Is there a Silver Lining to the Cloud?

A Research Proposal for Synthesizing[1] a Viability Model[1] for CERN's Large Hadron Collider (LHC) outsourcing its Storage to the IaaS-Cloud

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Abstract
IT Outsourcing is a business strategy that has achieved significant success over the last decade. Traditionally, IT Outsourcing has comprised of the host organization consuming services, which are being offered by vendors who maintain physical IT infrastructure. With the advent of Cloud Computing, host organizations now have an option of moving their IT Outsourcing needs to Cloud Computing rather than using specific vendors. On one hand, the analysis of traditional IT Outsourcing has been dominated by the rationalities of Business and Society while on the other hand, the analysis of Cloud Computing has been dominated by the rationalities of Engineering and Economics. If adopting Cloud Computing is inherently an IT Outsourcing decision, then shouldn't the analysis of the decision be made holistically by all the rationalities keeping in view the interaction amongst the various rationalities? Even though, the answer is 'yes', there exists no model or, guidelines today to support this requirement. In this Research Proposal, a Viability Model is put forward, in the context of the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN), which looks at IT Outsourcing to Cloud Computing through a multi-rational lens.

Key Words
Cloud Computing, IaaS-Cloud, Large Hadron Collider, Viability Model, IT Outsourcing, Transaction Cost Theory, Core Capabilities Theory, Political Model, Social Exchange Theory, Partnership Quality Model, DeLone and McLean Model, Resource Based View of the Firm, Systems Theory, Multi-Rational Lens, Iterative Econometric Model-Building Method

1. Introduction

The basic argument of this Research Proposal is that an IT Outsourcing decision for moving to Cloud Computing should be looked at from multiple rationalities[1] in order to increase the probability of success for such a decision. In support of the argument, the Research Proposal will utilize a multi-rational lens to look at the computing requirements of CERN's LHC and how its storage can be viably outsourced to the IaaS-Cloud to achieve engineering, business, economic and societal benefits.

Firstly, the foundation for the Viability Model will be prepared by describing the computing needs of the LHC at CERN and how it is viable for some of the computing components to undergo IT Outsourcing to the Cloud. Secondly, the Research Proposal will describe the basic building blocks of Cloud Computing's Infrastructure as a Service (IaaS) offering and how it may be useful for CERN's LHC to move its Storage to the IaaS-Cloud.

Thirdly, the Research Proposal will move onto the analysis of the IT Outsourcing decision of the LHC of its Storage to

[1] "One of the possible meanings of 'Rationality' is a rational opinion, belief, or practice" (Merriam-Webster Dictionary). In the study of Information Systems, the concept of rationality has been used as an aggregator for related thoughts and ideas viz., the ideas and thoughts related to the study of Information Systems by looking at Information Systems as more of an integrated social phenomenon rather than an isolated technical phenomenon is called, 'Social Rationality'

the IaaS-Cloud by arguing through a multi-rational lens: (i) For the Economic rationality, it will bring in perspectives from Transaction Cost Theory (Aubert, 2002; Wang, 2002; Ngwenyama et al, 1999) and Core Capabilities Theory (Arnold, 2000; Willcocks et al, 1996), (ii) For the Engineering rationality, it will look at the work done by (Misra et al, 2011), (iii) As a part of the Business rationality, it will bring in aspects of Systems Theory (Nevo et al, 2010), Resource Based View of the Firm (Nevo et al, 2010; Melville et al, 2004) and DeLone & McLean Model (Wang, 2008), and (iv) For the Societal rationality, it will bring in perspectives from Political Model (Lacity et al, 1993), Social Exchange Theory (Emerson, 1976) and Partnership Quality Model (Lee et al, 1999).

Lastly, the Research Proposal will propose a Viability Model built from relevant components from all the rationalities on the lines of a typical Research Model in terms of Independent, Dependent & Control Variables and propose Determinant Relationships for the Null Hypotheses. It will also make use of the Iterative Econometric Model-Building Method (Zellner, 1979) to propose calibration and further refinement of the Viability Model.

2. The Worldwide LHC Computing Grid (WLCG)

2.1 Introduction: What makes CERN's LHC unique

"The Worldwide LHC Computing Grid (WLCG) is the world's largest computing grid. Today, the WLCG combines the computing resources of more than 200,000 processors from over 170 sites in 34 countries, producing a massive distributed computing infrastructure that provides more than 8000 Physicists around the World with near real-time access to LHC data, and the power to process it. The computing centres providing resources for the Worldwide LHC Computing Grid are also active in other grids, in particular European Grid Initiative (EGI) in Europe and Open Science Grid (OSG) in the United States, but also national and regional grid structures such as GridPP in the UK, INFN Grid in Italy and NorduGrid in the Nordic countries" (WLCG, 2010).

"The LHC accelerator creates extremely high energy particle collisions, which in turn create new particles that decay in very complex ways as they move through the detectors. The detectors register the passage of these particles with a vast number of sensors and, finally, a digitised summary of this is recorded as an 'Event'. With more than 8,000 LHC physicists across the four main experiments - ALICE, ATLAS, CMS and LHCb - actively analysing the data, a lot of computing power is needed" (WLCG, 2010).

"The WLCG consists of three layers or, 'Tiers', which are made up of computer centres which contribute to different aspects of the WLCG. Tier-0 is one site: The CERN Computing Centre. All data from the LHC passes through this central hub but it provides less than 20% of the total compute capacity. It is connected to other major tiers and Grid services using dedicated 10 gigabits per second optical wide area links. Tier-1 consists of eleven sites: These are located in Canada, France, Germany, Italy, the Netherlands, the Nordic countries, Spain, Taipei, the UK, and two sites in the USA. These sites provide distribution networks, processing of raw data, data analysis, and storage facilities. Tier-2 has around 140 sites covering most of the globe: These sites provide localized data retrieval and processing. Together, these Tier-2 sites provide approximately half of the capacity needed to process the LHC data" (WLCG, 2010).

