A General Framework to Measure Organizational Risk during Information Systems Evolution and its Customization

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Information systems change initiatives often represent the single largest investment (and therefore risk) for large corporations yet there exist few management frameworks in the literature to help decision makers measure risk during this organization-wide change process. The Organization Risk Evaluation (ORE) framework has been developed based on the design science paradigm as a multi-criteria, relative risk, condition consequence, management decision framework enabling executive decision makers to calculate and compare risk evolution at fixed points of the change cycle and make structured and balanced risk mitigation decisions.

Enterprise Resource Planning systems evolution initiatives in distribution companies are a model example of the defined problem. The ORE framework is customized into the ERP-ORE framework to demonstrate its application. The ERP-ORE framework emphasizes the political and process dimensions of systems evolution and utilizes the Analytic Hierarchy Process to enable management to make disciplined risk mitigation decisions. The ERP-ORE framework is illustrated through a case study description of a medical supplies distributor implementing an ERP system. The focus is on the ERP system’s role as an information manager within the supply chain.

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ACM Classification: K.6.1, K.6.3, D.2.9

1. RISK MANAGEMENT IN INFORMATION SYSTEMS EVOLUTION PROBLEM

Information systems (IS) are a vital part of corporate operations, tactics and strategy and are often critical to business competitive advantage (Rosemann, Klaus and Gable, 2000). With any change in process or systems there are always associated risks. Hence any failure during the evolution of the information system can seriously impact the corporation (Sumner, 2000). It has been claimed that 67% of enterprise application initiatives can be considered negative or unsuccessful (Davenport, 1998).

Software process change is inevitable and should ideally be based on quantitative software measurement programs (Offen and Jeffrey, 1997). Yet most organizations do not have formal risk assessment methodologies and metrics to help management measure the change in risk as the
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organization evolves (Dedolph, 2003). One of the reasons for lack of management use of formal
methods is that few models directly address the ultimate purpose of metrics, which is to provide
support for managers for improved decision making (Fenton et al, 2007). The Project Management
Institute’s (PMI) Guide to the Project Management Body of Knowledge (Project Management
Institute, 2000) defines risk management as “the systematic process of identifying, analyzing, and
responding to project risk with the aim of minimizing the probability and consequences of adverse
events to project objectives”.

There are two approaches to address the shortcomings of current frameworks and enable
effective risk management. The first approach is to develop a framework where absolute risk and
its impact are measured. It is easy to use a framework where absolute risk is measured qualitatively
(e.g., three levels such as high, moderate and low). However such a framework has limited
applicability as the qualitative risk could be always high. One can also measure absolute risk and
impact in financial terms but developing accurate absolute risk measures is a time consuming and
difficult process. This is because one needs to estimate the events that are risky, the probability of
each event actually occurring and the impact (cost) of the event when it eventuates. From a change
management or system evolution point of view an early quantitative indicator of potential risk and
its evolution is useful (Nogueira, 2000). Nair (2006) identifies the three main estimation method-
ologies as Analogy, Top Down and Bottom Up. Analogy uses historical data to estimate current
measurements; Bottom Up combines individual component estimations to compute overall
estimations while Top Down emphasizes overall estimations and ignores low level individual com-
ponents estimations.

A new information system is a complex political and social game (Keene, 1981) where the
context is critical and it is difficult to isolate the impact of a small number of variables due to highly
complex interactions. Hence interpretative research methods (Skok and Legge, 2001) are relevant.
They need to be combined with traditional software engineering risk identification and measure-
ment techniques to enable measurement of organizational risk.

Two paradigms characterize much of IS research, behavioural science and design science. In
design science knowledge and understanding of the problem domain and its solution are achieved
in the building and application of the designed artefact. IS research is therefore concerned with the
development of behavioural theories and design artefacts to add to the knowledge base, and appli-
cation studies to the environment to test and refine the knowledge base (Hevner et al, 2004).

The organizational perspective is especially important in risk management. Curtis (1989)
explains how software systems need to be analyzed in their broader organizational context. Technical
metrics such as Function Points, Halstead’s measures and McCabe metrics for cyclomatic
complexity etc. were developed to measure and analyze different artefacts in the software develop-
ment process. However the risk of individual software development/evolution projects is only a part
of the overall risk in enterprise wide systems evolution (Keene, 1981). Chang (2004) used an open-
ended Delphi type survey to capture two main categories of information system implementation
issues as lack of incorporation of organizational context and reluctance to accept dissenting views.
Enterprise wide risk evaluation therefore requires both individual project specific factors and organi-
zational wide factors to avoid change which is a technical success but an organizational failure.

For technical risk, Higuera and Haimes (1996) in their description of the Carnegie Mellon
Software Risk Program (CMU SRP) describe a taxonomy-based approach to risk identification.
This approach has been incorporated into the ORE framework to assign default sub-project factor
weights (see section 5.8 below). Possible risks are categorized into Product Engineering, Develop-
ment Environment and Program Constraints. Each category contains a list of factors and an
associated questionnaire as guidance for risk elicitation. The taxonomy based approach provides an
empirical referential structure enabling the risk assessment team to quickly and comprehensively
survey and choose the risks (and weight them) most relevant to their organizational domain. The
software development, evolution and deployment phenomenon itself is considered as an n-
dimensional space where each dimension is a relevant risk causing element to the successful
completion of the project (Gluch, 1994). At any point in time the state of the system is thus
expressed as a point in space with values relating to each risk dimension. This enables management
to assess whether the state is desirable/undesirable and how the state might change and take correc-
tive measures as necessary. This methodology emphasizes a relative risk, condition consequence
approach to risk identification and measurement (away from root cause analysis) enabling decision
making oriented measurement.

Specific examples are a good mechanism to demonstrate the applicability of a framework. In
this paper we do this in two steps. The first step is to customize the framework to an application
domain. The second step is to use the customized framework in a particular situation. Enterprise
Resource Planning (ERP) systems have been chosen as the generic application domain. An import-
ant issue in the customization and application phase is the need to select the right parameters in the
context of multiple and conflicting aspects. The research also recommends the Analytic Hierarchy
Process (AHP) to select the appropriate parameters. The rest of this section motivates an application
domain for the risk measurement framework and outlines the key aspects of AHP.

Distribution businesses are redefining themselves in the context of their new role in the supply
chain. This involves a change from a make or break bulk aggregator to the supply chain information
manager. In order to better manage internal customer and operational information and ready them-
selves for their new role in the supply chain several distributors are implementing ERP systems.
ERP systems are a form of integrated business application packages (Rosemann, Klaus and Gable,
2000). However the essence of ERP is the process of connecting all information flows within the
firm and using that connectivity together with analysis to advise decision makers and make routine
decisions. This leads to better internal and external communication resulting in decreased costs,
better decisions and greater customer satisfaction (Lawrence, Jennings and Reynolds, 2005).

