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Application of cloud computing in financial services: an agent-oriented modelling approach

Subhas C. Misra and Kriti Doneria
Indian Institute of Technology Kanpur, Kanpur, India

Abstract

Purpose – Cloud computing is rapidly becoming the new norm of doing business. Lately, the extent of virtualization has enabled full-fledged cloud solution to become affordable, quantitatively and/or qualitatively. The purpose of this study is to explore the former in detail. In this paper, implementation of cloud-based services in the financial services, intermediaries and banking industry where security has always been the greatest concern are studied through actor-based stakeholder modelling. Drivers for adoption, benefits and trade-offs and challenges have been discussed in detail through a hypothetical comprehensive case study of a bank.

Design/methodology/approach – An actor-dependency-based technique for analyzing and modelling requirements prior to changes and charting out roadmap and rationale behind it all has been used. Through the use of i* modelling, dependencies and relationships between various stakeholders have been studied. Further, how decision makers in the financial services industry evaluate, consolidate and finally migrate to a new architecture is also explored.

Findings – Two hypothetical use cases on a hypothetical bank referred to as "The Bank" illustrate the technique and possible roadmap for implementation.

Originality/value – To the best of knowledge in the public domain, no similar work has been carried out with the perspective of modelling stakeholders and change management configuration in the financial services using cloud. This approach is valuable for augmenting technological advancements with business insights and spotting value in synergies of the sectors whenever and wherever apparent.

Keywords Finance, Banking, Modelling, Business strategy, Computing

Paper type Research paper

1. Introduction

The information technology (IT) forecasts exponential growth in terms of usage and adoption for the next decade. The key drivers of this growth are reduction in prices of electricity coupled with increase in computing and storage power. So, for the industry to understand the techniques and tools aimed at solving business challenges it becomes increasingly important to look at it from the viewpoint of synergies and symbiotic relationships it is capable of bringing in to the ecosystem. In this paper, the cloud computing landscape has been explored in detail as a standalone technology and its possible implementation in financial and banking sector.

Historically, banking intermediaries and financial services have been the innovators for products with a steep learning curve, but the reasons why this sector is still apprehensive about adopting agile cloud technologies is explored (Gaetjen *et al.*, 2015; Awadallah, 2016; Misra, *et al.*, 2017). While these challenges are valid, it has been noticed that some institutions around the world (for example, hospitals) seem to have found a middle ground and adopt cloud to cater to the non-core functionalities of the business. The idea that has been proposed in this paper is that banking sector can begin to think along similar lines.

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Through the use of a strategic dependencies stakeholder modelling during early phase requirement engineering, two hypothetical use cases have been suggested. Some parts and subparts of these cases come from a pure academic understanding of extrapolation from other industries. It is noteworthy that these cases do not represent any real existing industry case in the public domain as per the best of knowledge of the authors and operates on the assumptions loosely structured around the way actual financial institutions operate around the world. The cloud services listed in the model come from various vendors that offer these functionalities, bundled and/or unbundled, and it is assumed that geographical barriers are insignificant here, which is more so the case in the connected world of today. Although doing business over the cloud does present an apparent security threat, there are ways to reap the benefits without going all in at once.

Aligning businesses with information communication technology has always been a challenge, and today, newer challenges have emerged. Any technological change, no matter the scale, is ultimately dependent upon the "actors" that are responsible for carrying out the change management successfully (Khajeh-Hosseini *et al.*, 2012) minimising the risks that are present. So, it is rational to model the requirements based upon the interests of the actors, describing their roles, areas, boundaries and tasks to be carried out. Introducing new people at the middle levels during change configuration management is a practice reserved solely for emergencies in most corporates; hence, newly created roles have been assigned to existing people in the ecosystem for the sake of simplicity. There are different types of cloud computing and because of its massive scalability, robustness and cost-effectiveness, all industries are beginning to adopt cloud implementation for their technological needs.

2. Cloud computing: types, usage and challenges

Cloud computing is the sharing of infrastructure, services and applications over the internet on demand for customers. It differs in conventional computing in the sense that companies using cloud services can save the infrastructure and maintenance costs incurred within their business. Over the past decade, the move to cloud has been accelerated.