2.2 Storage

"Massive, multi-Petabytes, storage systems and computing clusters with thousands of nodes connected by high speed networks are the building blocks of the WLCG. The WLCG uses specialised tools to manage the immense disk and magnetic tape mass storage systems needed for LHC data, and allow applications to access the data for simulation and analysis, independent of the storage medium (tape or, disk) that the data resides on. The LHC produces around 15 Petabytes (15 Million Gigabytes) of data every year. The WLCG is running over 1,000,000 tasks per day, and this will increase as time goes on and as computing resources and new technologies become ever more available across the World, which in turn will dictate the increase of capacity in storage systems" (WLCG, 2010).

2.3 Cost Analysis

The total Capital Expenditure (CAPEX) for the LHC was 4355 Million GBP. CERN's share of LHC's Computing Infrastructure was 112 Million GBP, while other member countries and institutions paid for the rest. For CERN, the LHC Computing Infrastructure cost 57 Million GBP for Personnel and 55 Million GBP for Materials. (CERN, 2009)

As a part of Operational Expenditure (OPEX), CERN contributes on an average 20% of cost for Materials for experiments being conducted at the LHC (CERN, 2009). This translates into a significant amount of OPEX in which the LHC Computing Infrastructure also has a large share.

In case CERN's LHC adopts IT Outsourcing to Cloud Computing, a significant amount of cost saving in OPEX will be achieved, with maximum cost saving coming from Personnel. Other major cost savings in OPEX would be obtained through utilization of On-Demand S/W Licenses and Pay-As-You-Go Payment for computing resources (such as Storage, Processing, S/W and Platform) in Cloud Computing.

3. The Infrastructure as a Service Cloud (IaaS-Cloud)

3.1 Introduction

As per the National Institute of Standards and Technology (NIST), "Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell et al, 2010).

"Cloud infrastructure services, also known as 'Infrastructure as a Service (IaaS)', delivers computer infrastructure - typically a platform virtualization environment - as a service. Rather than purchasing servers, software, data-center space or network equipment, clients instead buy those resources as a fully outsourced service. Suppliers typically bill such services on a utility computing basis and amount of resources consumed (and therefore the cost) will typically reflect the level of activity" (Cloud Computing, Wikipedia).

3.2 Benefits Analysis

There are numerous benefits of using an IaaS-Cloud over grid architecture such as: (i) Performance enhancement in terms of platform construction, application deployment, compute rates and completion times, and (ii) Optimal resource usage and cost-efficiency in creating and deploying applications on different platforms (Kondo et al, 2009).

3.3 Risk Analysis

As per Gartner Research, the Top-7 Risks in IT Outsourcing to Cloud Computing are: (i) Privileged User Access, (ii) Data Location, (iii) Data Segregation, (iv) Regulatory Compliance, (v) Recovery / Continuity, (vi) Investigative Support, and (vii) Vendor Perpetuity (Brodkin, 2008). Other prominent risks for IT Outsourcing to Cloud Computing are Privacy and Management & Control (Armbrust, 2009).

The Research Proposal will take these risks as the Control Variables (Processing) for the Viability Model and they will be assumed to have different levels of influence on the Independent Variable (Output), as per contextual application.

4. The Economic Rationality[2] of IT Outsourcing

4.1 Transaction Cost Theory

"Outsourcing can be defined as the handover of an activity to an external supplier and can be considered as an alternative to internal production. However, using a market is not frictionless i.e., when buying a service or a product, one incurs costs called, 'Transaction Costs'. If these

[2] The ideas and thoughts related to the study of Information Systems by looking at Information Systems as more of an integrated economic phenomenon rather than an isolated technical phenomenon is called, 'Economic Rationality'. In the Economic Rationality of IT Outsourcing, the focus of study is on the maximization of economic gain through outsourcing IT

Transaction Costs become too high, it will be advantageous to rely on internal production in order to get the desired product or service" (Aubert, 2002). As a corollary, it can be said that if the friction costs of the market are low (i.e., Transaction Costs are low) then it will be advantageous to pursue outsourcing.

"There are two underlying assumptions in the Transaction Costs Theory: Bounded Rationality and Opportunism. Bounded Rationality represents the inability of the human mind to find or, to process all the information regarding a transaction, and so transactions are conducted with a certain level of Uncertainty" (Aubert, 2002). Opportunism is more than the simple defence of one's interest or value maximization; it is "self interest seeking with guile" (Williamson, 1989). "The combination of these two assumptions results in Information Asymmetry" (Aubert, 2002). The greater the Information Asymmetry, the higher the Transaction Costs and the lesser will be the advantage of outsourcing.

The factors determining the importance of Transaction Costs are grouped into three broad categories: "(i) The Asset Specificity required to perform the transaction, (ii) the Level of Uncertainty surrounding the transaction, and (iii) the origin of the Critical Investments associated with the transaction and their alignment with the allocation of Residual Rights" (Aubert, 2002; Lacity and Willcocks, 1996).

"The degree of Asset Specificity can be measured by the difference between the cost of the asset and the value of its second best use" (Williamson, 1981). Demand / Market and Measurement Uncertainty are directly proportional to Transaction Costs, as are Critical Investments, Residual Rights, and the level of Technical Skills; Business Skills are taken to be inversely proportional to Transaction Costs (Aubert, 2002).

"Transaction Cost Theory regards firms, markets and mixed modes as alternative means of organization and views the allocation of economic activity among them as a decision variable. As transactions with different attributes can have different Transaction Costs, transactions with certain attributes can be administrated relatively more efficiently by the organization, thus helping to explain the existence of the firm" (Wang, 2002). As a corollary, some transactions will exist with certain attributes that make outsourcing a more efficient option. As additional elements from Transaction Cost Theory, Frequency and Reputation have also been taken to be directly proportional to Transaction Costs (Wang, 2002).

As per Transaction Cost Theory, "IT Outsourcing is accompanied by two basic risks: Shirking and Opportunistic Bargaining. Shirking refers to the vendor's under-performance on the contracted activities, and Opportunistic Bargaining refers to a vendor's ability to demand higher than market prices" (Ngwenyama, 1999). These two basic risks will decrease the probability of success of an IT Outsourcing decision.

4.2 Core Capabilities Theory

As per Core Capabilities Theory, firms can be characterized by three factors: (i) Customers must be able to differentiate between host organization and competitor's capabilities, (ii) Capabilities must enable Competitive Advantage for the host organization over time, and (iii) Capabilities must enable sustainable Competitive Advantage for the host organization and protect against erosion by competitors. If Capabilities of the host organization are usable for multiple purposes, they are 'Core Competencies' and should not be outsourced (Arnold, 2000).