An ERP implementation initiative is critical for distribution firms and there are few projects in
a corporation’s history which have a greater financial and organizational impact (Summer, 2000).
ERP systems represent a new business operating system (Chang, 2004) and are a significant invest-
ment of time and resources. It is claimed that this could be between 2% and 5% of revenues (Austin,
Cotteleer and Escalle, 1999). Inadequate and poorly planned implementation is one of the most
frequently cited reasons for ERP disasters (Hong and Kim, 2002). ERP standard processes often
conflict with the non-standard distribution processes (Lawrence, Jennings and Reynolds, 2005) and
can cause disruptive change (Soh, Kien and Tay-Yap, 2000). Successful implementation can lead to
key competitive advantage (e.g., Cisco, Tektronix) while failed implementations have caused bank-
ruptcy (e.g. Fox Meyer) (Skok and Legge, 2001). Risk assessment and mitigation is therefore
critical to managing and ensuring the success of the ERP evolution. There are no formal frameworks
in the literature which support distributors in implementing ERP systems.

The Analytic Hierarchy Process (AHP) is a widely used management science framework (Saaty,
1980). It is a mathematical decision making technique that allows consideration of both qualitative
and quantitative aspects of decisions. It reduces complex decisions to a series of one-on-one
comparisons and then synthesizes the results. The within-criterion matrices are mathematically
merged with the between-criteria matrix to yield an overall prioritization of the decision alternatives
in light of the decision maker’s elicited preferences. AHP provides support for all major phases of
the decision making process: intelligence, design, and choice. It can be used with an individual (unitary) decision maker or with groups thus drawing all stakeholders together and providing a means of conceptualizing and communicating the problem permitting shared vision. Most importantly it provides a means to manage the cognitive complexity which is so often attendant to problems with multiple decision criteria for which multiple decision alternatives must be considered (Karsten and Garvin, 1996), such as understanding and managing risk during ERP evolution.

2. PROPOSED SOLUTION – THE ORE FRAMEWORK

The approaches described provide important guidance in developing a risk measurement framework. The Organization Risk Evaluation (ORE) framework has been developed to provide a quantitative measure of risk and support development of a risk scale calibrated to the organizational specifics which allows management to compare risk evolution versus system evolution and make strategic risk mitigation decisions. Based on PMI guidelines ORE has been designed to support a structured approach to risk measurement that helps to manage change complexity and can be used throughout the evolution lifecycle. All three estimation methodologies have been reflected in the ORE architecture. It supports an organizational condition consequence approach by viewing the organizational system risk at a point in time due to contributions by metrics that are part of relevant organizational dimensions and by emphasizing cause and effect relationships in assessing risk evolution.

Therefore ORE has been developed as a multi-criteria, relative risk, condition consequence, management decision framework enabling executive decision makers to calculate and compare risk evolution at fixed points of the information systems evolution change cycle and make structured and balanced risk mitigation decisions (Agrawal, Finnie and Krishnan, 2008). One of the key characteristics of the original ORE framework was its generality of application to various business domains and information system paradigms with the flexibility to customize it for particular domains and paradigms (Agrawal, Finnie and Krishnan, 2007).

To illustrate a particular customization the ERP-ORE framework has been developed. ERP-ORE is an instantiation of the original ORE framework for measuring risk during the evolution of the Enterprise Resource Planning information system paradigm in the distribution business domain. ERP-ORE is described and illustrated through an example of a medical supplies supplier replacing its legacy technology infrastructure with an ERP platform to meet the new demands of its role in the supply chain.

The rest of the paper is organized as follows. The next section describes ORE; both conceptually and in terms of the key principles underlying its construction. Next the ORE architecture is formally defined as part of the design science paradigm and its measurement process and output are defined as per the representational theory of measurement. Following this description the ORE framework is customized for the ERP in Distribution problem. The description of the customization process begins with defining the ERP in Distribution problem. The main architectural and metrics changes in ERP-ORE are then explained. Finally ORE and ERP-ORE are illustrated through a case study of a medical supplies distributor implementing an ERP system to replace its legacy systems to meet the new demands of the supply chain.

3. ORE ARCHITECTURE

The ORE framework has a multi-level architectural design based on a set of core principles and a hierarchical organizational decision making model that enables effective use in management decision making. ORE supports both buy and build approaches to information systems evolution.
Figure 1 illustrates how the framework can be used at various levels within an organisation. It indicates how the risk measured at the project level can be used to create a risk measure at the organization level. At each level different personnel are involved in the risk measurement process.

The typical levels of decision making in an organization can be divided as operations, tactics and strategy (Emery and Trist, 1965). ORE provides support for all three levels of decision-making. A corporate wide evolution project would be broken into management wrappers named technical sub-projects. Then, following Torsten and Guido (1997), three levels of management would look after the operational, tactical and strategic dimensions of the evolution respectively.

The technical sub-project managers would use ORE sub-project factors (and associated metrics) to measure operational concerns across all organizational dimensions. At the tactical level the PLC (the Project Level Controllers) would use the risk assessments from all sub-projects to assess the progress of the corporate project. The PLC would make tactical resource allocations decisions and facilitate smooth communication flows between and within project teams. Their judgment of progress would flow to the OLC (Organizational Level Controller.) Based on their understanding of business objectives the OLC would set and revise project dependencies and priorities and establish the strategic direction of the systems change.

The ORE methodology is based on the paradigm of fixed time sampling in a cyclic process as illustrated in Figure 2. ORE is designed to support the constant change (Volker and Rohde, 1995) by allowing organizational decision makers to measure risk at certain comparable points in time such as the inception phase of each change cycle (this aspect is defined formally in Section 6.2). More importantly, ORE allows application multiple times within the same evolutionary phase. Hence the time granularity of ORE application is flexible. ORE timestamps each risk assessment
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and uses them to build a self-referential risk scale that is fully customized to the organizational specifics and can be credibly used to measure and compare organizational risk at later comparable times. The results of the analysis can be used to make risk mitigation decisions thus providing structure to an evolving and changing world.

The ORE methodology will be used as follows. The sub-project managers (SPMs) and PLCs will use the basic framework to develop a domain specific model. The OLC will not be involved in the customization process and would use the domain specific model to capture the change in risk at the organisational level.