To the best of industry knowledge convergence, the key features of cloud computing include:

- *Automated on-demand service*: Users (human/non-humans) can request provisioning of computing resources on the cloud without any middlemen intervention, generally though a browser or command line tools.
- *Encompassing network access*: Resources hosted on the cloud are accessible over the internet from a wide array of devices such as mobiles, desktops, laptops and tablets.
- *Resource pooling*: There are provision requests from more than one customer without the need of separating the physical hardware layer, by securely running separate instances on logical level.
- *Rapid elasticity*: Resources are re-provisioned, provisioned, un-provisioned and released as per system requirements or automated based on flags or parameters. This ensures that user application has exactly the capacity needed at any given point of time, minimising wastage.
- *Measured service*: Resource usage is monitored, measured and reported. The final bill is made as per the amount of resource utilized by the client, which provides a great deal of flexibility to the client.

Although cloud is a relatively new technology, it was not developed overnight. It can be seen rather as a gradual evolution which started with Grid computing in the 1950s and has slowly evolved into the form it is today. Grid computing was using parallel computing with multiple mainframe systems connected to solve large problems. Then, companies started offering virtual machines for clients at some cost for using its services. In the 1990s, companies started offering their application services to be used by customers over the internet. This model was called SaaS or Software as a Service. As years rolled by, cloud providers added more functionality on top of infrastructure and applications and started providing additional functionalities and services, which has led to the development of cloud computing as it is known today. Cloud computing has evolved into various deployment and delivery models and is continuously evolving. Today, many businesses have embraced cloud computing and cloud providers have also constantly improved their offerings to suit the needs of customers.

Crudely, cloud computing can be classified into two types: service models and deployment models.

Service models are further classified (but not limited to) as:

- *Software as a Service* (*SaaS*): The user is provided instances of applications hosted by the provider on a cloud. The applications can then be accessed from through a thin net client such as an API or a browser. The consumer need not manage, control or modify underlying infrastructure including OS, servers, network and storage.
- *Platform as a Service* (*PaaS*): The customer deploys infrastructure, libraries, services, applications, tools, languages, etc. onto the cloud. Consumer can control the applications hosted and settings, but not the underlying hardware.
- *Infrastructure as a Service* (*IaaS*): Consumer itself can provision computing resources where it can further deploy and run any software. The consumer has control over these applications and select control of n/w components (e.g. firewalls). The consumer still has no control over the actual hardware.

In all of these service models, the consumer has no access to underlying hardware, virtualization software or architecture. That rests with the cloud service provider, and all services are provided as capabilities instead of physical computing resources. Advantages to this kind of architecture are in terms of high scalability and flexibility and an economical pay-as-you-go cost. It requires no upfront investments.

Deployment models classify cloud services on the basis of the physical arrangement of deploying the services location-wise: It can be categorised into the following categories [10]:

- *Private cloud*: It is used by a single organization only, managed and owned by the organization and a third party on or off premises.
- *Community cloud*: It is used by a particular community of consumers from organizations having shared interests, managed and owned by one or more organizations or outsourced to vendor and may exist on or off premises;
- *Public cloud*: It is used by the general public openly, managed and owned by a business or government agency and exists on the premises of the cloud provider.
- *Hybrid cloud*: It is a combination of two or more types of cloud listed above (private, community or public) that remains separately identifiable entities, bound together by open licences or technology that enables app and data portability.

The choice of the model to be used is open-ended and depends mostly on the alignment of business objectives with the IT objectives, strategic decisions, ease of implementation, time and resources available at hand, costs associated, upgrading decisions, upfront investment goals, etc. (Chang *et al.*, 2010). A business may choose to change its deployment or delivery model, and given the transparency of cloud services, the same can be achieved at minimal cost and effort. Having long-term plans chalked out and growth plans set in place, an organization has plethora of options to choose from and also the freedom to revise those decisions as needed with much less complexities involved than in traditional, in-house IT systems. Speed, agility, dexterity and differentiation (Oly Ndubisi, 2007) are the key pillars of succeeding in an uncertain IT environment and looking at the benefits of cloud systems and virtualization is important while considering a move.