Figure (1) below represents the Causal Model[3] for Economic Rationality of IT Outsourcing to Cloud Computing, which is based on a synthesis of Transaction Cost Theory and Core Capabilities Theory.

[3] "A 'Causal Model' is an abstract model that uses cause and effect logic to describe the behaviour of a system" (Wikipedia.Org)

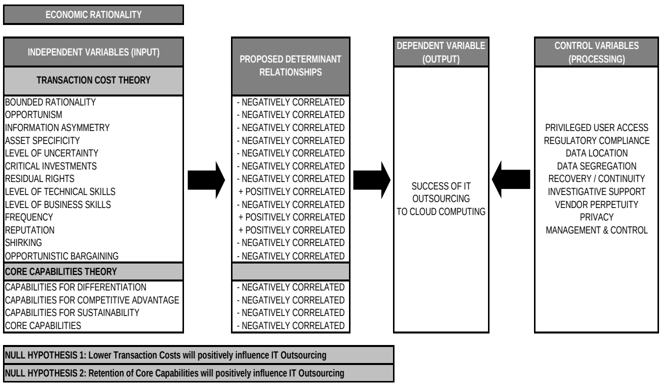

Figure 1: Causal Model for Economic Rationality of IT Outsourcing to Cloud Computing

4.3 Evaluating the Economic Rationality of IT Outsourcing of LHC's Storage to the IaaS-Cloud

At the LHC, the Dependent Variables from Core Capabilities Theory will not have much affect on the outcome of the IT Outsourcing decision as CERN is not a commercially-driven organization and therefore can afford to not focus on sustainable competitive advantage and differentiation. Therefore, even though Storage at the LHC is a Core Capability, it can be assumed that it can be outsourced to the IaaS-Cloud.

As per the Dependent Variables from Transaction Cost Theory, the Storage at LHC has high Asset Specificity and high Critical Investments: These two factors will negatively impact the outsourcing of Storage to the IaaS-Cloud. A mitigating factor in such a scenario may be the high Level of Technical Skills, which is positively correlated to the success of IT Outsourcing, in general.

5. The Engineering Rationality[4] of IT Outsourcing

5.1 Suitability of Cloud Computing for Adoption

The suitability of adoption (i.e., IT Outsourcing) of Cloud Computing by an organization is dependent upon: "(i) Size of IT Resources, (ii) Utilization Pattern of Resources, (iii) Sensitivity of Data, and (iv) Criticality of Work Done" (Misra et al, 2010).

The Size of IT Resources is further dependent upon: (i) Number of Servers, (ii) User Base, (iii) Annual IT Revenue and Expenditure, and (iv) Geographical Spread. For Utilization Pattern of Resources, the constituent factors are: (i) Average Usage, (ii) Peak Usage, and (iii) Number of Data Handling Transactions (Misra et al, 2010).

Based on the above, the Suitability Index for IT Outsourcing to Cloud Computing is given as a composite function of: (i) Largeness Value, (ii) Average Usage Value, (iii) Peak Usage Value, (iv) Workload Variability, (v) Data Sensitivity, and (vi) Business Criticality (Misra et al, 2010). Apart from Data Sensitivity and Business Criticality, all other factors are positively correlated to the success of IT Outsourcing to Cloud Computing. By using the same constituent factors, miscellaneous metrics can be computed such as: (i) Return on Investment (ROI), (ii) Cost Saving, (iii) Time Value, (iv) Agility & Scalability, (v) Customer Satisfaction, and (vi) Lead Time (Misra et al, 2010). Apart from Lead Time, all other factors are positively correlated to the success of IT Outsourcing to Cloud Computing.

Laid out below in **Figure (1A)** are some selected formulae and accompanying narration for the Engineering Rationality of IT Outsourcing to Cloud Computing (Misra et al, 2010) –

Largeness Value (L) = NoS × CNoS + NoC × CNoC + AR × CAR
Average Usage Value (AU) = ToS × CToS (or) ToP × CToP + (4 ? SCB) × CSCB
Peak Usage Value (PU) = DoP × CDoP + PbA × CPbA
Value of Workload Variability (WV) = PU × CPU + AU × CAU + ADH × CADH

Suitability Index = L × CL + WV × CWV + DS × CDS × ADH + C × CC × (65 ? L)

Here,
Value of Data Sensitivity (DS) = SoD | Value of Criticality (C) = CWD
CNoS = Credit of Number of Servers | NoC = Number of Countries it is Spread Across
CAR = Credit of Annual Revenue | SCB = Size of Customer Base
CSCB = Credit of Size of Customer Base | ToS = Type of Service
CToS = Credit of Type of Service | ToP = Type of Project
CToP = Credit of Type of Project | DoP = Duration of Peak
CDoP = Credit of Duration of Peak | PbA = Peak by Average
CC = Credit of Criticality | AR = Annual Revenue
CPbA = Credit of Peak by Average | CPU = Credit of Peak Usage
CAU = Credit of Average Usage | ADH = Amount of Data Handling
CADH = Credit of Amount of Data Handling | CWV = Credit of Work Variability
CNoC = Credit of Number of Countries it is Spread Across | NoS = Number of Servers

ROI = (Increase in profit + Reduction in cost ? Cloud costs) / Cloud costs
Cost Saving = (Initial no. of servers ? Present no. of servers) × TCO of each server

Here,
TCO = Total Cost of Ownership

[4] The ideas and thoughts related to the study of Information Systems by looking at Information Systems as an integrated engineering / technology phenomenon is called, 'Engineering Rationality'. In the Engineering Rationality of IT Outsourcing, the focus of study is on the maximization of engineering / technological gain through outsourcing IT

Figure 1A: some selected formulae and accompanying narration for the Engineering Rationality of IT Outsourcing to Cloud Computing (Misra et al, 2010)

NOTE: All selected formulae and narration laid out above in **Figure (1A)** are from the seminal work done by Misra on IT Outsourcing to Cloud Computing (Misra et al, 2010).

Figure (2) below represents the Causal Model for Engineering Rationality of IT Outsourcing to Cloud Computing, which is based on a synthesis of Suitability Index and Miscellaneous Metrics.