4. FORMAL DEFINITION OF ORE

4.1 Design Science Definition of ORE

The design science paradigm defined in Hevner et al (2004) is used to define the ORE framework as a design science artifact. This work follows the various guidelines advocated by the paradigm.

Following the first guideline a viable model (ORE) which provides utility in understanding and measuring organizational risk during information systems evolution has been developed. The second guideline requires the problem to be relevant. The importance of risk measurement during information systems evolution has been described earlier. The third guideline requires evaluation rigor which is addressed after the framework has been developed. The evaluation details are described in Section 8.3. The other guidelines that govern the research process of novelty, conducting appropriate literature surveys, using appropriate theory and notation, support iterative refinement are also followed. The brief justification is presented here with the details present in appropriate sections. Section 1 provided the context of this work and argued for its novelty. The aim of this work is to measure organizational risk so that it is possible to compare the measured risks during different phases of evolution. Furthermore the framework is particularly suited for organizations that have a large portfolio of projects that undergo constant change. The details of the model that supports measurement and refinement or customization and analysis is developed later.
particular, Section 7 describes the ORE measurement and analysis process and clearly demonstrates
the Generate/Test cycle which represents a heuristic search process enabling organizational
management to iteratively measure and understand organizational risk based on domain specifics.
As the paper describes both the theoretical basis of the framework and presents examples of use,
the paper is suitable for both a technical and management audience.

4.2 Measurement Theoretical Definition of ORE
The representational theory of measurement (Roberts, 1979) is used to describe ORE and its scales
of measurement to facilitate real world comprehension of the measures developed. Our specific
purpose in the development of ORE is to measure risk during information systems evolution. The
output of our measuring process (as formalized by ORE) is a numeric measure (in risk units)
representing organizational risk within a time-stamped context. There is no meaningful origin point
or zero risk value as there is always risk and the project is never completed (operational running of
the system is just another cycle for ORE before change/replacement). Both parametric and non-
parametric statistical tests are applicable on ORE output. Meaningful statistics include mean, stan-
dard deviation, t test, and ANOVA etc. The level of formality (in terms of scales of measurement)
chosen for metrics within ORE are based on the measurement maturity of the specific metric. Some
metrics such as Function Points are mature (Fenton, 1998) and therefore mapped to a ratio scaled
numeric measure. Others such as project team cohesion are subjective and measurement scales are
not widely accepted within the industry, hence an ordinal scale is chosen.

Normally measurement progresses from direct to indirect measurement as a natural process of
understanding the attribute and the entities that possess it (Fenton, 1998). However one of the key
contributions of our work is to explain that measuring organizational risk directly is difficult
(corporate executives measure risk perceptively innumerable times and fail) hence organizational
risk must be measured indirectly through direct measures (where possible) of identified structural
components. Furthermore the work hypothesizes that the identified constituent elements of
organizational risk and their relationships are generally valid and will produce useful risk measures.

The ORE method of risk computation involves identifying a set of factors $F$ with members
$F_1,...,F_n$, assuming fixed weights $\omega_1,...,\omega_n$ for each factor. For each factor $F_i$ identify a set
of metrics $M_i$ consisting of metrics $M_{i1},...,M_{in}$. At any given time $t$, only a subset of $F$ may be relevant,
say $F_t$. Further the contribution to a factor $F_i \in F_t$ at time $t$ may only be a subset $M_i$, say $M_{it}$. The
risk value due to factor $F_i$ at time $t$ can be denoted as $\sum_{M_i \in M_{it}} M_i(t)$. Thus organizational risk value

at time $t$ is $\sum_{F_i \in F_t} \omega_i * F_i(t)$. Two organizational risk measures at times $t_1$ and $t_2$ are comparable if
$F_t^1 = F_t^2$, and for every $F_i \in F_t^1$, $M_{it}^1 = M_{it}^2$; that is the set of factors and metrics are the same.

This process of computation is repeated up to the desired level of abstraction where higher level
factors are composed of lower level factors and so on till the point of empirical assessment.

For example in a buy based information systems evolution process, technical issues are a factor
and data conversion is a metric. Similarly in build based information systems evolution process,
project team is a factor and size, experience are its metrics. Despite the formalizations introduced
for precision the numeric measures by ORE are subjective assessments (as is all measurement) and
expect to be enriched (in terms of sophistication of scale, classifications of severity and meaning)
and refined with usage and maturity for different contexts.
5. ORE COMPONENTS
5.1 Sub-Project Risk Assessment
A sub-project is a management wrapper with specific technical objectives. ORE defines a balanced set of factors to measure technical, process, organizational form and people issues during sub-project evolution which are described in the following subsections. Different subsets of these factors or metrics may be chosen for specific sub-projects based on whether a buy or build approach to information systems has been undertaken, organizational specifics etc.

In the following subsections each factor is described using the notation: Factor = \( \sum_{i \in I} f_i \cdot w_i \)

The contribution of each factor is calculated as a weighted sum of the various metrics for that factor indicated by an index set I. Only the elements of I, viz. the set of metrics is stated.

5.2 Technology Change
The use of new technologies in a company has been observed to be an important and recurring problem in the industry (Tatikonda and Rosenthal, 2000). Measuring the effect of technology change requires consideration of the amount of technological change in the product (or service), the amount of process change this entails, and the interdependence and integration of the new technologies with existing technical infrastructures. All these factors are weighted and combined in an appropriate manner based on the domain to provide a holistic measure of the risk due to technological change. Technology change metrics are: Product Technology Novelty, Process Technology Novelty and Technology Interdependence.

5.3 Size Change
Incorrectly sized projects (with respect to implications on cost, effort and time projections) add risk to the change process (Ropponen and Lyytinen, 2000). Size is measured by using the Function Points metric (Albrecht, 1979) which is suitable for management information system projects (Nair, 2006).

5.4 Requirements Change
Requirements change metrics are the Birth rate (BR) and the Death rate (DR). Studies have shown that the early parts of the system development cycle such as requirements and design specifications are especially prone to error due to changing business requirements. The birth rate and death rate metrics provide a way to calculate the effect of new requirements during evolution (BR) and the changes in previous requirements (DR). A typical function can be \( \text{INT}(\frac{BR + DR}{10}) \) (Nogueira, 2000), where \( \text{INT}() \) takes a numeric argument and converts it to the nearest integer.