Some of the noteworthy benefits cloud computing provides to financial businesses in particular are enumerated as follows [10]:

- *Reduce costs*: By adopting cloud computing, banks can reduce costs required for hardware, software and manpower. Virtualization is a good way of saving on the bottom line (Agarwal and Doneria, 2016).
- *Flexibility and scalability*: Banks can adapt to changing trends in the industry and its customers and adapt to the technological challenges faced during scaling up much faster with cloud implementation.
- *Greater efficiency*: Banks can achieve greater performance and efficiency with cloud implementation. They will also be well prepared to adopt new technologies quickly if they have a cloud installation.
- *Better service to customers*: Cloud computing enables easier development and deployment of multiple applications across a shared platform which gives faster service to customers and a good customer experience.
- *Customer relationship management*: With the advent of big data and analytics, banks can use cloud-based technologies to develop highly customised services to its customers and help them in making better financial decisions (Auh *et al.*, 2007; Wright and Watkins, 2010).

Cloud computing also poses certain challenges for banking services which are listed below:

- *Security*: Data security is of highest importance in the banking sector. Banks are hesitant to adopt cloud-based services because of the threat to data security in a cloud implementation when compared to traditional in-house implementation.
- *Reliability*: Banking services must always be available to customers, even during extreme situations like disasters and other such unpredictable events. Usually, banks go for disaster switchover mechanism when implementing its services, but such implementation is very expensive in the cloud.
- *Regulatory compliance*: The banking services are governed by very strict regulatory governance which varies from country to country and will have to follow the guidelines which might limit the functionality of cloud implementation.
- *Cloud management*: Banks usually adopt cloud services from multiple providers for different functionalities which require management and interoperability between different modules, creating a challenge to users.

3. Early phase requirement engineering: strategic actors dependency modelling

Requirement engineering is of paramount importance when one begins to explore uncharted waters. As functional and structural details are only rudimentary and subject to further refinement at this stage, it becomes even more important to model requirements based upon actions and their interests so as to get a hawk-eye view of the proposed system.

Modelling organizational processes, functions, strategies and how it aligns with the actors is the sole purpose of RE. In this paper, the actor dependency concept using i* modelling (Yu and Mylopoulos, 1993; Misra *et al.*, 2006; Misra *et al.*, 2007) has been used. i* contains concepts from software engineering, but it is one of the simplest yet impactful tool for modelling organizational stakeholders' interests and objectives. i* explores why steps are performed in a certain order. It is easy to conceptualise requirements using i* modelling (Deb *et al.*, 2016), as the framework forces engineers to model processes in detail and ease of modification to increase, improve and optimize enterprise output quite early on.

Two types of i* diagrams are used: strategic dependency (SD) model and strategic rational (SR) model. SD diagram depicts interdependencies between actors, while SR diagram illustrates the underlying causes for those dependencies. The two are complementary in nature. Some argue that SD describes dependencies from a higher level of abstraction; all dependencies comprise A "Depender" depending on a "Dependee" to get "Dependum". The pivotal elements of an SD diagram are:

- *Goal dependency*: When an actor depends on another actor to make a tangible condition true. Dependee is free to choose how to achieve this goal.
- *Resource dependency*: When an actor depends on another for the availability of an entity. Depender assumes lack of any transitivity.
- *Task dependency*: When an actor depends on another to perform an activity. There is an implicit depender's goal, explaining the need of that task.
- *Softgoal dependency*: When an actor relies on another actor to make a fuzzy (means that there are no clear, logical criteria for the condition to be true) condition come true. A dependee collaborates and depender decides how to achieve the softgoal.

Intuitively, SR diagrams focus on actors in depth. Generally, SR diagrams exhibit both external and internal data and influences. External information is modelled using the same elements as SD diagrams (goals, softgoals, resources and tasks). Internal information is represented similarly, hierarchically in end or task-decomposition relationship. External dependency relationships among actors' map to internal elements of SR. Internal tasks might be simplified as subtasks, sub-goals and sub-softgoals (task-decomposition relationships). Internal goals might depend on other subtasks (means-end relationships) and might have negative or positive contribution from other tasks and sub-softgoals.

4. Banking and financial services – newer technologies, emerging challenges

Banking and financial service institutions are early adopters of new technologies and mainly use it as a key differentiator. With high levels of automation transforming business processes, capability maturity of the functions. Horizontal processing and technological outsourcing that have stood ground for long, banking and financial institutions can reap significant benefits from the cloud if planned properly. As challenges become increasingly complex, so does the technological sophistication required to address the former (Ghule *et al.*, 2014; Shi *et al.*, 2010).

