A Conceptual Investigation: Towards an Integrative Perspective of Risks in Information Systems Development & Usage

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Abstract— **A review of existing literature in academia and in profession, along with real cases, reveals a fragmented approach to risk identification and management in information systems development and usage (ISDU). Such a disjointed approach to risk management fails to consider critical threat components and under evaluates the maximum potential risks involved in a situation. The present study argues that ISDU Risks need to be expansively identified and perceived in an integrative manner. The views generally exercised by IS researcher's, within the limited attention provided to risk, are segmented and microscopic with no defined risk ecosystem to place them in . So also, practitioner groups have been individualistically producing IS artifacts for risk mitigation with a primary purpose of creating significant ROI, adding to fragmented perspectives on ISDU risks. We observe significantly high failure rates for IS projects, in spite of the claims of the application of highly advanced risk management models. In any domain, the presence of an abnormally high rate of failure would imply an absence of successful risk management and imply that not all significant risks have been accounted for. The present study identifies various cross-domain risk measures and risk constructs with macro-level relevance to the ISDU ecosystem. Based on literature review and observational reflections, a taxonomy for the classification of types of risks is presented. The present paper is an attempt at expanding the portfolio of risk concepts associated with ISDU and posits an early stage high-level integrative risk perception framework that will represent various cross-domain measures and dimensions of risk in an integrative manner. This theoretical contribution and its continued development is expected to initiate additional scholarly work on integrative perspectives on risks and new dimensions of risks associated with IS, open up a new stream of risk-related research in IS and lead to the development of enhanced risk management models.**

Index Terms— **Risk, Information Systems, Volatility, Macro, Mesa, Micro, Uncertainty, VaR, Integrative, Variance, Constraints, Control, temporality.**

I. Introduction

WITH the continued rapid advancement of computing technologies, we see a significant rate of progress in the efficiencies and effectiveness driven by advances in information systems. These advances have created a complex ecosystem of technologies and this dynamic is aptly captured by World Economic Forum's Executive Chairman Klaus Schwab (Abu Dhabi, 2011) *"... we need a new model to master the trend of technology. The velocity of technological change, for which we are not really prepared, will accelerate in an exponential manner, having significant implications... ...What is particularly striking, for me as an engineer I may add, is the character-changing nature of technological change..."*. Attention is also being drawn towards an uncomfortably challenging observation: The IS domain, in both research and practice, suffers from an inadequate appreciation of risks associated with the complexity of advancing technologies (Collins, 2008). This is evident by the scarcity of research output in understanding, measuring and mitigating a wide variety of risks in IS beyond the micro-management of specific risks. This can also be extrapolated on the basis of the high failure rate of software development projects (Bloch et al, 2012). The present research provides a novel contribution by creating a macro level framework of risks associated with information systems development and usage (ISDU). This paper examines a variety of perspectives on risk including those from the domains of IS, finance and operations management. The Standish Group report "CHAOS Summary 2009" showed that there was an increase in project failure rates and a noticeable decrease in project success rates. 32% of all projects succeeded with timely delivery, within budget completion and with required functionalities and features; 44% of the projects faced difficulties and these were late, over budget and (or) with compromised /incomplete functionalities and features; While 24% failed completely and were cancelled or delivered but could never be deployed /used. For illustration purposes concerning risk management in financial services, here is an interesting quote: *"It's difficult to do risk assessment in this environment because of the added level of complexity involved"*. Marios Damianides made this statement while serving as international president of the Information Systems and Audit Control Association (ISACA) and the IT Governance Institute following serious attempts to analyze the sub prime crisis. He reiterated that risk management technology has not been able to keep up with top global financial firms who have been introducing increasingly esoteric investment devices and variations of financial instruments such as CDOs (Collateralized Debt Obligations)

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and sophisticated equity derivatives. The value of these instruments is derived, at least in part from equity securities, using complex mathematics and software sophisticated programming, supported by high speed trading enabled computer systems. This example of the development of technology driven complexity is extensible: just as with the domain of finance, every other domain has leveraged the power of information systems by developing and deploying appropriate software systems. The disquieting fact is also that many of these systems, both in the private sector as well as in the public sector, are subject to an unexpectedly high probability of failure at various stages of their lifecycles - An IBM global CEO study (2008, a study involving 1500 global practitioners, conducted with ZEM, Center For Evaluation and Methods – University of Bonn, Germany,) indicated that only a meager 41% of its projects were fully successful, implying a whopping 59% failure rate for projects across the world for projects related to any significant level of change.

These and other market events serve as a compelling call for IS researchers and practitioners to examine the domain of ISDU and articulate integrative risk models which, in the very least, must provide a conceptual identification of all major risk dimensions and risk types.