5.5 Personnel Change
Staff turnover and productivity trends during a project are important indicators of change management success and indicate new staffing requirements, training and learning requirements on the new system etc. all of which importantly affect project risk. The first metric is \( \frac{\text{Direct}}{\text{Idle}} \) which is one form of productivity ratio and stands for the direct time spent on the project for all the personnel involved divided by the idle time they spend. This ratio has been found useful in differentiating high productivity scenarios from lower productivity ones. Values between 2 and 6 represent high productivity scenarios while values less than 2 represent low productivity scenarios (Nogueira 2000).
Loss of key personnel during software evolution often triggers loss of key knowledge and experience (Bennett and Rajlich, 2000). The second metric is which represents the personnel turnover during the last evolution cycle.

5.6 Parallelism
Software evolution with a high degree of parallelism might allow several tasks to be carried out concurrently. However, it also represents a greater management overhead. On the other hand, less parallelism leads to the weakest link issue due to sequential dependencies (Capital Broadleaf International Pty. Ltd., 1999). A balanced approach to scheduling activities based on the specifics of the environment is the middle path towards risk mitigation. Therefore, parallelism is measured using the ratio $\frac{\text{Concurrent Phases}}{\text{Sequential Phases}}$, where $\omega_{\text{EC}}$ is the environment constant.

$\omega_{\text{EC}}$ is based on the suitability of the environment for concurrent/sequential work. The ratio will have a value of 1.0 if the environment does not impose any advantage for either scheduling mechanism. For example, it will seek to increase risk if the environment is better suited for sequential work and there are more concurrent phases.

5.7 Ranked Metrics
The following project sub-metrics are designed to elicit subjective expert assessments regarding people and politically based risk criteria for IS projects based on the recommendations of the Information Systems Audit and Control Association (2002). They are based on an ordinal scale of measurement due to their subjective nature and measurement maturity.

**Development Platform:** The sub-project manager makes a judgment about the risk due to development platform ranked on a five-point scale based on whether the development platform is proprietary or open source, the length and quality of the platform’s track record, scalability of the development platform (Fenton, 1998) and support and constant improvement provided for the platform.

This metric is expected to be of utility in build-based information system evolution projects where modules or the entire system are being custom designed and coded on single or multiple development platforms.

**Manpower Outourcing:** Manpower outsourcing is an important part of modern corporate strategy and this metric incorporates this business reality into the risk assessment and decision-making process. It is expected to be of utility in build-based information systems evolution projects. The sub-project manager makes a judgment on a five-point scale based on the percentage of manpower outsourcing relative to the total manpower required for the project, overseas or local outsourcing and the number of manpower suppliers and their track record.

**Project Team:** The importance of team cohesion and leadership is difficult to overestimate in a project and the criteria are designed to elicit the project manager’s assessment of project team leadership and inter-team communication and cohesion. Each team is ranked on a scale of 10 based on size, organization and experience of team and the project management experience of team leader.

5.8 Default Sub-Project Factor Weights
ORE assigns a default set of weights to all sub-project factors based on empirical results collected and organized by the software risk program at Carnegie Mellon University (Higuera and Haimes, 1996; described in Section 1). The CMU SRP organizes risk causing dimensions into three main
classes (with associated subclasses), Product Engineering, Development Environment, and Program Constraints. All the main classes have approximately equal weighting. Sub-project factors are assigned to appropriate classes. Therefore Technology Change and Size Change are assigned to Product Engineering (subclass Design). Requirements Change to Product Engineering (subclass Product Engineering). Personnel Change to Program Constraints (Resources). Parallelism has been assigned to Development Environment (Management Process). Development Platform is assigned to Development Environment (Development System). Manpower Outsourcing to Program Constraints (Resources) and Project Team to Development Environment (Work Environment).

Factors from all main classes are represented in ORE; however some subclasses are not used. Subclasses in use are scaled to ensure they equal total risk for their class while maintaining their weightings between each other within each main class. The overall sub-project risk equation may be expressed as,

$$\rho_{(subproject)} = 0.1(\text{Technology Change}) + 0.1(\text{Size Change}) + 0.2(\text{Requirements Change}) + 0.37(\text{Personnel Change}) + 0.18(\text{Parallelism}) + 0.09(\text{Development Platform}) + 0.37(\text{Manpower Outsourcing}) + 0.06(\text{Project Team})$$  
(Equation 1)

5.9 Project Priority and Dependency

Project priorities (0-10) are set by the Organizational Level Controller (OLC) based on considerations of sub-project scope, budget and political issues. Priorities are used to weight the sub-projects risk contribution to organizational risk and enable structured consideration of what-if scenarios and resource allocations.

The dependency measure helps describe cause and effect relationships between sub-projects. ORE looks at project dependency relationships as graphs and by default propagates the entire parent project risk (weighted by priority) to the children. For example if projects B, C and D are dependent on A then each of their risks equals the sum of their own risks and their dependency risks (i.e. A’s risk). Once a project is complete its risk becomes zero; hence the graph self-adjusts the risk values as evolution progresses. Additionally not all projects may be related to one another in this simple way. These dependency relationships and the effect of dependency can be modified as per the organizational specifics.

5.10 Overall Organizational Risk Equation

Drawing from Equation 1 and priority and dependency models the default organizational risk equation may be mathematically expressed as

$$\rho_{(organizational)} = \sum_{i=1}^{n} (\rho_i * \sigma_i + \delta_i)$$  
(Equation 2)

Where $\rho_i$ stands for sub-project risk of project $i$, $\sigma_i$ stands for priority for sub-project $i$, and $\delta_i$ stands for $\sum_{j=1, j \neq i}^{n} \rho_j * \sigma_j$ where $\rho_j$ represents the $x$th project on which $\rho_i$ depends (hence $j$ iterates over all the projects $\rho_i$ depends upon) and $\rho_j$ and $\sigma_j$ represent the sub-project risk of a related project and its priority respectively. There are $n$ sub-projects in the organizational information systems evolution.

5.11 Illustrating ORE for the ERP in Distribution Problem

One of the key characteristics of the ORE framework is its generality of application to various business domains and information system paradigms. This generality however prevents effective use of the framework in real world business situations. Hence it is expected that the ORE...
framework will be customized for specific business problems defined by business domain and IS paradigm.

To illustrate the customization process the ERP-ORE framework has been developed. ERP-ORE is an instantiation of the original ORE framework for measuring risk during the evolution of the ERP information system paradigm in the distribution business domain. A preliminary version of the ORE framework based tool has been developed for testing and development purposes. A copy of the tool is available at http://shakti.it.bond.edu.au/~sand/projects.htm. Please address any comments to pkrishna@staff.bond.edu.au.