Banks face the challenges like lowered capital results in thinner margins, empowered customers with high expectations, entrance of non-traditional firms and increasing industry consolidation, evolving business models continue to shift from product centric to customercentric and enhanced government regulation.

5. Moving to the cloud-charting the path

The banking sector has managed to embrace the challenges in cloud implementation and have adopted cloud computing for their businesses. With improvement in data security, they might also implement core business functions in the cloud in the future. First movers' advantage is always there to act as a motivator for banks.

When beginning to shift to cloud, an incremental approach works better than the traditional in one-go approach (Misra *et al.*, 2007; Misra and Mondal, 2011). Cloud systems provide the flexibility to do so at minimal extra costs. When businesses are still testing the waters, it makes more sense to move a small, non-critical but auxiliary function or a superset thereof to cloud. Too often does the business lose sight of its core competency while driving out the competition and it is usually these services that act as a deal or no deal for the consumers. Another reason is apportioned costs instead of straight up-front investment. Decision makers and stakeholders agreed upon one thing that speed is a source of competitive advantage but reliability is also a must.

Conceptually, two possible use cases have been modelled in this paper. An entity named "The Bank (as it is referred to from here on) has been used to demonstrate the model. While one deals with how banks can leverage faster provisioning of Database services, the other deals with how differentiated and personalized marketing (Shields, 2015) can be moved to the cloud and leveraged as a source of competitive advantage. Various actors, goals, relationships, interdependencies and possible changes in the organizational structure initially have been outlined. Assumptions and simplifications if any have been clearly stated.

Both these scenarios have been modelled using i* modelling (OpenOME tool) in this paper, subsequently.

5.1 Database as a service for faster provisioning and rapid elasticity

Conceptually, the bank gets a major part of its revenue from the lending business. It had to stay ahead of the competition by constantly offering new products, maintaining existing customers and acquiring new customers. The bank's IT team required to provision the database. With traditional IT infrastructure, the process can take up to five days to complete. This time lag may cause losses and incur billing costs for the entire duration. Thus, The bank can safely consider moving this process to the cloud by using Database as a Service (DBaaS), possible one that provides in-memory computational capability and does not take longer than a few hours for provisioning.

Figure 1 shows the database provisioning using traditional IT setup, mostly undertaken by in-house IT team of a bank. The in-house IT team depends on the infrastructure to achieve the goal of reducing downtime. With traditional IT setup, the downtime is around three to five days, assuming average load. This delay is significant, and employee's resources which could have been put to better economic use during the work week.

The IT team's responsibility in this context is to provision the database, achieved by obtaining user data as the goal and user convenience as soft goal.

For moving to the cloud, mapping out possible actors, goals, tasks. Resources, soft goals and dependencies are crucial. Given below is a generic layout of the former, subject to change according to business objective. The ordering of the elements is insignificant, and all elements can be assumed to be of roughly equal importance. Here, it has been assumed that it is a free oligopolistic market and banks compete for higher market share that directly translates to profit margins. For the sake of simplicity, bank management team has not been considered as a separate actor here.

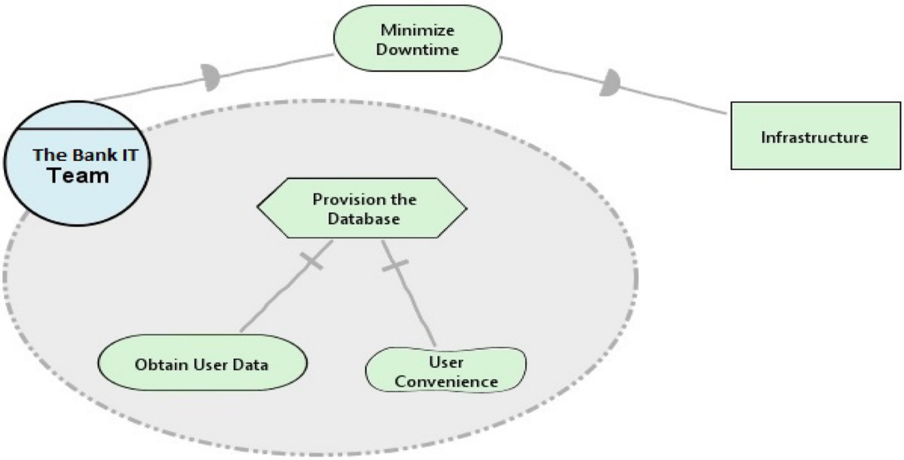

Figure 1.
SR diagram for database provisioning using traditional IT setup

(1) Actors:
- the bank IT team;
- cloud service provider team; and
- cloud service provider management.