II. Scanning the Risk Ecosystem

Integrated risk models must provide clear perspectives of various levels of risk, including but not limited to domain risk, process risk, methodology risk, technology risk, resource and security threats. In turning to IS literature to examine this phenomena, it is observed that in the past 25 years of publications of the top two journals in IS: In MIS Quarterly publications (1986 to Spring of 2012) only 11 papers have used the word 'risk' in the title and about 8 more have "risk" in subject terms, taking the total to 18. Similarly there are about 10 articles with "risk" in the title and subject terms combined in Information Systems Research (1995 to 2012). Of these 29 articles in about 40 publication years between the two top IS journals, the primary emphasis has been on intrinsic systems risks and related process risks(Table 1:1). All the papers have inward looking implications for individual entities and none of these explore integrative or interactive models of risk with respect to the emerging and rapidly changing global technological environment. Interestingly, searching for "security (threat and failure management)" brought up more papers (Table 1:1) than that for "risk" in each of these top IS journals - again highlighting the micro-perspective bias in the choice of topics for research in IS.

There is also some work on risk management which simply appears to apply operations management principles in an adaptive and iterative manner to provide a measure of protection against obvious clusters of commonly respected threats. It appears that IS researchers have been making some scattered progress in developing disconnected pieces of knowledge associated with the potential weaknesses, flaws and intrinsic vulnerabilities - risk posed by ISDU and have unwittingly failed to study the big picture using a birds eye view strategy. Therefore, the present research direction aims to fill that gap by creating an expanded and integrative macro-framework for ISDU, with the intention that this expanded and integrative risk framework would possess better risk identification capability and explanatory power with regards to the wide array of risks facing ISDU.

Thus far the general perspective has been that IS risk is associated with the probability of something going wrong in some way through vulnerability, flaw or failure (Straub and Welke, 1998). In the present study, I develop logical arguments using a multi-domain literature review strategy and an analysis of multiple perspectives on risk identification, risk measurement, risk mitigation, risk valuation, risk creation, risk management and risk control. These have been instrumental in shaping the call for integrative perspectives on risk presented in this paper. This paper leverages a inductive logic approach with phenomenonological underpinnings as a research strategy to develop an integrative perspective model for risks associated with ISDU

A. The Changing Nature of Risk

Researchers and practitioners have hitherto placed a stronger emphasis on the rewards and provided attention to risk primarily to the unavoidable extent it would be required to preserve the survival of visible-return-on-investment-economics, explain obvious challenges to specific technology artifacts, tool imperfections and volatile processes. The advent of complex adaptive business systems (CABS) have resulted in evolving complexity (Tanriverdi et al, 2010) as we have leveraged IS to address a variety of problems, create value and improve the quality of life. We have reaped the rewards of the collective effects of the world adopting information technology and this societal force was defined by our needs, we created the rules. However, we have not acknowledged the iterative (Giddens, 1982) deep structures (El Sawy, 2003) between these rules we have created and nor have we gauged the impact of the new and hitherto theoretically undefined risks. Giddens work on social theory (Giddens, 1979) and his elaboration on Structuration theory (Giddens, 1982) presents an interesting principle for exploring the relationship between IS and risk. Structuration theory presents an evolutionary iterative path of "production and reproduction of actors and systems across time and space" using a helix structure and this perspective of reality can be applied to initiate the study of the risk in Information Systems by treating it as a societal effect, as elaborated below. The extraordinary capabilities of IS have kept our attention largely focused on the positive results of leveraging information technologies. Our action upon the IS "societal force" is our demand for rewards and benefits and as we receive them, we in our utilization of the benefits enter into the IS environment which is evolutionary in nature and presents risk cycles of increasing cross domain complexity and magnitudes. The application of structuration theory to the study of information systems was popularized by Orlikowski's structurational model of technology (Orlikowski, 1992) and also it application to information technology and organizational life (Orlikowski and Robey, 1991). An extension of structuration theory is evident in the 'Adaptive

Structuration Theory' (AST) which posits that technology and social processes act upon organizational change through the adoption of advanced technologies (Poole and DeSanctis, 1994).

B. Measuring Macro-level Risk?

In a unique presentation of strategic thoughts, Michael Vitale writes about "The growing risks of information systems success" (Vitale, 1986). The paper describes "the risks of Information Systems success achieved in the absence of appropriate regard for the potential impacts". The paper provides case studies on how IS adoption and leverage produced competitive advantage. However, an inability to foresee the adverse effects of this success led to failure implying the absence of recognition of associated IS risks. The paper provides a theoretical discussion on how companies need to go beyond the obvious and explore the effects of IS adoption and leverage on a strategic and longer time horizon level. Vitale's model is parsimonious but highly conceptual and does not suggest a conscious recognition of risk beyond the call for the consideration of a longer time horizon. One of the present expressions defining IS security based on risk management models (Schechter, HBS, 2004) are given by the conceptual equation "Security risk = (likelihood of security breach) x (cost of security breach)" and also "Security risk = (security breach rate) x (average cost per breach)". These models, though parsimonious, oversimplify the notion of IS risk to an extent which is counter productive because none of the variables used have established measurement parameters nor is there any integrated and standardized comparative framework.

