chain activities. The frequent refactoring of plans and changes with appropriate shaping and selection logic decides an organization's agility or the extent to which they dynamically adapt to external pressures.

This study contributes to the transition theory by examining the meso-level activities that contribute to organizational agility. It considered both the upstream and downstream processes with associated social and technical changes.

7 CONCLUSION

This paper examined an SME's meso-level responses, especially information systems development, to obtain insights into its transition and shaping and selection logic. It uses on-premises applications and competes with cloud-based organizations. It devised a phased transition. In doing so, they attempted agility by prioritizing upstream and downstream activities of its entire value-chain and devised social and technical changes. We can construe its shaping and selection logic of addressing debt and harness its first phase's fallout agility in subsequent phases. Along with external pressures, it is essential to continuously manage debt if it wants to further leverage its agility and transition. The findings assist transitions of both on-premises and cloud-based application development organizations.

Since this paper used a single case study, there are limitations in the generalization of results, i.e., similar organizations. The author did not verify the cost implications (cost per payslip) that the COMP-XLL's leadership team envisaged for their managed services and self-managed products. By examining the cloud infrastructure provider's cost calculations, we can get further insights on making changes to existing applications or migrate to the cloud. This paper examined changes with Agile methodology and MDPD and did not test it in different contexts and diverse organizations. After changing the processes and architecture, it did not consider feedback from respondents. It did not examine the extent to which the changes assisted in dynamically adapting to external pressures. All these can add further insights to the findings.

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