(2) Goals:
- *obtain user data*: boundary goal for the bank IT team;
- *reduce time*: boundary goal for cloud service provider team;
- *project delivery*: goal between cloud service provider management and cloud service provider team;
- *cloud implementation*: goal between the bank it team and cloud service provider team; and
- *reduce cost*: goal between the bank it team and cloud service provider team.

(3) Tasks:
- *provision the database*: boundary task for the bank IT team; and
- *in memory*: boundary task for cloud service provider team.

(4) Resources:
- *cloud service provider exadata*: boundary resource for cloud service provider team; and
- *budget*: resource between cloud service provider team and cloud service provider management.

(5) Softgoals:
- *user convenience*: boundary soft goal for the bank IT team;
- *reduce cost*: boundary soft goal for cloud service provider team; and
- *scalability*: soft goal between the bank it team and cloud service provider team.

(6) Dependencies:

- the bank IT team depends upon cloud service provider team for achieving the goal of cloud implementation of Database as a Service (DbaaS);
- the bank IT team depends upon cloud service provider team to reduce costs;
- cloud service provider team depends upon cloud service provider management for allocation of budget as a resource to implement the project;
- cloud service provider management depends upon cloud service provider team for achieving the goal of project delivery; and
- the bank IT team also depends upon cloud service provider team to achieve the soft goal of scalability through cloud implementation (Figure 2).

5.2 Implementation of marketing services–cloud vendor

The bank may start using marketing services–cloud vendor platform for delivering personalized digital experiences to customer base. This included a digital marketing solution using multiple communication channels like email, SMS, social media and mobile apps automated via marketing services–cloud vendor's platform. Cloud platforms are generally capable of handling the enormous customer load of the order of hundreds of millions of emails in a month. This boosts the bank's marketing efforts by supplementing their planning, automation and marketing communications across channels and consequently project the image of a more personalized banking experience to premium and non-premium consumers.

Figure 3 illustrates the modelling of the bank's executive team using i* modelling technique. Executive vice-president of the project for the bank can either be Head of Marketing, Head of Data Analytics, basically a person who has prior experience working with the management change configuration and who can be a good point of contact for the technical team of the cloud vendor. This project manager shall be responsible for the goal of cloud implementation of marketing platform using marketing services provided by the cloud vendor. The means of achieving the goal is through the task of project management, which has finance and HR as resources and user experience, profit and increasing customers as soft goals within the boundary of the position of project manager. Softgoals may also include other organization-specific elements such as compliance and formalisation.

The strategic relationship model in Figure 4 shows the representation of marketing services–cloud vendor's IT team. The boundary task is to develop cloud application for the bank's marketing business challenge. Typically, this task has two main resources: developers and testers. It also has user interface as a soft goal. For simplicity, security, privacy issues and other softgoals have been taken as implicit.

Figure 5 showcases typical goals of the bank's marketing team. it has boundary goal of increasing customers. It achieves this by performing the task of carrying out successful marketing campaign, an implicit softgoal being reducing churn rates as well. This goal is fuzzy, as success parameters may vary from bank to bank, but in accordance with the assumptions stated at the beginning, increasing market share and hence profits can be taken as an inherent goal.