In recent IS research in the past few years, there has been an attempt to adopt and integrate risk and risk relevant concepts from multiple disciplines into IS risk perception and management frameworks such as the work on IS security (Mejias, Roberto J., 2012) which brings in concepts from system dynamics, cybernetic theory and Technological Threat Avoidance Theory (TTAT). Others have attempted to adopt singular concepts of risk from other disciplines in an attempt to develop improved perspectives and models for understanding and managing risks in IS projects such the work by Koch S (2006) who argued for using "Value-at-Risk" which is a risk measure from the discipline of Finance for "IS/IT Project and Portfolio Appraisal and Risk Management". Other recent singular risk measure that have been adopted include infrastructure risk management concepts (Obrand et al, 2012) and another economic concept of return on investment (Armour, P. G., 2010) has also been used a lens to view IS risks. However, there has been very little done to date, to the best of my knowledge to develop a conceptual framework which can serve an umbrella to house these various efforts within a systematic macro-perspective. A notable attempt in this direction is seen in the generic 'Project Management Body Of Knowledge' (PMI, 2012) commonly called as the PMBOK, which outlines key principles of risk management. However, the PMBOK fails to include domain risks with la levels of analysis perspective and thus in spite of a few macro-level factors, the primary focus is to start from multiple risk-identification points and travel downstream to focus on micro-level risk management techniques.

Classification	*Journal:*		
	ISR, 1995-2012	*MISQ, 1986 - 2012*	*Combined*
ROI Risk / IS Economics	2	1	3
Systems Risks	3	8	11
Information Risks	3	1	4
Process Risks	2	8	10
Risk of IS Success / Strategy		1	1
Total for "RISK"	10	19	29
Security / Threat/ Miscellaneous	13	30	43

Table 1.1: "Risk" in Title or Subject for Main IS journals

C. Literature on risks in IS & IS Risk Management

The four classical approaches to risk management in IS include Alter & Ginzberg's (1978) implementation approach, Boehm's (1991) software risk approach, McFarlan's (1981) portfolio approach and Davis' (Davis et al, 1992) eventuality approach. Alter and Ginzberg (1978) studied ways of managing uncertainty in IT execution by leveraging the change management model used by Klob and Frohman (1970). Interestingly they identified eight key risk drivers and their approach is one of deploying tactics to mitigate the risk factors and thus manage overall risk. Arguments positing that non-IT persons would find it difficult to understand IT deliverables due to the non-tangible nature of software were presented by Boehm (1991). He also argues that organizations tend to acquire newer technologies without evaluating all the associated risks as they cultivate impractical notions about the adaptability and flexibility of software. Boehm argues in favor of early detection and states that active management of risk will reduce failure and improve effectiveness. He also developed a two dimensional Risk Management typology risk assessment and risk control which had further sub-divisions.

Another prominent contribution is made by Barki, Rivard and Talbot (1993) who posit that information communications technology (ICT) projects need to be appropriately controlled for the reduction of risks associated with ICT projects. They examined various issues and highlighted the absence of a systematic approach to rein in costs, meet user requirements and maintain project schedules by studying project with some level of failure including the "Allstate Insurance Company" case in which the cost estimates for a new information system changed from $ 8 million to about $100 million and from an original estimate of five years duration to an actual time of nine years.

Mark Keil has written extensively on risk in IS and one of his papers explores the dimensionality of risk (Wallace, Keil, and Rai, 2004) – this provides very interesting insights into the nature of risk management from an operational perspective but this work explores the dimensionality of risk within the context of IS project management and misses an opportunity to move the analysis into the nature of risk itself and thus lacks ontological value. However, the arguments presented therein using sociotechnical systems theory demonstrate that "*social subsystem risk influences technical subsystem risk, which, in turn, influences the level of project management risk, and ultimately, project performance.*" Another work of significant importance was by McManus (2001) who posited that "*the major causes of project risk as lack of planning and lack of top management control during the project life cycle.*" McManus proposed that IS projects tend to be started with some relevance to change and therefore such initiatives tend to be different from the ordinary and incremental change processes. His Risk Management cycle approach consisted of four key phases, such that each phase must be performed and, repeated as necessary so as to optimally reduce risk and these 4 phases include "Establish that a risk exists; Analysis of risk severity and associated probability; Plan to manage the risk using the risk's severity and probability; Minimize risk consequence." He appears to have based this from Edward Deming's quality cycle with four phases Plan, Do, Study, Act. McManus also emphasizes the role of interactive forces in amplifying risk in software development. Risk management can be described as a set of steps used for identifying, analyzing, measuring and controlling risk through the life of any project under consideration to meet its objectives (Schawlbe, 2005). Redzic, et al. (2006) tried to investigate, analyze and ascertain planned changes that considerably increased the software quality of all software products over a period of two years using the Six Sigma DMAIC approach, which is used for software quality improvement. Current research (Ezamly Abdelrafe and Burairah Hussin, 2011) shows that most of the risk management initiatives in practice and also most of the academic research on risk management has focused on addressing commonly recognized challenges in efficiency, information security, project management and governance. They argue for the significance of the risks identified in the entire lifecycle of the ISDU. A risk management approach for building confidence and trust for Internet users is studied by Flinn and Stoyles (2004). Iversen, J. H., Mathiassen, L., and Nielsen, P. A. (2004) use an action research strategy to develop an insightful model for risk management and their discussions on risk addresses various methodologies and tactics to mitigate risk. They however do not attempt to expand our view of risk itself and provides not insights into the scope of risks that could hold potential uncertainties and values at risk for SA & D projects. Most of the risk management literature has thus far focused on individual aspects or a set of characteristics of ISDU risk but have, to the best of my present knowledge, failed to provide an integrative perspective which combines various risk concepts into a single framework such that it is better represents the environment of risks for ISDU projects. . From a practitioner perspective, risk is reduced to elements that introduce uncertainty, quality and project schedule issues. However the present paper identities and integrates risk concepts relevant to ISDU on a higher level of overall relevancy than the past efforts.