Although this paper describes the customization of ORE to ERP-ORE, it has actually been derived from other projects. One of the projects was to apply ORE to a collection of IT infrastructure and service portfolios managed by a large Commonwealth government department. The organisation wanted a framework that was applicable to a situation where more than 150 sub-projects were running concurrently. The equivalent of the OLC wanted a high level and yet quantitative view of the risk to the organisation. Although this is not exactly the same as an ERP system, the system characteristics were very similar. The other project was for an industry that wanted to study the risk involved in implementing an organisation wide ERP system. Our customization and the example presented later are derived from these real case studies. However, owing to non-disclosure agreements the details cannot be revealed.

In the following sections the ERP in Distribution problem is defined, the ERP-ORE architecture and customizations are described and the case study is used to illustrate ORE and ERP-ORE.

6. ERP IN DISTRIBUTION PROBLEM

Distribution firms have a unique position in a typical supply chain as they sit between the manufacturer of products and the retailers selling the products to customers as illustrated in Figure 3. Traditionally the primary role of distributors was to make/break bulk which involved disaggregating products from the same manufacturer and/or re-aggregating component products from multiple suppliers. Distributors provided inventory facilities for storage and logistical services involving transportation and delivery to customers. They also served as the sales and marketing arm of suppliers, and providing financing for small customers and other final value adds. Thus they were primarily low skill intermediaries in the traditional manufacturing supply chain. However in the last few years there has been an exponential growth in information flow passing through the supply chain due to developments in information and communication technology. Increasing competition and the maturation of economic markets are making it necessary for supply chains to work together as a whole to provide a differentiable value to customers. To do this they must fully utilize the information of the supply chain. Distribution warehouses are microcosms of the supply chain and all information flows pass through them. Hence due to their unique intermediary position distributors have become the main information handlers within the supply network (Lawrence, Jennings and Reynolds, 2005).

![Figure 3: Inventory Flows Within the Supply Chain (Lambert and Pohlen, 2001)](image-url)
Apart from efficient warehouse and logistics management, distributors are now also expected to carry out complex forecasting activities to smooth supply and demand curves and soften the Bullwhip Effect in the supply chain (Lee, Padmanabhan and Whang, 1997). To perform these new functions distributors are implementing ERP systems as a stable integrated technical platform for their major business functions. The common modules implemented by distributors are:

- Distribution Systems Planning: Forecasting activities, support for semi-automated purchasing and procurement, and value added processing.
- Warehouse Management: pick slip generation and management, tracking orders through the warehouse, cross dock, receiving and putaway, warehouse information automation.
- Financial: tracking, managing and reporting on financial information.
- Sales and Order Processing: request for quotation, request for information, entering the sale and tracking the transactions.
- Executive Information Systems: management analytics including metrics development, mapping strategic, tactical and operational dimensions and developing analytical reports for decision makers.

However there are few formal frameworks in the literature and in practice which support distributors in implementing business critical ERP systems.

7. ERP-ORE FRAMEWORK: A DOMAIN SPECIFIC MODEL

7.1 Overview

ERP-ORE customizes the original ORE design and thinking for the ERP in Distribution problem. ERP systems represent a buy rather than build approach to information systems design (Skok and Legge, 2001). Therefore the major work during the implementation process is structured process mapping of the current business processes in comparison to the ERP processes. Once this is completed decisions have to be taken regarding which processes to change or what software modifications are necessary. Next a strategy needs to be devised to manage the organizational implications.

Figure 4: Operationalization of Dimensions into Factors and Metrics
including education of the corporate staff in adjusting to the new paradigm, alleviating their fears regarding their jobs, and earning support and consensus (Lawrence, Jennings and Reynolds, 2005).

Hence the two major dimensions of risk are *process* and *politics*. The operationalization of these dimensions into factors and metrics is illustrated in Figure 4.

### 7.2 Key Architectural Customizations

Several ORE architectural concepts are re-defined in ERP-ORE. Technical sub-projects are now defined as the specific ERP modules including sales order processing, distribution systems planning, warehouse management, financials and executive information systems. The Project Level Controller (PLC) becomes the formal ERP management team (Delta team) (Lawrence, Jennings and Reynolds, 2005) which is usually composed of power users within the different business units who manage the organizational politics and have executive management support. They are primarily concerned with the day to day operational and tactical management of the implementation. The Organizational Level Controller (OLC) is defined as the steering committee which represents executive management and whose main role is one of guidance, mentoring and directing. They understand the strategic objectives and can make important resource allocation and political decisions.

ERP project management has to support ongoing tasks as the customization of the system for new business objectives and incorrectly understood current requirements continues (Chang, 2004). Hence the framework is expected to support continued decision making through continuing refinement of the company specific risk scale.

### 7.3 Additional Factors

Most distribution and supply chain metrics such as lead time, fill rate, on time performance etc. are internal focussed metrics aimed at measuring operational concerns. Measuring the organizational and supply chain wide impact of ERP systems deployment however requires broader metrics. There are no such widely accepted metrics (Lambert and Pohlen, 2001). ORE lacked any general organizational level metrics due to their dependence on the contextual business and work model. ERP-ORE provides organizational level factors specific to the ERP in distribution business domain.

The organizational level factors serve as a formal mechanism to consider and think about important organizational risk dimensions and incorporate them into risk measurement. Due to the lack of maturity in scale and metrics the framework includes them as highly unstructured factors to allow flexibility for choice of metrics, weightings of metrics within the factor, and of the factor weight itself in comparison to other factors based on the domain specifics. Weights can be decided using AHP. It is expected that as the framework is used and customized further to the organizational specifics metrics can be plugged into the unstructured factors provided. The process is in accordance with the representational theory of measurement (Fenton, 1998) according to which ORE measurements were defined. By default these factors are assigned the same weight as the priority and dependency adjusted project risks of the ORE model. There is no empirical evidence to support a different weighting.

Based on Porter’s (1980) Five Forces model that provides a strategic check of internal and external corporate strategy, two organizational level factors have been developed.

**Internal Context**

The purpose of this factor is to formally consider several internal corporate risk issues. The factor has the following unstructured metrics:
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• Cultural and Organizational issues. ERP solutions are developed using best practice business and work models. It is necessary to consider the suitability of these implicit models for the organization. Misalignments between an organization and a ERP solution can be classified into the categories of source (company specific, industry specific or country specific) and type (data, function or output) (Soh, Kien and Tay-Yap, 2000). These misfits and their resolution is the major source of customization efforts and mitigating and managing their risk is a key activity.