The entire modelling of the bank's implementation of marketing services–cloud vendor is shown in Figure 6. Some salient features and insights that can be inferred from this model are:

- The bank's project manager depends upon marketing services–cloud vendor IT team to achieve the goal of cloud implementation;
- The marketing services–cloud vendor IT team depends on the bank's marketing team for content to be circulated across channels;

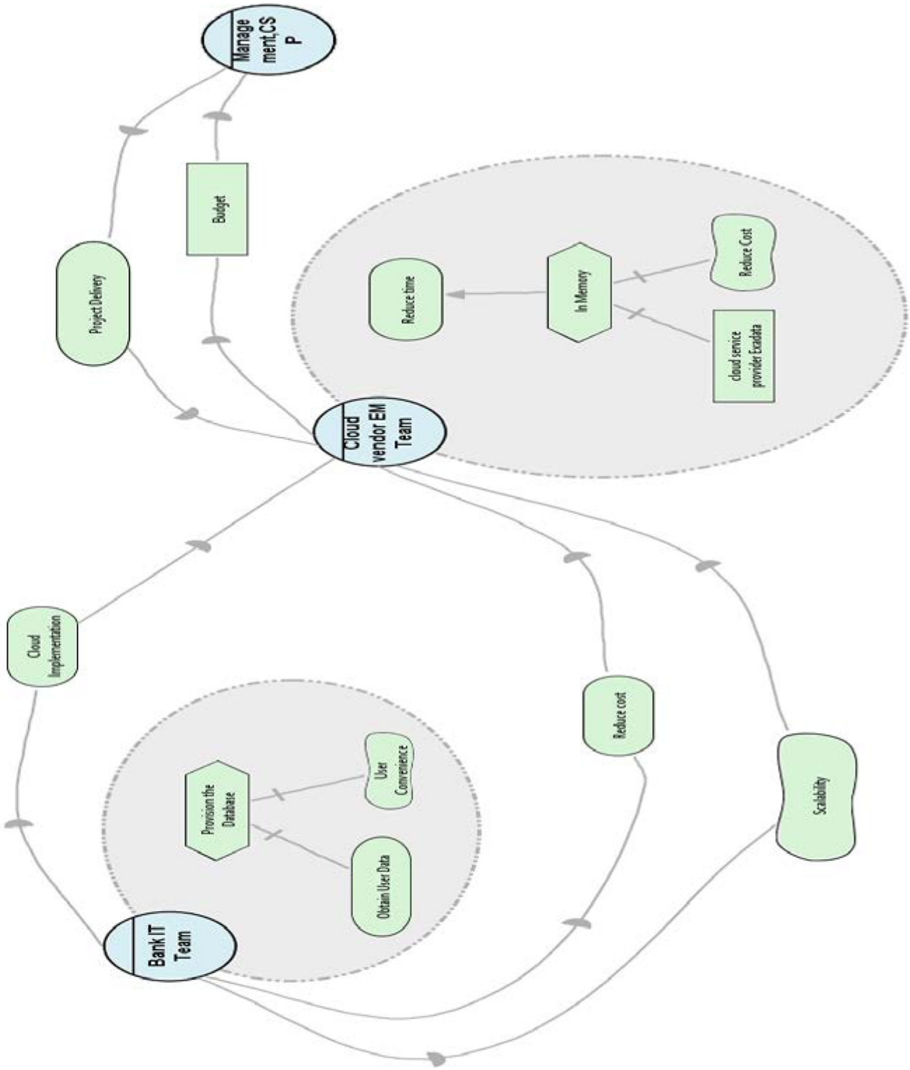

Figure 2.
SR diagram for provisioning of database using cloud

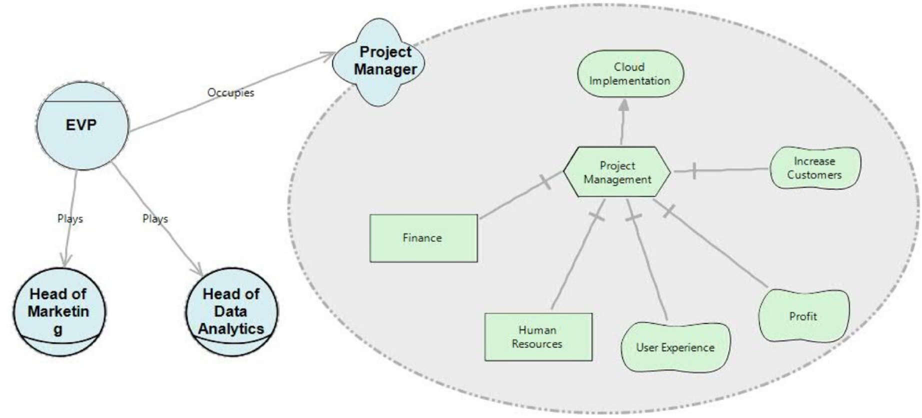

Figure 3.
SR diagram for the bank's marketing team