III. THE DECOMPOSITION AND NATURE OF RISK

Detmar Straub and Richard Welke define risk as "Risk is the uncertainty inherent in doing business; technically, it is the probability associated with losses (or failure) of a system multiplied by the dollar loss if the risk is realized"(Straub and Welke, 1998). Furthermore they extend the definition of risk specific to information systems ""Systems security risk is the risk that the firm's information and/or information systems are not sufficiently protected against certain kinds of damage or loss—is one form of systems risk. Another is project risk, the risk that a systems development project will fail". A clear consideration of risk has been viewed as necessary for understanding the impact of IT on economic organization (Clemons and Row, 1992). This idea of risk is further elaborated and decomposed to include 'opportunism risk' and 'operations risk' (Clemons, Reddi and Row, 1993). They suggest the decomposition: "transactions cost = coordination cost + operations risk + opportunism risk". This decomposition of risk is insightful and useful. However, the scope of risk addressed is severely limited and therefore more holistic models are required to position this decomposition in the right perspective.

Another common understanding is that IS reduces risk through aiding transparency and price discovery (Bloomfield and O'Hara, 1999). However, additional research has shown that while this maybe true on a quantitative count level of increased number of users who have access to market data, it may not be qualitatively true of all industries. Examining the online pricing in the computer industry, research has suggested that the qualitative aspect of price discovery may be in question: "IT-enabled online markets have clearly increased market transparency in terms of the accessibility and availability of price information. However, increased market transparency may not be directly translated into consumer benefits." (Oh Wonseok and Henry, 2006).

A. Decomposing Risk

The financial domain has given much attention to risk and developed strong empirical models for risk identification and risk mitigation. One basic approach involves the decomposition of risk associated with any given equity into the sum of market risk and equity specific risk. Market risk is composed of stock prices, interest rates, foreign exchange rates, and commodity prices. This means that generic market level variance in any of these can prove to be a risk factor to the value of the equity under consideration without any fundamental change in the business value of the equity itself. Equity specific risk captures the risk inherent in that specific equity's business fundamentals. The third kind of risk that the financial domain refers to is 'systemic risk', not to be confused with 'systematic risk' which is the same as 'market risk' discussed above. Systemic risk refers to the probability of loss from a catastrophic event that could collapse the entire financial system. Market risk cannot be diversified and market participants, being aware of this price their return expectation accordingly. Equity specific risk can be managed through diversification. In information systems risk analysis, the general tendency has been to focus on systems risk which is akin to focusing on the risk associated with a specific equity. IS practitioners and responsible managers are also, in many cases, prepared to mange the equivalent of a systemic crisis such as a flood or some such dramatic and often instantaneous disaster by using well defined disaster management and recovery processes.