• Business Process Risk. Distributors due to the nature of their business have developed highly non-standard processes suited to providing their customers whatever they need as and when they need the items from the distributors. The sales oriented distribution culture demands such customizations and changing the processes without understanding can mean loss of key competitive advantage. Legacy systems at most firms had evolved over many years and were specifically designed to meet the firm’s needs. There have been several cases of distributors going live with the new system and immediately experiencing customer service failures. The ERP systems had likely not been completely programmed to capture those processes that were critical to important customer service needs and so the firm’s employees were forced to go off-line to meet customer needs. ERP-ORE incorporates this important measure through the Business Process Risk metric (Lawrence, Jennings and Reynolds, 2005; Mashari and Zairi, 2000).

• Communications Flow. Communication flows are an important indicator of the success of the system evolution and corporate education process. The political complexity of the social situation cannot be over-emphasized. At any given moment each political constituency is constantly evaluating the usefulness of the new system to their political power and influence and playing games to maintain their position (Keene, 1981; Skok and Legge, 2001). Success of the Delta team in selling the ERP idea to the corporate staff is an important consideration in this process. Political considerations therefore need to be considered in determining an appropriate risk value for this metric.

While primarily being a matter of judgment this metric can also be measured through artefacts such as number of emails and chat messages in a given period of time exchanged between business user groups, technical teams etc. The balance between communication flows can be visualized as a Kiviat graph and ratio of balance can be scaled, interpreted and included into the organizational risk calculation (Bruegge and Dutoit, 1998).

External Context
The purpose of this factor is to formally consider several environmental corporate risk issues. The factor has the following unstructured metrics:

• Legal and Environmental issues. An aspect of ERP packages often missed is that they also contain implicit models of regulatory, legal and environmental contextuality that can seriously affect the useful operation of the system if the organizational environmental context is different. An example in the context of a hospital ERP system is the difference between the medical models of Asia and Europe. While the Europe healthcare model is usually privately delivered and the government or insurance pays the bill, in the Asian model often the individual is responsible for healthcare costs and the government subsidizes healthcare costs through economies of scale and community control (Holland and Light, 1999; Soh, Kien and Tay-Yap, 2000). These issues can be formally considered within this metric.
• Compatibility. The compatibility of the new system with the infrastructure of partners within the supply chain is a key risk criterion. Since a major purpose of the initiative is allowing integration with the supply chain proper customization to ensure the systems are technically compatible with partners is necessary. Common misalignments include plug and play e-process misalignments, information co-ordination misalignments, and knowledge sharing misalignments (el-Sawy, 2001). Compatibility issues are therefore a significant cause of risk in supply chain systems evolution.

• Supply chain pressures. A distributor is defined by its role in the supply chain and supply chain pressures drive the distributor’s initiatives. Issues such as channel partner pressure (e.g. Wal-Mart) for quicker implementation (Phillips and Caldwell, 2005) can quickly destroy all structure as the company scrambles to cope under the pressure applied. Hence this metric has been left unstructured to be used based on management judgment as a changing barometer of these pressures and their risk impact.

7.4 Re-Definition of ORE Factors
Some of the default ORE factors need to be re-understood or clarified in the context of ERP. Size change is interpreted as the total size of the system that needs to be customized and its evolution is understood to be the portion that remains to be mapped and customized. The Development Platform metric is retained in ERP-ORE due to the possibility of some modules being customized through coding or custom development to meet business needs. Manpower outsourcing is no longer relevant to the framework unless actual project management and customization of a module is being outsourced. Finally project team is re-interpreted as the risk due to inner-team cohesion and communication between the ERP, consultant, management and specific business function teams. The original general ORE interpretations can be used for a particular sub-project if more appropriate.

7.5 Adding AHP to the Methodology
The Analytic Hierarchy decision methodology is incorporated into the ERP-ORE framework at several key steps in the estimation and decision making process. During sub-project risk assessment AHP can be used to decide the weightings of metrics within the factors and the weightings of factors within the overall sub-project risk assessment. Once the sub-project risk assessments are completed, AHP is next used to decide the priorities of the different sub-project metrics relative to one another and to agree upon the dependencies between the different sub-projects. Finally AHP is used to decide the weightings of the different organizational level risk factors (and their metrics) relative to each other.

7.6 Overall ERP-ORE Organizational Risk Equation
The ERP-ORE framework retains the original sub-project risk factors, metrics and weights of the ORE framework. Priority and dependency models too retain their original definitions, though through the use of AHP the weighting and prioritization process now becomes more formal and systematic. ERP-ORE however re-interprets several sub-project factors, and adds two important ERP in Distribution specific organizational level risk factors to the original ORE organizational risk equation as stated in Equation 2. The revised overall organizational risk equation may be represented as,

\[ \rho(\text{organizational}) = (\omega_{sp} \sum_{i=1}^{n} (\rho_i \sigma_j + \delta_i)) + (\omega_{ic} \ast IC) + (\omega_{ec} \ast EC) \]  

(Equation 3)
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Where $\rho_i$, $\sigma_i$, and $\delta_i$ have their usual meanings, and there are $n$ sub-projects in the ERP systems evolution. AHP can be used to decide the weights $\sigma_i$ of the sub-projects. AHP can also be used to agree upon the dependencies $\delta_i$, and weights of factors constituting sub-project risk $\rho_i$, and the metrics constituting each factor.

Organizational level weights $\omega_{SP}$, $\omega_{IC}$, $\omega_{EC}$ are by default assigned equal (unary) weights as there is no empirical evidence to support any other weighting. Management judgment assisted by the AHP decision making process can be used to assign a priority suited to the domain and circumstances.

- **IC** stands for Risk due to Internal Context, and may be represented as

  \[
  IC = \sum_{f \in F_{IC}} f \cdot \omega_{IC}(f) \tag{Equation 3.1}
  \]

  Where $F_{IC} = \{Culture and Organization, Business Process, Communications Flow\}$ and the function $\omega_{IC}(\cdot)$ (weight of) can be decided using AHP.

- **EC** stands for Risk due to External Context, and may be represented as

  \[
  EC = \sum_{f \in F_{EC}} f \cdot \omega_{EC}(f) \tag{Equation 3.2}
  \]

  Where $F_{EC} = \{Legal and Environment, Compatibility, Supply Chain Pressures\}$ and the function $\omega_{EC}(\cdot)$ (weight of) is decided using AHP.

8. EXAMPLE

8.1 Overview

The ORE application is described through a hypothetical example. Although the framework can be applied in a continuously evolving environment, this paper focuses on the application of ORE at two points in the implementation lifecycle of an ERP system. Although the details presented in this section are hypothetical, they are actually derived from two specific applications. The example abstracts the key aspects of the two applications without divulging the details of the specific applications. The specific applications are recast in terms of a scenario available in the literature. The various steps in applying the framework are now developed. The purpose of presenting all the details is to demonstrate the application of ORE to relevant practitioners.