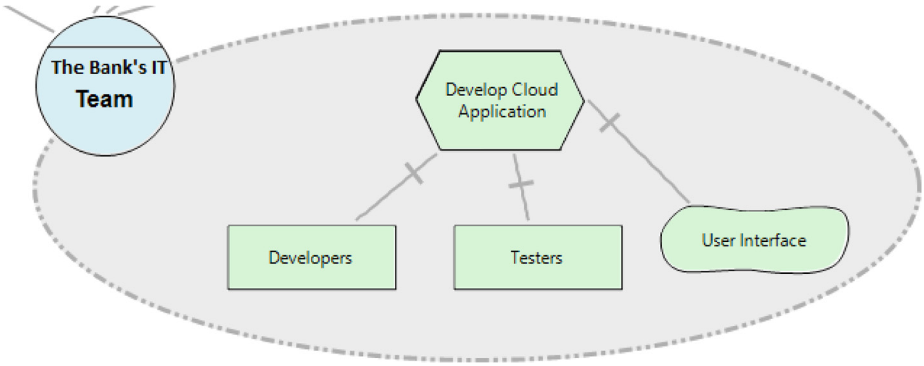

Figure 4.
SR diagram marketing service provider cloud vendor team

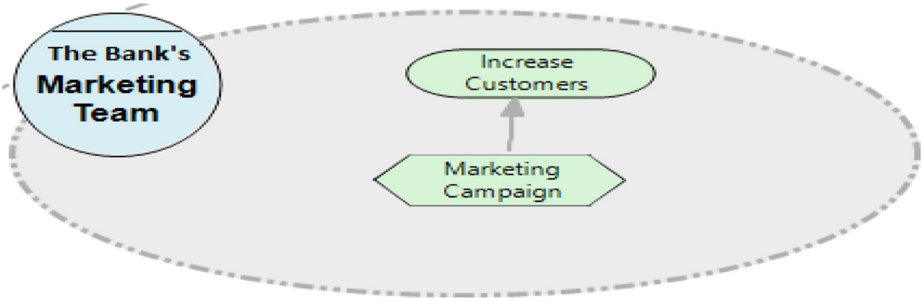

Figure 5.
SR diagram for the bank's marketing team

- The marketing team in turn depends on the in-house data team of the bank for the task of obtaining customer analytical data;
- The marketing services–cloud vendor IT team depends on the chief finance officer, managing director or the chief executive officer for budget to implement the project; and
- The managing director in turn depends on marketing services–cloud vendor's IT team to achieve the goal of delivering the project.