B. Behavioral Risk

A great measure of uncertainty can be attributed to potential human behavior and various theoretical studies have identified a broad range of behavioral risks and human agent risks. Agency theory (Eisenhardt, K., 1989) addresses the issue of conflicting interests in case of a principal who hires an agent to achieve the principal's objectives but a complete dedication to the principal's objectives may hinder the accomplishment of the agent's self-objectives. Here human motivation is critical and agency theory posits that if the agent's motives are not aligned with that of the principal then the principal will be at risk to the degree of non-alignment. ISDU provides opportunities for agency problems to arise when projects are undertaken and executed in a distributed environment where the 'agents' who are implementing may have alternative objectives, such as the recording more man hours for financial gains, as compared to the client who will be working to a strict time-line. On the other hand it could be that the 'agent' is working to the time for the sake of completion and avoidance of contractual penalties but compromises on code quality in the process, once again putting the 'principal' at substantial risk. Numerous such scenarios could lead to such agency issues in ISDU, spawning significant risks which cannot be ignored. Thus this behavioral driver of project risk on various dimensions poses a real potential return on investment problem which needs attention from ISDU researchers and practitioners. Additionally Moral hazard theorists (Gershkov, Alex; Perry, Motty; 2012; Mirrlees, J. A..1999) posit that individuals and entities will act in a manner that propagates risk when the situations are such that these individuals or entities do not have to bear the costs of the risks they create. The challenge in coping with moral hazards is that behavioral aspects may be difficult to observe – such behavior is often based on information asymmetry in this that a entity who responds to an offer made by another entity may have private information which could be used by the responding entity to take undue advantage of the entity making the offer. This is logically obvious in software development projects, where the 'experts' with private information, which is often superior to the subjects expertise / knowledge, take advantage of the situation to procure a contract or agree to a particular pricing structure with prior awareness of creation of future benefits or the awareness of favorable transfer of risk in the future. The impact of information asymmetry can be further amplified in case of increased project technological complexity, distributed implementation environments, cross cultural teams and subjective contractual arrangements: In each of these cases and others, the human agents involved have an increased opportunity to behave in a manner that increases ISDU project risks on various dimensions by leveraging information asymmetry and exercising moral hazards. In using "bounded rationality" to explain organization learning (Simon, Herbert; 1991), Simon has explained well the underlying concepts of how human intent and human ability interact with interesting consequences. The limitations of human rationality, even in cases where human objective is aligned with the intended goals and objectives, leads to the creation and propagation of risks, indicating higher levels of uncertainty than that which could have been gauged in the absence of the consideration of bounded rationality dimensions. This notion of bounded rationality, in an open ended manner, connects to the concept of 'irrational exuberance' in economics and finance. Alan Greenspan, in his now famous 1996 address, said "...Clearly, sustained low inflation implies less uncertainty about the future, and lower risk premiums imply higher prices of stocks and other earning assets. We can see that in the inverse relationship exhibited by price/earnings ratios and the rate of inflation in the past. But how do we know when irrational exuberance has unduly escalated asset values, which then become subject to unexpected and prolonged contractions as they have in Japan over the past decade?". Yale professor, Robert Shiller (2000, 2005) picked this term 'irrational exuberance' and expounded upon it with a clear articulation of how risk can be mis-estimated through the irrational exuberance phenomenon, with significant consequences both to the individual investor as well to the markets at large. In spite of the wide acceptance of the Efficient Markets Hypothesis, behavioral finance has made rapid strides and crafted a space for itself partially on the basis of an inability of the efficient markets approach to gauge the levels of risks plaguing markets across the world. Expanding on the understanding of the firm boundary (Coase, Ronald -1937), another work by Holmström, Bengt,& John Roberts (1998) use the 'hold up' problem to explain the economics and contractual engagements of firms. 'Hold-up' phenomena refers to situations where two parties could be mutually benefited by working together in a pareto optimal fashion but do not do so because one of them may fear loss of negotiating power and eventually a loss of a degree of profitability due to this loss of negotiating power. This would be particularly applicable to ISDU situations where whole or part of the work is outsourced – a vendor may not want to over-commit or move ahead with a relationship suspecting that mathematically optimal approaches may lead to loss of bargaining power and thus reduce profitability in the times ahead. Another aspect is 'shirking' (Gintis H.,1976), which refers to a willful avoidance of work by employees or contracted agents to an extent such as would create maximum ease for themselves at significant cost and risk to the employer or principal.