The scientific estimation process involves the steps (Nair, 2006):

1. Estimation of evolution size.
2. Development of effort plans based on size estimation.
3. Development of schedule based on estimated effort and resource constraints.
4. Estimation of cost based on above estimations.
5. Iterating over the aforementioned four steps on a periodic basis as estimation activity progresses. All estimations are based on historical data in a systematic manner.

The case study illustrates the ORE methodology which customizes these scientific estimation steps for the risk assessment activity. The descriptions also illustrate support for different organizational levels of decision making and different approaches to information systems evolution, how the results may be used to inform analysis, how ORE brings structure into a complex process, and finally how and when ORE may be misused and therefore legitimately ignored by decision makers as they seek to make correct decisions.
ERP-ORE specific features are also described. The environment of supply chain management is highlighted. Distribution businesses are primarily sales and marketing businesses. This culture has its particular strengths and weaknesses which serve as a background for this case. The ORE methodology based on the scientific estimation process is further formalized in ERP-ORE through the use of AHP. The dimensions of process customization and organizational political management are emphasized. Finally measurement of the organizational factors for both the internal and external context is illustrated.

8.2 Case Scenario
Medinc (adapted from McAfee, 2001) is a US based national distributor of brand name medical supplies to medical practitioners. The company seeks to be a one-stop shop providing a broad range of medical supplies, drugs and equipment, and filling orders quickly, accurately and reliably. The orders are small and the customers are unsophisticated (compared to drugstores) and require a lot of help. Hence the marketing and sales function is highly emphasized within the organization.

The company has several major competitors who have a greater product mix and a larger sales force. In order to meet its ambition to be a one-stop shop and make up for its size weaknesses the company must utilize internal and supply chain information flows, improve marketing, better forecast needs and better maintain warehouse inventory. The supply chain also requires them to expand their role and carry out complex forecasting activities to smooth supply and demand curves and soften the Bullwhip Effect in the supply chain (Lee, Padmanabhan and Whang, 1997). There is considerable pressure by Medinc’s suppliers to implement solutions to achieve these goals. Hence the company has decided to replace its legacy multiple systems based infrastructure with a brand name ERP solution. The main selection criteria were single brand name vendor, size and financial strength of vendor, analytic functionality, upgradeability and customization, and cost and support for all major business functions. Needs analysis, high level process flow model comparisons and product demonstrations were conducted. Technical support track record and test database and orders were studied. Channel specific consultants were consulted. Vendors also arranged for user site visits (Lawrence, Jennings and Reynolds, 2005). After considerable discussion a world class European ERP vendor was selected.

Modules being implemented are A) Distribution Requirements Planning: forecasting, value added processing and semi-automated procurement support, B) Warehouse Management: pick slip generation and management, tracking orders through the warehouse, cross dock, receiving and putaway, and warehouse information automation, C) Sales and Order Processing: automation of activities and information flows relating to request for quotation, request for information, entering the sale and tracking the transactions, D) Financials: tracking, managing and reporting on financial information, and E) Executive Information Systems: metrics development, mapping along strategic, tactical and operational dimensions and developing analytical reports for decision makers. Each module implementation is considered a sub-project.

Executive management is aware of the business criticality of the project. They decide to use ERP-ORE to assist in managing risk during the project evolution. A consulting firm specializing in ERP implementations is also engaged to bring project specific expertise. A Delta team composed of power users and managers of all business units is formed and management publicly informs the staff of its unconditional support to the Delta team. A War room is established to accommodate the Delta team. The Delta team acts as Project Level Managers (PLC). A steering committee of all executive directors and several members of the executive management team is setup to act as Organizational Level Controllers (OLC). The Delta team meets weekly with major users, consultants and ERP
vendor officers and the OLC team meets fortnightly with the Delta team and major representatives from consultant and ERP vendor teams.

The major project phases are decided as process mapping and data scrubbing, modifications testing and approvals, pre-testing of system, activating ERP processes, and system cutover and go-live. Standard project management scheduling allocates three months for the implementation of each phase.

### 8.3 Process Mapping and Data Scrubbing Phase

The purpose of the process mapping and data scrubbing phase is to study process differences between the ERP system and the company and begin the process of data standardization and migration.

#### Organizational Parameters

The OLC team uses the AHP to decide organizational parameters. The three single node decision trees are shown in Figure 5. Pair-wise preferences are elicited from decision makers for each tree. For priorities and organizational factor weight trees the alternatives are ranked relative to each other. Saaty’s (1980) 9 point scale is used. The scale ranges from 9 (extremely preferred) to 1 (equally preferred). For dependencies binary values 1 (is related) and 0 (is not related) are used. Priorities are assigned based on the business importance of better forecasting and analysis, followed by operational efficiencies. The comparison matrices are depicted in Figure 6.

Since there is no prior scale or empirical results the OLC assigns all organizational parameters equal value 3.3. The priority matrix is simplified using eigenvector computations to the following alternative priorities (rounded x10) A: 5.13 B: 0.63 C: 0.33 D: 1.29 E: 2.61. Executive information systems (E) analytics is dependent on all other modules. Financials (D) depend on the operational information (A, B and C) from other operational modules to develop financial analytics. Default full dependent risk propagation is maintained. The AHP synthesis phase is not required for these single node decision trees (dependencies do not even need the eigenvector computation) however the pair-wise comparison procedure decreases the complexity of the decision process.

![Figure 5: AHP Trees for Organizational Parameters](image)
Sub-Project Factors Risk Assessments
The module implementation managers assess different risk factors of the sub-projects. Since there is no reference scale the PLC advises the managers to use the default framework weightings for metrics within factors, and the weighting of factors. PLC also advises the managers to maintain the default Equation 2.

PLC Decision Making
Based on the risk assessments the list of sub-project risk values are derived as summarized in Table 1 (second column). The third column contains updated values which are recalculated as the project progresses and the risk changes (discussed later). The dependent projects naturally have a higher risk due to dependency risk propagation. The main risk sub-projects that PLC discovers are module A (Distribution Systems Planning) for complexity and importance, and C (Sales Order and Processing) where employee resistance is very high. Medinc has a powerful sales and marketing department that is highly resistant to change. The department has a highly customized quoting system designed for the non-standard medical supplies business and it does not want to relinquish the system and the informational control it signifies. Sales staff are particularly reluctant to allow technical personnel to “tell them what to do”. Poor politics by the ERP team has increased their paranoia.