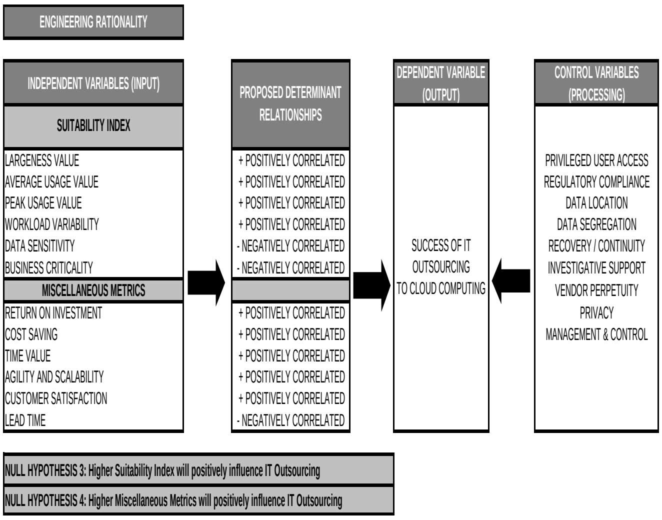

Figure 2: Causal Model for Engineering Rationality of IT Outsourcing to Cloud Computing

5.2 Evaluating the Engineering Rationality of IT Outsourcing of LHC's Storage to the IaaS-Cloud

On one hand, the Suitability Index for the LHC shows that the Dependent Variables of Largeness Value, Average & Peak Usage Values and Workload Variability are highly in favour of outsourcing LHC's Storage to the IaaS-Cloud but, the Dependent Variables of Data Sensitivity and Business Criticality are not in favour and may exert considerable negative influence on any such decision. On the other hand, all the Miscellaneous Metrics for the LHC are highly in favour of outsourcing Storage to the IaaS-Cloud. As an example, the metric for ROI, which is positively correlated to the probability of success of IT Outsourcing, will exert the maximum positive influence on the outsourcing decision.

6. The Social Rationality[5] of IT Outsourcing

6.1 Social Exchange Theory

"In the Social Exchange Theory (Homan, 1974), there are five propositions of human behaviour, namely: (i) The Success Proposition: For all actions taken by persons, the more often a particular action of a person is rewarded, the more likely the person is to perform that action under similar stimulus conditions, (ii) The Stimulus Proposition: If in the past the occurrence of a particular stimulus, or set of stimuli, has been the occasion on which a person's action has been rewarded, then the more similar the present stimuli are to the past ones, the more likely the person is to perform the action, or some similar action now, (iii) The Deprivation-Satiation Proposition: The more often in the recent past a person has received a particular reward, the less valuable any further unit of that reward becomes for him, (iv) The Value Proposition: The more valuable to a person is the result of his action, the more likely he is to perform the action, and (v) The Rationality Proposition: In choosing between alternative actions, a person will choose that one for which, as perceived by him at the time, the value (VK) of the result, multiplied by the probability (p) of getting the result, is the greater" (Emerson, 1976).

In the Social Exchange Theory, IT Outsourcing would have to be considered as a function of human behaviour and therefore all the five propositions of human behaviour (taken to be Dependent Variables) are positively correlated to the success to IT Outsourcing to Cloud Computing.

6.2 Partnership Quality Model

As per the Partnership Quality Model, "the probability of IT Outsourcing success to Cloud Computing is a function of Dynamic Factors (Participation, Joint Action, Quality of Communication, Coordination and Information Sharing),

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Static Factors (Age of Relationship and Mutual Dependency) and Contextual Factors (Cultural Similarity and Top Management Support)" (Lee et al, 1999).

In the Partnership Quality Model, IT Outsourcing would have to be considered as a function of partnership quality and therefore the Dependent Variables of Dynamic Factors, Static Factors and Contextual Factors are all positively correlated to the success to IT Outsourcing to Cloud Computing.

6.3 Political Model

"To understand outsourcing decisions, the Political Model suggests that we focus on the power of the IT Department, the vested interests of different stakeholder groups, and political tactics they may enact to sway decisions in their favour" (Lacity et al, 1993).

The Political Model bases the outsourcing decision on top of two broad factors: "(i) Power (Authority, Resource Acquisition, Dependability & Low Substitutability and Uncertainty Absorption), and (ii) Political Tactics (Selective Use of Decision Criteria, Selective Use of Information, Use of Outside Experts, Building Coalitions and Co-optation)" (Lacity et al, 1993). In the Political Model, IT Outsourcing would have to be considered as a function of power and political tactics, and therefore all the Dependent Variables from the Political Model are positively correlated to the success to IT Outsourcing to Cloud Computing.

Figure (3) below represents the Causal Model for Social Rationality of IT Outsourcing to Cloud Computing, which is based on a synthesis of Social Exchange Theory, Partnership Quality Model and Political Model.

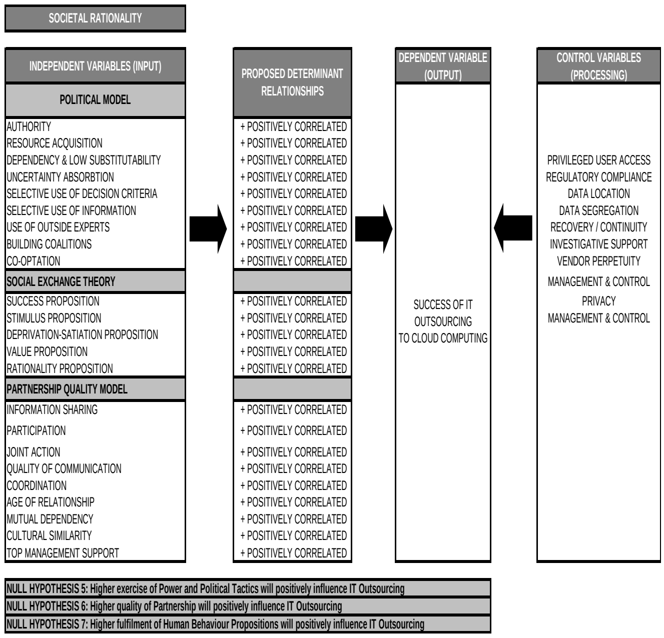

Figure 3: Causal Model for Social Rationality of IT Outsourcing to Cloud Computing

6.4 Evaluating the Societal Rationality of IT Outsourcing of LHC's Storage to the IaaS-Cloud

As per the Social Exchange Theory, the outsourcing of LHC's Storage to the IaaS-Cloud will be viable only if all the five propositions of human behaviour hold true. However, keeping in mind that an outsourcing decision of such magnitude would be the first time at the LHC, there will be no background to evaluate the postulates of the Social Exchange Theory presently. Thus, all the five propositions of human behaviour may exert only a weak influence on the decision of outsourcing LHC's Storage to the IaaS-Cloud.