C. Decomposing Risk

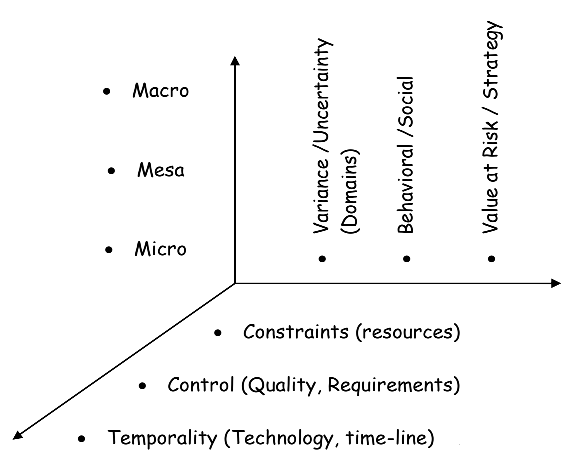
A discussion on risk with a focus on ISDU would be incomplete without developing a clear perspective on ISDU strategy risk and underlying business strategy risk. It is important to consider strategic risks, Michael Porter described risk thus: “Risk is a function of how poorly a strategy will perform if the ‘wrong’ scenario occurs.” (Michael Porter, 1998). ISDU projects could be affected by the technology strategy being adversely affected or due to non-performance of the underlying business strategy that could call for significant changes. Many projects fail due to the choice of inappropriate technology – projects are initiated using programming languages which are assumed to be able to efficiently serve the project purposes but the technology could either become redundant or it could be discovered that the technology selected does not best suit the project needs (Dorsey, P, 2005). Operational strategies such as outsourcing or the adoption of various strategic methodologies also needs to evaluated with regards to risk – any evaluation without due consideration of associated risk would tend to provide an incomplete picture of the situation. Value at Risk (VAR) is another way to view and measure risk which has been extensively used in finance and economics both as an area of research and as a valuable risk measure in practice. VAR is not a substitute for risk adjusted value frameworks nor is it a purely probabilistic or stochastic measure for risk, though it leans on these in its development to some extent. VAR is used to measure the potential loss in a scenario, though by design VAR measures the potential loss in value of a portfolio with risk, over specific time periods, with a stated confidence interval. As an example, if the VAR on a portfolio with risky assets is $ 1 million for a 30 day period with a 95% confidence level, this implies that there is just a 5% chance that the value of the portfolio with risky assets will drop more than $ 1 million over any period of 30 days. Practitioners in a variety of ways have used VAR and the measure is used to imply a possible loss in value from “normal market risk” thus contrasting it with overall risk that is a sum of market risks and non-market risks. A VAR measure has implications at a strategic level and adapting the use of VAR for ISDU would provide both business and technology managers with an excellent and tested framework for evaluating potential losses and develop contingencies. VAR measure could be used to effectively develop alignment between the business side or the client side and the technology side or the developer side through a careful planning process thus providing increased stability to ISDU initiatives. Koch S (2006) has used the VAR model for “IS/IT Project and Portfolio Appraisal and Risk Management” and the present study posits the extension of this risk measure to ISDU and to IS initiatives at large.

Risk, Success and Failure: Risk and uncertainty are not synonymous though, in a conceptual sense there could be elements of risk in uncertainty (Kaplan, 1981; Riabacke, 2006). The purpose of this note on risk, success and failure is to support the development of an understanding for research questions Q1 and Q2 – by discussing risk, success and failure with a focus on delineating certainty, risk and uncertainty we can develop a better understanding of risk concepts and ways in which an integrated risk framework could be developed. Risk is associated with the probability of an event while uncertainty with the information associated with an event: "Variability is a phenomenon in the physical world to be measured, analyzed and where appropriate explained. By contrast uncertainty is an aspect of knowledge." (Sir David Cox). ‘Certainty’ refers to an event with only one possible outcome (Riabacke, 2006) irrespective of the nature of the outcome, whether it be success or failure or a specific point in the failure to success range. However, risk refers to events with two or more possible outcomes (Riabacke, 2006) and thus represents the probability of failure (or another measure) and the chance that vulnerability (or another measure) will be exploited. If a matter is known, no matter how serious, no matter how negative, devastating or disastrous – if it can be ascertained with hundred percent certainty, then there is no risk (Riabacke, 2006; Branmark and Sahlin, 2010; ; Lapin and Whisler, 2002; Taha, 1987) there is only a certain failure or a guaranteed catastrophe that exists. It must be noted that “no risk” is very different from “zero risk” or even “riskless”. “No risk” in the present context simply implies that the outcome in specific and certain. Risk is associated with probability and therefore with non-guarantee-able but known variability. Where uncertainty exists –there risk exists at least in perception but it is not necessary that uncertainty must exist with risk. Therefore as an example, if an individual jumps of an aircraft flying at 30,000 feet above sea level without any parachute or any alternative safety mechanism to the earth below, then there is no risk, only the certainty of death. However, if the same individual were to jump of an aircraft flying at 30,000 feet above sea level with a parachute hat has not been tested or used for a long time and is suspected to have been damaged in transportation or is know to have a design flaw which sometimes causes it to not open and works well otherwise, then the individual is taking a risk which is a function of at least two variables: one is the probability that the parachute won’t open or work appropriately enough to protect the diver from a lethal fall and the second is the extent of damage or the value at stake, which in this case is the persons life - This is in line with past research where risk has been identified as being a function of the probability of an event and the extent of impact caused by or associated with the probable event (Kaplan, 1981). The first case is sure death, and therefore the presence of certainty but no risk and the second case is probable death (more than one possible outcome) and hence the presence of risk, along with the implicit absence of certainty. This is inline with past research (Riabacke, 2006; Branmark and Sahlin, 2010; ; Lapin and Whisler, 2002; Taha, 1987) which classify the occurrence of certain events as being different from risky events. Additionally this notion on ‘no risk’ is supported by research on decision making under risk which includes the Expected Utility theory (Neumann and Morgenstern, 1947) and Prospect theory (Kahneman and Tversky, 1979) – the important takeaway being that “no risk” is assumed by a rational agent who would either optimize for certain success or avoid totally for certain failure. This helps us to understand that success involves the mitigation and avoidance of risk and using the same logical thought process as above, we can posit that it is possible and though weakly in certain domains, to have success without risk. It is also necessary to note the difference between risk perceptions (Oltedal, 2004) which are subjective or descriptive measures of risk and risk evaluation which include objective measures of risk and are based on quantitative methods. From an implementation perspective, managers need to take decisions which are often associated with risky events and for the purposes of addressing research question 2 of the present paper, Utility theory (Neumann and Morgenstern, 1947) and Prospect theory (Kahneman and Tversky, 1979) would serve to support the risk concepts integration framework.