The OLC listen to the feedback of the PLC teams and suggest that the ERP teams be more tactful. As a team they use the AHP to assign weights to organizational factors internal and external context, and weights to the metrics within each factor. Since there is no reference scale they assign equal weights to all elements. They discuss and assign a risk value out of 100 to each of the metrics within each factor as summarized in the second columns of Table 2 and 3 (third column contains updated values discussed later). Despite strong advice from consultants and the ERP team the OLC
believes communication flows and the legal issue are not important and assigns them a low weight. The company prides itself on its considerate and flexible culture and the team assigns Cultural and Organizational issues a low value. Compatibility, business process risk and supply chain pressures are the key reasons for implementation and are therefore assigned highest risk. The OLC feeds the values into the model and framework outputs risk at this time (denoted by $t_{phase1}$) to be $risk_{phase1}$. Since there is no scale the OLC does not feel justified in acting further at this stage and adopts a wait and watch policy.

8.4 Modifications Testing and Approval Phase
The purpose of this phase is to conclude the process mapping phase and make important customization decisions regarding whether to redesign the business process, modify the software, or add components. OLC decides to carry out the process using informal meetings between PLC and the stakeholder groups.

Organizational Parameters
The OLC meet to discuss the organizational parameters. On the advice of the consulting team the dependencies and weightings are retained. There is discussion on the priorities as the sales executive director insists that the sales module should be given highest priority as his salesmen are not happy with the ERP team and “want to do things their way”. The CEO has to intervene and decides to retain original priorities. On vote the motion is passed in favour of supporting the CEO. Thus political and “me too” issues dominate.

Sub-Project Factors Risk Assessments and PLC Decision Making
The project managers work with their teams to re-assess progress since the last phase. The PLC attempts to reach consensus. The teams fail to reach any consensus on which customizations to carry out and how to proceed. Power users reluctant to lose control threaten to derail the normal running of the corporation. The problem is especially acute with Warehouse Management. The low skill workers in the warehouse are afraid for their jobs. The CEO on advice of the PLC hires a labour speciality law firm for an external view. The PLC increases the risk to all projects, except B: Warehouse Management where the action seems to have had a disciplining effect. The new assessments are summarized in Table 1 (third column).

Organizational Factors Risk Assessment and Decisions
The OLC now have to handle the dissension and political issues faced in the first three months. There is great unrest and lack of staff support. For example, the sales staff are refusing to share information. All three internal context metrics are increased in risk as detailed in Table 2 (third column). The importance of cultural and communication issues is realized. External pressures also increase. Some of the customers and suppliers have rival ERP platforms and put pressure on the firm to change vendors. Unknown technical compatibility concerns arise with a major supplier using a rival ERP solution. The hiring of the legal firm decreases several legal issues but puts additional financial pressure on the ERP budget. Changes to the external context metrics are detailed in Table 3 (third column). The OLC feed the risk values and the framework outputs $risk_{phase2}$ at time $t_{phase2}$. They discover that $risk_{phase2} - risk_{phase1}$ is highly positive. The OLC realizes that a major internal and external education program needs to be developed to manage staff and supply chain partner fears and demonstrate how the project benefits them. At the same time more discipline needs to be instilled into the customization decision process.
OLC instructs the PLC to use a formal change management methodology and asks the consulting team to research and propose one. Key business requirements are re-iterated with the PLC to allow them to make choices between ‘nice to have’ changes and key changes. They are advised to speak to the OLC in case of doubt. The OLC also develops in conjunction with the Human Resources department (HR) a fortnightly ERP newsletter that will answer questions for different departments and educate staff about the ERP initiative, its motives and purposes. This newsletter is based on the picture devised by the OLC detailing common questions, concerns and issues (Figure 7). Common delaying games such as diverting resources, deflecting goals (especially the sales team), dissipating energies are studied and strategies are devised to manage them (Keene, 1981). The CEO and COO schedule meetings with all major partners on supply and demand sides to manage expectations and the PLC are instructed to repeat the approval phase again and ensure definite decisions are taken. HR is also instructed to develop a recruitment plan for all business functions to manage staff turnover.

9. CONCLUSION AND DIRECTIONS FOR FURTHER WORK

9.1 ORE

Organizational risk is considered as a composite of the risk caused by the different organizational elements incorporating operational, tactical and strategic dimensions. The framework is self-referential and develops its own scale of reference by time-stamping the organizational risk assessments conducted. ORE is intended to be used as fixed time sampling of risk during cyclic organizational change and maintenance processes and is based on the paradigms of balance, cycle and time. A balance between prescription and generality has been maintained as part of design by
providing default functional configurations and weightings to all framework metrics and models with the understanding that these will be modified to suit the industry, business and work model specifics. ORE generates sub-project risk measures for project managers, collated sub-project risk for Project Level Controllers and a composite organizational risk measure including sub-project risk, priority and dependencies for the Organizational Level Controller. A variety of well known technical and system measurement metrics have been used at all levels of the framework and flexible priority and dependency models enable effective resource allocation. Overall ORE provides a scalable structure at a sufficient level of abstraction to measure and manage the complexity and risk of organizational change during information systems evolution. ORE also attempts to enforce management discipline upon the executive audience to consider all elements and make patient, well measured decisions based on metrics and judgment.

9.2 ERP-ORE
ERP-ORE customizes the risk measurement for distribution businesses during ERP systems evolution. It focuses on the dimensions of politics and process which are identified as the most important issues. ORE concepts are re-defined for this domain. Two organizational risk factors internal context and external context are added to the framework. Internal and External context factors assess the risk impact of political and process issues internal and external to the company. Due to the lack of widely accepted metrics these factors are semi-structured to allow management to plug in metrics and weights as necessary. Each sub-project becomes a module implementation and AHP allows a formal consensus building and decision making methodology to decide weights and priorities at several steps of the ERP-ORE methodology. The AHP discipline is expected to permeate the entire decision making process.

9.3 Directions for Further Work
The most important avenue of further work is refinement through application in corporate projects. IS is a constantly changing paradigm and the ORE framework itself is expected to be constantly adapted to meet new forms and developments of the paradigm. We plan to document the growing maturity of the framework through experience papers that can be eventually collated into a guide book for practitioners, consultants and management in the use of the ORE framework and its instantiations such as ERP-ORE.

For example ORE risk outputs can be structured into back office and front office components to support important resource allocation decisions where front office risk must be politically managed (Evangelidis, 2003). More formal mathematical structures such as matrices can be introduced to capture risk values and make possible additional types of analysis on framework output. The framework could be integrated into standards such as the IEEE Standard for Quality Assurance Plans (Software Engineering Standards Committee of the IEEE Computer Society, 1998) used in building and assessing secure systems.

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BIOGRAPHICAL NOTES

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