In the Partnership Quality Model, the outsourcing of LHC's Storage to the IaaS-Cloud will be supported heavily by the Dynamic Factor of 'Participation' and Contextual Factor of 'Top Management Support' (as CERN is a paying-member of all LHC experiments and a controlling-member of all LHC decisions). In the present *ab-initio* stage, the Static Factors of 'Age of Relationship' and 'Mutual Dependency' may not exert any influence on the decision of outsourcing LHC's Storage to the IaaS-Cloud.

The factors of Power and Political Tactics will play a major role in the outsourcing of LHC's Storage to the IaaS-Cloud, as CERN is a heterogeneous organization characterized by dynamic cross-sectional and cross-cultural influences. Even though the entire constituent sub-factors are positively correlated to the success of IT Outsourcing, the greatest positive influence on the decision to outsource LHC's Storage to the IaaS-Cloud may probably come from the 'Use of Outside Experts' and 'Authority'.

7. The Business Rationality[6] of IT Outsourcing

7.1 Systems Theory

The Systems Theory (Nevo and Wade, 2010) proposes to look at IT Outsourcing as an 'Enabled Synergy'. Enabled Synergy is a function of Potential Synergy (i.e, synergy between IT Assets and Organizational Resources) and Enabling Conditions (i.e., synergy between Compatibility and Integration Effort). Thus, as per the Systems Theory, the probability of success of IT Outsourcing (i.e., Enabled Synergy) is positively correlated to Potential Synergy and Enabling Conditions (taken to be Dependent Variables).

7.2 Resource Based View of the Firm

The Resource based View of the Firm (RBVF) represents the success of IT Outsourcing through a function of multiple factors: (i) Value, (ii) Rarity, (iii) In-imitability, (iv) Non-substitutability, and (v) Sustainable Competitive Advantage (Nevo and Wade, 2010; Melville et al, 2004). Thus, as per RBVF, the probability of success of IT Outsourcing is negatively correlated to all the constituent factors (taken to be Dependent Variables).

7.3 DeLone and McLean Model

As per the DeLone and McLean Model (Wang, 2008), the success of e-Commerce Systems is characterized by an interaction between System & Information Quality and Use & User Satisfaction, which bring about Individual and Organizational Impacts. Superimposing this model on IT Outsourcing to Cloud Computing: The success of IT Outsourcing to Cloud Computing (i.e., Organizational Impact) will be successful only when there is high System & Information Quality and high Use & User Satisfaction. Thus, as per the DeLone and McLean Model, the probability of success of IT Outsourcing is positively correlated to all constituent factors (taken to be Dependent Variables).

Figure (4) below represents the Causal Model for Business Rationality of IT Outsourcing to Cloud Computing, which is based on a synthesis of Systems Theory, Resource Based View of the Firm and DeLone and McLean Model.

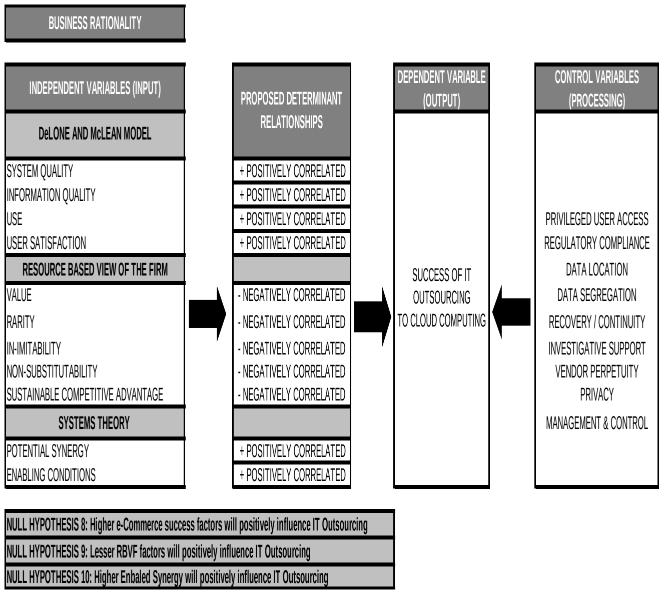

Figure 4: Causal Model for Business Rationality of IT Outsourcing to Cloud Computing

7.4 Evaluating the Business Rationality of IT Outsourcing of LHC's Storage to the IaaS-Cloud

As per Systems Theory, the outsourcing of LHC's Storage to the IaaS-Cloud will depend upon Potential Synergy and Enabling Conditions, which have a high probability of being present at CERN as it is a World Leader in its research field and will want to maintain this place.

As per RBVF, the outsourcing of LHC's Storage to the IaaS-Cloud will be highly influenced by the factors of Value, Rarity, In-imitability, Sustainable Competitive

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Advantage and Non-substitutability. However, since these factors are negatively correlated to the probability of success of IT Outsourcing, it can be taken that the Dependent Variables of RBVF do not support the outsourcing of LHC's Storage to the IaaS-Cloud. As an example, the 'Value' and 'Rarity' of IT Assets and IT Capabilities are very high at CERN thus, the probability of success of outsourcing LHC's Storage to the IaaS-Cloud will be low.

Similarly for the DeLone and McLean Model, we see that all the factors are positively correlated to the probability of success of IT Outsourcing, and so all these factors will exert a strong positive influence on the decision of outsourcing LHC's Storage to the IaaS-Cloud. In particular, the factors of 'Users' and 'User Satisfaction' will play the major role as CERN has a large, geographically distributed audience, which in turn is also working on different experiments at CERN and other organizations, and will therefore welcome the outsourcing of the LHC's Storage to the IaaS-Cloud.