IV. Towards an integrative view of ISDU risks

It is important to reiterate the importance of the IT artifact in ISDU, and strong arguments for the same on a broader perspective on the IS research domain has been made by Orlikowski (ISR, 2001). Here we acknowledge not only technological artifacts such as programming languages, necessary hardware, coding, methodologies and innovations but we also need to acknowledge the non-IT artifacts such as human resources, financial resources, organizational resources (those in addition to human and financial) and intangible assets, all of which interact with the IT artifact and ISDU processes to impact risk measures. It is through this dynamic interaction of IT artifacts with non-IT artifacts that we see an increase in complexity levels, the usual effect of which should be an increase in uncertainty and thus normatively, but not necessarily, an increase in the overall ISDU process or project risk measure. This interaction-istic view of information systems is not novel and has been well addressed by Silver Mark S., M. Lynne Markus and Cynthia Mathis Beath (1995) in their argument for the scope, content and pedagogical context for IS courses. They refer to the model they develop as the "Information Technology Interaction Model" and they posit it to be so because of their argument that information systems covers the interaction of technology with the organization, implicit here is the idea that technological artifacts are in interaction with organizational, a.k.a. business, artifacts and this interaction works in a similar fashion within the narrower scope of ISDU. This understanding of the interaction-ist nature of technological artifacts is necessary for the development of an expanded framework of risk concepts because the expanded framework is directly relevant to a broader involvement of technological artifacts.

Numerous risks plague ISDU projects and risks are commonly identified with the operational measures such as the risk of the ISDU project not being completed on time or the risks associated with the ISDU initiatives going over the allocated budget or the risks for the development objectives not being met, in part of the failure of the project as a whole. The present paper both expands the scope of risks taken into account for ISDU projects and also looks at risks as being multidimensional in the way they influence ISDU. The present investigation leads to the creation of new directional framework: "Conceptual Integrative Risk (CIR)" framework for ISDU initiatives – this framework is three dimensional in nature and incorporates three levels of analysis (Micro, Mesa & Macro) along the vertical axis. The two horizontal axes are used to represent risk with the forward axis representing risk measures (constraints of temporality, control and quality, and resources -including financial resources). The second and lateral horizontal axis captures the risk dimensions and includes risk constructs of variance and uncertainty which tend to be driven by technological and process factors, behavioral risks which play out in the social context and VAR which provides an overall view of the downside – the potential loss that the ISDU initiative owners would need to be prepared for. In the past, many frameworks and risk management methodologies have been posited: Vepsalainen 1993 and Lucas (1981) refer to the four classical approaches to risk investigation and management, the essence of which has been carried over to modern day research. These historical and classical risk management approaches help us to understand the fragmented way in which risk in IS has been subsequently articulated. Alter, S. and Ginzberg, M. (1978) address the issue of uncertainty in IS implementation scenarios but their notion of risk is limited to the probability of failure in the implementation process and cannot thus be extended to accommodate other issues such as budget risks and behavioral risks. Likewise Boehm (1989 and 1991) restricts the analysis to a loss minimization approach in favor of the stakeholders and Davis (1982) focuses on the risk of non-achievement of alignment based on his focus on the difficulties in understanding the task well enough through the requirements gathering process – again a good but very limited way of looking at risk. McFarlan (1982) takes a more business centric perspective by focusing on the project's goals and develops the idea of risk around the probability of failure to meet all or some of the goals. In all of this and in practice, based on what we have seen so far and to the best of my present knowledge, no significant and scholarly work exists on risks in ISDU from an integrative and broad perspective.



Conceptual Integrative Risk (CIR) Framework for ISDU

Figure 1

It is against this backdrop of fragmented theoretical studies and a dismal success rate for IS projects that the present framework for gauging risk in a broad and encompassing manner is presented. This directional framework is presented as a conceptual model "CIR" (Conceptual Integrative Framework).

Notes on the RCM qualitative methodology for the proposed Conceptual Integrative Risk (CIR) Framework: The development of the idea of an expanded and integrative risk framework "CIR" has been largely conceptual thus far and has limited applicability in its present form. Though it would be of theoretical interest to continue conceptual development and there would be significant value in articulating the ontological argument on the nature of risk in IS, it becomes necessary from a relevance perspective to develop this study using a qualitative methodology which supports conceptual development. The 'Revealed Causal Mapping' (RCM) method provides strong support for theoretical and conceptual development and is evocative in nature. Prior studies indicate that the use of the RCM methodology has been successful in various research streams including IS (Nelson, Nadkarni, Narayanan, and Ghods, 2000). Also importantly, RCM serves as an evocative qualitative methodology which reveals the relationships between the various theoretical constructs being explored. The present study represents an opportunity for the development of a mid-range theory in the development and usage of an expanded and integrative risk concepts framework and the RC methodology lends itself to the development of such mid-range theories (Narayanan and Fahey, 1990).