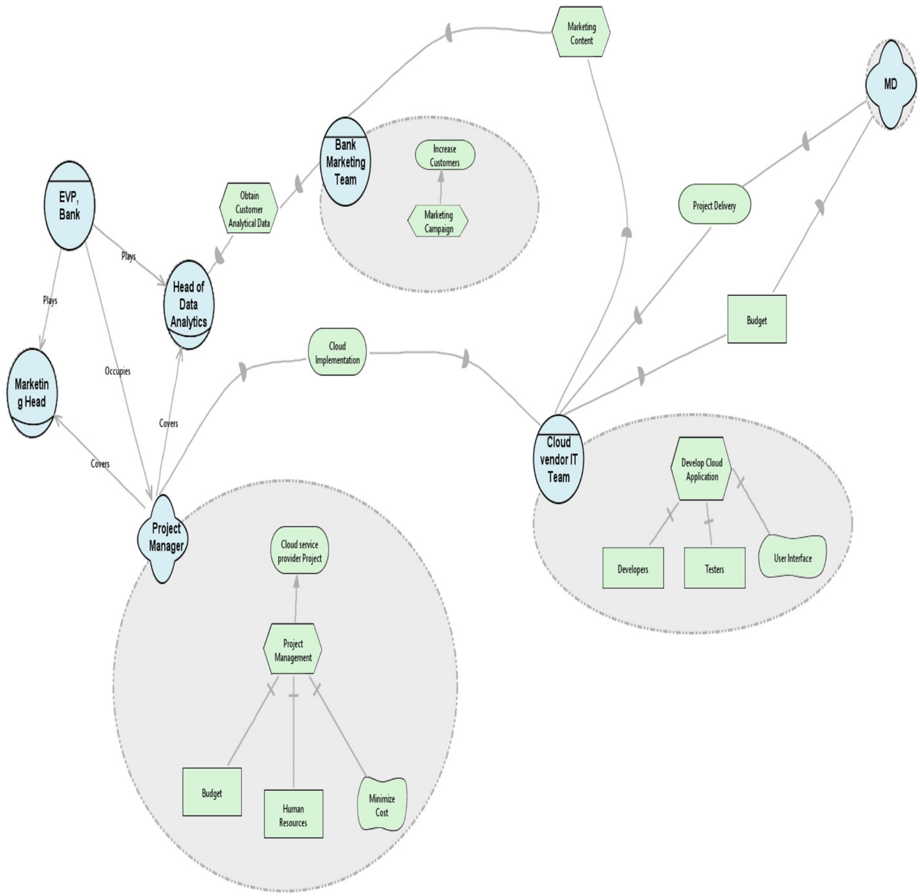

Figure 6.
SR modelling of marketing services–cloud vendor

6. Conclusions

It can be seen from the above examples that the implementation of cloud computing in financial sector is economically and technologically driven, but ultimately is dependent upon the actors who carry out that change. In this study, authors have assigned newly created roles to existing people in the ecosystem, which may not be the case if the existing actors lack required skills. Actors and their goals represent organizational goals and industry generic goals. Specific roles may be added as required. Actor-based modelling clearly shows the jurisdiction of each actor and entity, indicating actual limitations and grey areas to begin with.

Financial sector, where data are crucial and the information about customers is highly critical, has started shedding its fear in terms of lack of security in the conventional sense. In particular, non-traditional banking and financial services industry firms are quickly adapting to the new way of doing business. For starters, newer technology works on the cloud while the core banking services are still run in-house because of the critical nature of the data involved, as well as regulatory policies governing use of cloud computing (which is issued by the governing and regulatory bodies). With increase in customer base over time, banks might eventually be forced to move its core banking functionalities to the cloud because of the benefits of scalability and reduced costs.

Opening up new avenues requires scratching an existing itch, and much like the banking system embraced IT and internet wave, it is likely to absorb cloud seamlessly in the long run. It is prudent to start the move to the cloud incrementally, and the approaches presented in this paper are by no means exhaustive. As of now, keeping data security and privacy concerns in the picture, it is still possible for the banking sector to draw parallels from other high-growth industries and leverage cloud to reap its benefits while still retaining its core banking services inhouse.

With the advent of cryptocurrency, the need becomes even more acute. Taking into account the interests of all stakeholders and boundaries, future proofing of the business is a priority. For synergies to be garnered, there needs to be common goals in the long run. A lot of legal implication, including the drafting, revision and periodic re-revision of the service level agreements (Wieder *et al.*, 2011) between the cloud service providers, vendors and users is required, as it is a perpetual cost-based model. Looking at the growth patterns, several industry-wide new trends can be said to emerge. Internet of Things can be one, while sustainable IT can be another. Having looked at the symbiosis between the two sectors above, it may be possible to extend the scope of this study to more dimensions in the future.

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About the authors

Subhas C. Misra (Associate Professor, IIT Kanpur) is currently an Advisor to Indo Canada Education Council and the editor of several international journals published across the globe. Previously, a Visiting Scientist at Harvard University, his academic qualifications include PDF (Harvard University, USA) and PhD (Carleton University, Canada). With 15+ years of academic experience, his research interests include software, technology, modelling and governance. He has authored over 100 research papers and won Best Paper Awards in international conferences held in the USA, Canada and India. He has more than 15 academic awards including Research Excellence Award (USA) and NSERC Fellowship (Canada). Subhas C. Misra is the corresponding author and can be contacted at: subhasm@iitk.ac.in

Kriti Doneria is an MBA graduate from IIT Kanpur. Her interest lies in cloud computing, emerging technologies and analytics. Her work spans across technical and social domains. She writes papers, blogs and articles.