8. The Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud

8.1 Description and Schematic

Through the lens of Economic Rationality, and by using Transaction Cost Theory and Core Capabilities Theory, we saw that outsourcing LHC's Storage to the IaaS-Cloud is feasible. Additionally, by using the lens of Engineering Rationality, we saw that outsourcing LHC's Storage to the IaaS-Cloud is feasible too. The use of these two rationality-lenses enabled us to analyse the outsourcing of LHC's Storage to the IaaS-Cloud in a contemporary manner.

Through the lens of Business Rationality, and by using RBVF, Systems Theory, and DeLone and McLean Model, we saw that outsourcing LHC's Storage to the IaaS-Cloud is feasible. Additionally, by using the lens of Social Rationality, and by using Social Exchange Theory, Partnership Quality Model and Political Model, we saw that outsourcing LHC's Storage to the IaaS-Cloud is feasible too. The use of these two rationality-lenses enabled us to analyse the outsourcing of LHC's Storage to the IaaS-Cloud in a traditional manner.

In support of this Research Proposal's primary argument that an IT Outsourcing decision to Cloud Computing can only be made holistically, it proposes that the Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud should be a combination of all Causal Models i.e., a combination or, synthesis of Engineering, Economic, Social and Business rationalities.

A monolithic Causal Model synthesized from discrete / single-rationality Causal Models will provide an opportunity to study the interaction amongst different factors from various rationalities, and their impact on the probability of success of IT Outsourcing in general, and outsourcing of LHC's Storage to the IaaS-Cloud in specific.

Figure (5A) in **Appendix (A)** denotes such a monolithic Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud.

8.2 Primary and Secondary Research Questions

A set of ten Null Hypotheses have also been proposed in this Research Proposal to accompany the Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud. These Null Hypotheses have been derived from the Determinant Relationships between the Dependent Variables and the Independent Variable. During calibration and further refinement of the Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud, these Null Hypotheses may be reversed, cancelled out or, reinforced.

On one hand, the Primary Research Question of this Research Proposal is whether IT Outsourcing to Cloud Computing should be considered from a multi-rational lens or not while on the other hand, the set of Null Hypotheses define the set of secondary Research Questions that this Research Proposal will also look into (viz. (i) Do lower Transaction Costs positively influence IT Outsourcing, (ii)

Does higher Quality of Partnership positively influence IT Outsourcing, et al).

The set of ten Null Hypotheses (i.e., Secondary Research Questions) for the Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud is represented below in **Figure (5B)** –

Null Hypotheses (Secondary Research Questions)
NULL HYPOTHESIS 1: Lower Transaction Costs will positively influence IT Outsourcing
NULL HYPOTHESIS 2: Retention of Core Capabilities will positively influence IT Outsourcing
NULL HYPOTHESIS 3: Higher Suitability Index will positively influence IT Outsourcing
NULL HYPOTHESIS 4: Higher Miscellaneous Metrics will positively influence IT Outsourcing
NULL HYPOTHESIS 5: Higher exercise of Power and Political Tactics will positively influence IT Outsourcing
NULL HYPOTHESIS 6: Higher Quality of Partnership will positively influence IT Outsourcing
NULL HYPOTHESIS 7: Higher fulfilment of Human Behaviour Propositions will positively influence IT Outsourcing
NULL HYPOTHESIS 8: Higher e-Commerce success factors will positively influence IT Outsourcing
NULL HYPOTHESIS 9: Lesser RBVF factors will positively influence IT Outsourcing
NULL HYPOTHESIS 10: Higher Enabled Synergy will positively influence IT Outsourcing

Figure 5B: Null Hypotheses for the Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud

8.3 Calibration[7] (Roll Out) and Refinement[8] (Optimisation)

The Research Proposal will make use of the Iterative Econometric Model-Building Method (Zellner, 1979) to propose calibration and refinement of the Viability Model. **Figure (6)** below depicts the Iterative Econometric Model-Building Method.

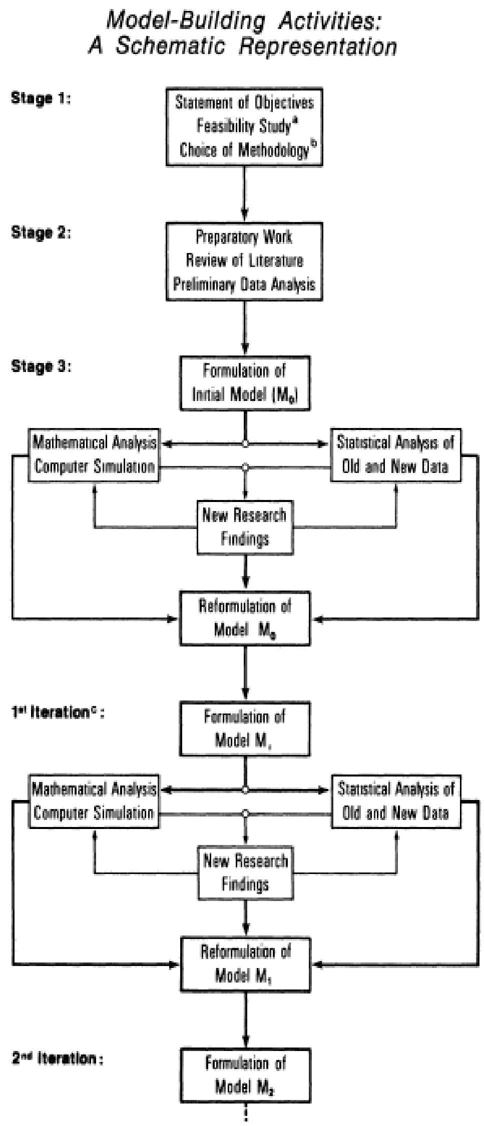

Figure 6: The Iterative Econometric Model-Building Method (Zellner, 1979)

In **Stage 1:** (i) A 'Statement of Objectives' was completed (as a part of the Research Proposal) by asserting the desire to make a Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud while making use of a multi-rational lens, (ii) A 'Feasibility Study' and 'Choice of Methodology was also completed through the use of various Theories and Models inside multiple rationalities and the formalization of the use of the monolithic Causal Model as the Research Model throughout this Research Proposal. This

7 "'Calibration' is a comparison between measurements – one of known magnitude or, correctness made or set with one device and another measurement made in as similar a way as possible with a second device" (Wikipedia.Org). In the context of this Research Proposal, the behaviour of the initial monolithic Viability Model for IT Outsourcing of LHC's Storage to the IaaS-Cloud is expected to be calibrated by the use of real-time data from CERN's LHC as a part of the Roll Out

8 "'Optimisation' means finding the best available values of some objective function given a defined domain, including a variety of different types of objective functions and different types of domains" (Wikipedia.Org). In the context of this Research Proposal, the monolithic Viability Model for IT Outsourcing of LHC's Storage to the IaaS-Cloud is expected to be refined further by the use of real-time data from CERN's LHC (and similar academic / research organizations) and from other commerce / business organizations

stage of the Research Proposal took almost three weeks to complete.