V. CONTRIBUTION AND IMPLICATIONS

The present research on the development of an expanded and integrative cross-domain risk framework .is expected to thus stimulate thought and encourage integrative perspectives on risk in ISDU amongst researchers and practitioners:

1) Serve as an initiation of an ontological discussion on the nature, the span, the scope and the process of risk in information systems.
2) Provide an expansion of risk concepts associated with IS risk perspective frameworks starting with CIR
3) Serve as a integration point for cross-domain risk measures
4) Serve as a starting point for developing customized risk management models and solutions
5) Serve as a new stream of research on the application of cross-domain risk measures in IS
    a) Case studies to explore risks in IS projects
    b) Qualitative studies to analyze the integration of various risk measures
    c) Experimental studies to analyze the effects of expanded cross-domain risk frameworks upon project performance

From a practitioner perspective, the present research can be expected to add a new dimension to risk investigation, risk identification and risk management. The CIR framework for ISDU also provides a better explanation of the way risks emerge in a multi-contextual situation where ISDU activities could be simultaneously implemented on various parts of a system in an organization. The risks that arise of the resultant complexities can be understood using the Value at Risk framework while specific contextual risks may be best understood using variance and uncertainty constructs or by leverage the behavioral construct. Risk is a very relevant and high priority subject for individuals and corporations. The extraordinary impact of IS on day to day life and the high amount of latent risks involved need to be studied and carefully modeled so that we can minimize the impact of risks and maximize the rewards of technological advances in ISDU and IS initiatives at large. Specifically, in addition to the first five points, practitioners can also benefit from the CIR framework and the theoretical arguments supporting the same by:

6) Using the CIR framework for strategic risk analysis – the framework being conceptual in nature along with its ability to provide a macro-perspective on risks, can serve as a direction setting and strategic analysis tool.
7) Leveraging the CIR framework to support existing risk management models and allow for positioning of such existing or future risk management models into the broader CIR ecosystem.

VI. LIMITATIONS OF THE PRESENT STUDY

This research proposal is qualitative in methodology and significantly conceptual in its articulation. The nature and the scope of the research topic has mandated that a conceptual framework needs to be established to create a direction for empirical research. The exhaustive level of literature review that is mandated by a topic of this nature has not occurred – there remain large sections of literature related to risk concepts that need to be reviewed and incorporated into the further development of the CAR framework. The present research proposal is expected to be high on external validity but the generalizability and the applicability of the model will remain a challenge till we see a stream of case studies, empirical and quantitative studies on the topic. Future studies need to explore empirical relationships between various constructs of IS capabilities and associated risks. Future research must also expand the scope and examine additional constructs such as systems rigidity and model variations for specific industries. The present research only touches upon one aspect of risk management and that is the identification of risk. There is significant scope for directing this research into a sub-stream of risk management.

VII. CONCLUDING NOTES

The present research proposal is expected to be a significant conceptual contribution to IS theory in expanding the understanding of risks associated with ISDU in a broad and encompassing framework which identifies the risk measures, dimensions and levels of analysis in an encompassing but parsimonious manner. This paper intends to emphasize that the commonly understood and used measures for identifying risks associated with ISDU projects are insufficient as they would tend to supply an incomplete and restrictive perspective on associated risks. Mere accounting of risk measures without a simultaneous consideration and inclusion of risk dimensions would lead to an understatement of risks associated with ISDU. This understatement would not only provide a misleading application of the risk adjusted economic values but would also miss out on identifying certain risks altogether. The present research is expected to create a shift from the general perspective that risk is measured and managing only by addressing commonly accepted risk measures which are only the surface expressions of the underlying risk dimensions. Developing mathematical equations using econometric modeling to capture this multifaceted view of risks in ISDU would be useful though it is beyond the scope of the present paper. We need to bear Anthony Giddens structuration principle in mind to recognize that the ISDU risk – rewards environment is dynamic, iteratively evolving and changing t any given point of time. This adds increased complexity to an already sophisticated mix. Today's "thought leadership" could be tomorrow's obsoletes. Therefore, the present contribution is expected to provoke and initiate a scholarly debate on risks associated with ISDU, with a broad encompassing perspective on risks, which not only includes commonly known and accepted risk measures but also includes risk dimensions that are critical for developing a fair, complete and holistic view of risks. This will be of significant help to both researchers and practitioners – researchers can use this to explain various risk phenomena better and articulate multi-dimensional risk management models while practitioners would be able to use this a starting point to better evaluate the scope and depth of risks, empowering them to create better risk management models and an advancement in understanding the economics of and ISDU projects and IS initiatives from a risk adjusted return perspective.

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