In **Stage 2:** (i) 'Preparatory Work' and 'Literature Review' have been completed (as a part of the Research Proposal), and (ii) For 'Initial Data Analysis', the Data Collection Instrument that will be used will be a Questionnaire, which will be designed based on the Viability Model and will be circulated to a relevant audience. The relevant audience will be made up of a sample of people representing all the rationalities that are being assumed to underpin the IT Outsourcing decision to the Cloud (a complete population study / census will not be possible as the number of stakeholders may be too large to manage vis-à-vis the scope of this Research Proposal). The Questionnaire will be made up of a majority of close-ended questions that will facilitate quantitative analysis and a minority of open-ended questions inviting opinions for qualitative analysis. Apart from the part already completed, it is estimated that this stage of the Research Proposal will take about four weeks to complete i.e., one week to define the Questionnaire and three weeks to roll it out and gather the responses. **Figure (7)** below represents a sample of questions in the Questionnaire.

In **Stage 3:** (i) An 'Initial Model' will be formed based on the collation of data from the collected and completed Questionnaires, (ii) A Computer Simulation / Mathematical Analysis / Statistical Analysis will be conducted on the Initial Model; If required, new research findings / observations and suggestions will be built into the Initial Model, and (iv) Required calibration will be done based on the analysis of the Initial Model. It is estimated that this stage of the Research Proposal will take about four weeks.

In **Stage (n):** Subsequent iterations of the Initial Model will be refined further, if required. In order to get a more refined and robust Viability Model, The Research Proposal aspires to take a two-pronged approach: (i) Share the Questionnaire with other research-focussed institutions such as NASA, ISRO, et al to get a biased, same-class average, and (ii) with purely commerce-driven organizations such as IBM, Accenture, Amazon, Google, Microsoft, et al to get a un-biased, class-less average. It is envisaged in the Research Proposal that the incorporation of these data elements will enable the Viability Check to be refined and strengthened further for the use of both, research-focused and commerce-driven organizations. It is estimated that each iteration of refinement in this stage of the Research Proposal will take about six weeks to complete.

SAMPLE QUESTIONNAIRE					
RATIONALITY	**PRIMARY RESEARCH QUESTION (WITH CONTEXT)**	**SECONDARY RESEARCH QUESTIONS / NULL HYPOTHESES**	**SURVEY QUESTION**	**TYPE OF SURVEY QUESTION**	**ALLOWED RESPONSES**
ECONOMICS	**SHOULD IT OUTSOURCING TO CLOUD COMPUTING BE ANALYSED THROUGH A MULTI-RATIONAL LENS (IN THE CONTEXT OF CERN's LHC OUTSOURCING ITS STORAGE TO THE IaaS-CLOUD)?**	Lower Transaction Costs will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if there was a large level of uncertainty?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Lower Transaction Costs will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if there were IT assets involved that are in use intermittently?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Retention of Core Capabilities will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if it involved outsourcing of IT assets considered to be or, supporting LHC's Core Capabilities?	OPEN-ENDED	FREE TEXT UPTO 1000 CHARACTERS AND NO SPECIAL CHARACTERS ALLOWED
				CONTINUED	
BUSINESS		Higher e-Commerce success factors will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if it involved outsourcing of IT assets considered to be in-imitable?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Higher e-Commerce success factors will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if it involved outsourcing of IT assets considered to be non-substitutable?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Higher e-Commerce success factors will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if there was a possibility that it may negatively affect user satisfaction?	OPEN-ENDED	FREE TEXT UPTO 1000 CHARACTERS AND NO SPECIAL CHARACTERS ALLOWED
				CONTINUED	
SOCIAL		Higher Quality of Partnership will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if it involved losing authority (control) over IT assets?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Higher Quality of Partnership will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if the prospects of partnership were low?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Higher Quality of Partnership will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if there was an absence of top management support?	OPEN-ENDED	FREE TEXT UPTO 1000 CHARACTERS AND NO SPECIAL CHARACTERS ALLOWED
				CONTINUED	
ENGINEERING		Higher Suitability Index will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if the IT assets involved were used in storage, processing or, transmission of sensitive data?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Higher Suitability Index will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if the IT assets involved were considered critical to the business of the LHC?	CLOSE-ENDED	YES / NO / MAYBE / DON'T KNOW / NO RESPONSE
		Higher Suitability Index will positively influence IT Outsourcing	Would you outsource the LHC's Storage to the IaaS-Cloud if there was possibility of a low ROI?	OPEN-ENDED	FREE TEXT UPTO 1000 CHARACTERS AND NO SPECIAL CHARACTERS ALLOWED
				CONTINUED	

Figure 7: Sample Questionnaire as a Data Collection Instrument for the Research Proposal

Conclusion

IT Outsourcing to Cloud Computing for all organizations must be looked at through a multi-rational lens: Engineering, Economics, Business and Social. Failure to take a multi-rational view of the decision of IT Outsourcing to Cloud Computing will definitely impact the probability of success of outsourcing for organizations and the Research Proposal has shown this through the creation of discrete / single-rationality Causal Models for different rationalities and their discussion thereof in the context of CERN's LHC outsourcing its Storage to the IaaS-Cloud.

Based on a multi-rational approach, The Research Proposal has proposed a monolithic Viability Model for IT Outsourcing to Cloud Computing by taking into cognizance all the discrete / single-rationality Causal Models based on numerous Theories and Models. Since, this Viability Model has been built in the context of CERN's LHC outsourcing its Storage to the IaaS-Cloud, the Research Proposal has put forward a Road Map for its calibration and further refinement. In order to have a more robust and generically usable model across academia / research and commerce / business, the Research Proposal has recommended the refinement of the Viability Model in terms of biased, same-class and un-biased, class-less averages.

The proposal of this Viability Model for IT Outsourcing to Cloud Computing is envisaged to trigger further research into analysing a traditional Business Strategy -- IT Outsourcing, through a multi-rational approach in the context of Cloud Computing, which is turning out to be the latest Disruptive Innovation. It will also be an interesting exercise to find out, as a part of the calibration and validation process of the Viability Model, which rationality has the greatest influence and which one the least on the decision of IT Outsourcing to Cloud Computing. Such empirical information may act as an oblique impetus to the field of IT Outsourcing to Cloud Computing, especially outsourcing Storage to the IaaS-Cloud.

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Abhishek Amal Sanyal has nearly a decade of full-time, professional work experience in the inter-related fields of Audit, Risk Management, Quality and Program & Project Management. He has a MS (Analysis, Design and Management of Information Systems) from the London School of Economics, a MS (Manufacturing Management) from BITS Pilani, a PGD (Marine Engineering) from MERI Mumbai and a BE (Mechanical Engineering) from the University of Pune. Additionally, he is CISA, CRISC, Six Sigma Black Belt, ITIL V2 Service Manager, ITIL V3 Expert, ISO 27001 Lead Auditor and CABM, amongst many other relevant professional certifications. Abhishek has a keen interest in research, and has presented his Research Papers and won numerous awards at multiple august forums such as LSE-Oxford-Cambridge (UK), IIT Roorkee, IIT Kharagpur, IIT Kanpur, IIM Bangalore, MERI Mumbai and QCFI Pune. His present research interests include, but are not limited to, Cloud Computing, Economics & Management of IT-enabled businesses, Outsourcing, Emerging Trends in Information Security Management, et al. Abhishek is married, has twin daughters and is currently settled in Mumbai while working for Morgan Stanley. His prior experience includes working for blue chip MNCs such as HSBC, TCS, and Infosys. Abhishek is a keen, amateur Glacier Trekker and Boxer, and when not indulging in these sports keeps himself busy writing short stories and novellas, which he intends to get published one day. Abhishek can be contacted on abhisheksanyal@hotmail.com and abhisheksanyal@alumni.lse.ac.uk.

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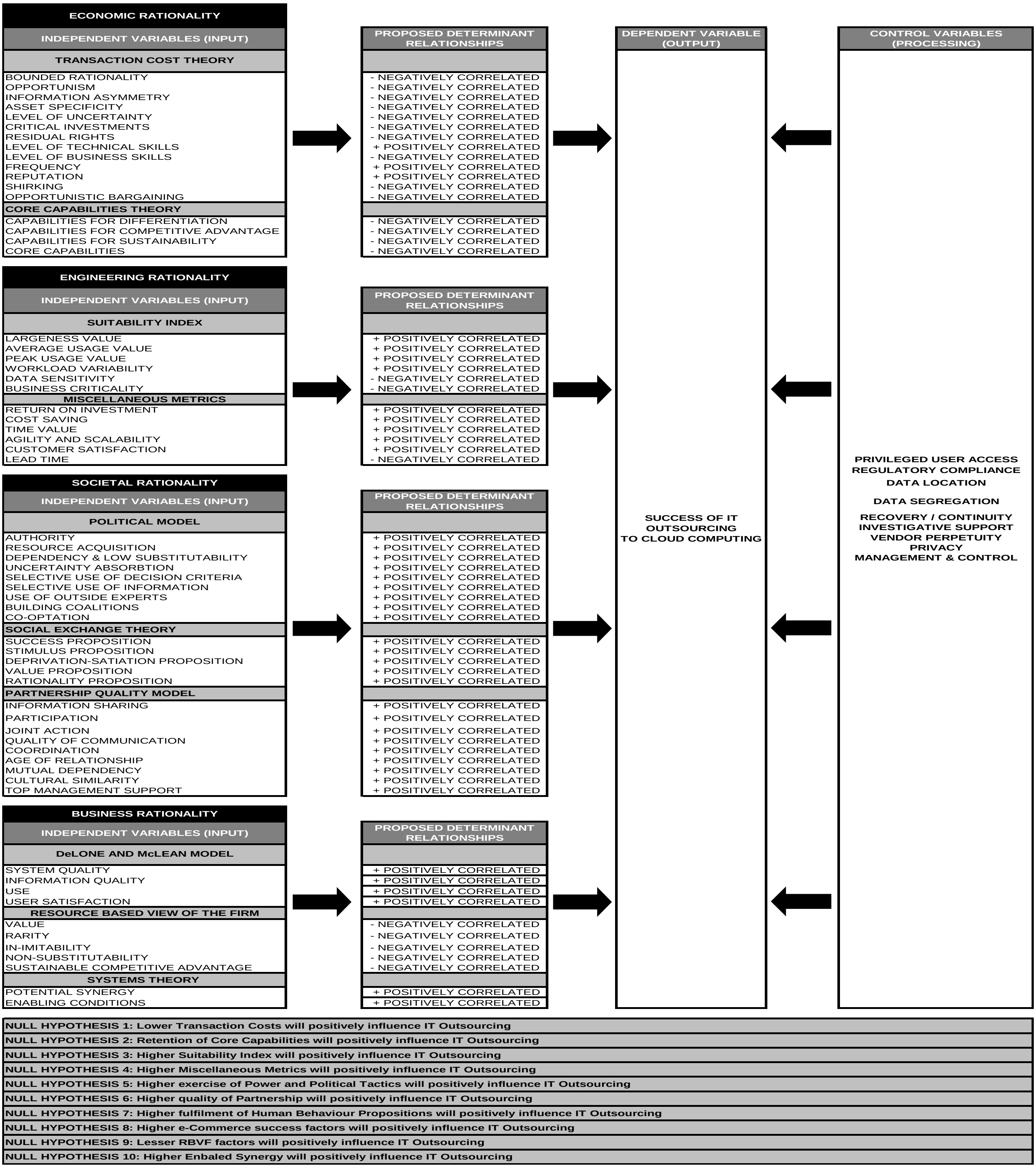

Figure 5A: Viability Model for CERN's LHC outsourcing its Storage to the IaaS-Cloud