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Reliability Analysis – A Tool Set for Improving Business Processes

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Outline

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Introduction

- Current economic environment heightens need to remove waste and error in business operations
- Opportunities for failure in a process can be numerous and difficult to characterize.
- Business processes include accounting processes including budgeting, scheduling, document management including configuration control, sales processes, marketing processes including requirements determination, and general management processes including hiring and personnel evaluation and promotions.

Introduction (cont)

- Historically, many Quality Assurance methodologies such as Six Sigma have been used to improve quality in business processes.
- Reliability Methodologies, particularly FMEA, address frequency of occurrence, severity of the failure effects and ability of a process to detect imminent failure.
- Developing Reliability analysis methodology to evaluate new business processes before implementation as well as periodic evaluation can provide significant savings

Defining Business Process Reliability

- ***Business Process*** - a documented method for performing a process necessary to the operation of a business.
- ***Business Process Risk*** – the combination of the probability a business process failure will occur with the degree of slip in schedule or increase in cost
- Reliability for a business process is generally a discrete event probability with an implied cost per occurrence.
  - The probability that an activity, i.e. entering a sales order or managing a cash account, will be completed without error and in a usable manner.
    - "Usable manner" refers to the fact that many business processes are links in a chain of activities that have suppliers and customers.
    - A business process, like a sub-system design, has many points of failure each of which can have different occurrence rates, and severity based on the effect of the failure on the business

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Quantifying Business Process Reliability

- Measured as probability of sustaining an unanticipated cost
  - Standardize loss value so reliabilities are evaluated on a level scale.
    - I.E., process with failure probability of 10% with cost of $10 is not as serious as process with failure probability of 1% with cost of $1000.
    - Probability of sustaining loss in unit currency should be used. Unit currency may be thousands or millions to get meaningful numbers
- Measuring reliability is necessary to assess effectiveness of improvement
  - Failure effects on subsequent processes are assessed

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Quantifying Business Process Reliability -2

- If process failures are documented, it is possible to measure frequency of occurrence against opportunities for failure to occur.
  - Modeled as binomial distribution (process can succeed or fail). Resultant probability and confidence limits are estimated with standard methods.
  - Failures should have cost of correction documented.
- Cost model of process failures is an alternative approach
  - Requires recording cost data for each failure.
  - Use Weibull modeling program or graphical methods

Quantifying Business Process Reliability - 3

Example

- Example is Accounts Payable procedure.
- 25 errors out of 500 invoices paid in past year.
- Zero cost assumed for correct payments.
- Costs of errant payments are associated with interest forgone on overpayments, interest charged on underpayments, additional labor to process payments a second time, etc.

Error Cost Inputs				
$500	$2250	$3750	$5750	$8500
$750	$2400	$4250	$6400	$8750
$1000	$2500	$4500	$6500	$9300
$1250	$3000	$5000	$7500	$9500
$2100	$3300	$5100	$8300	$10000

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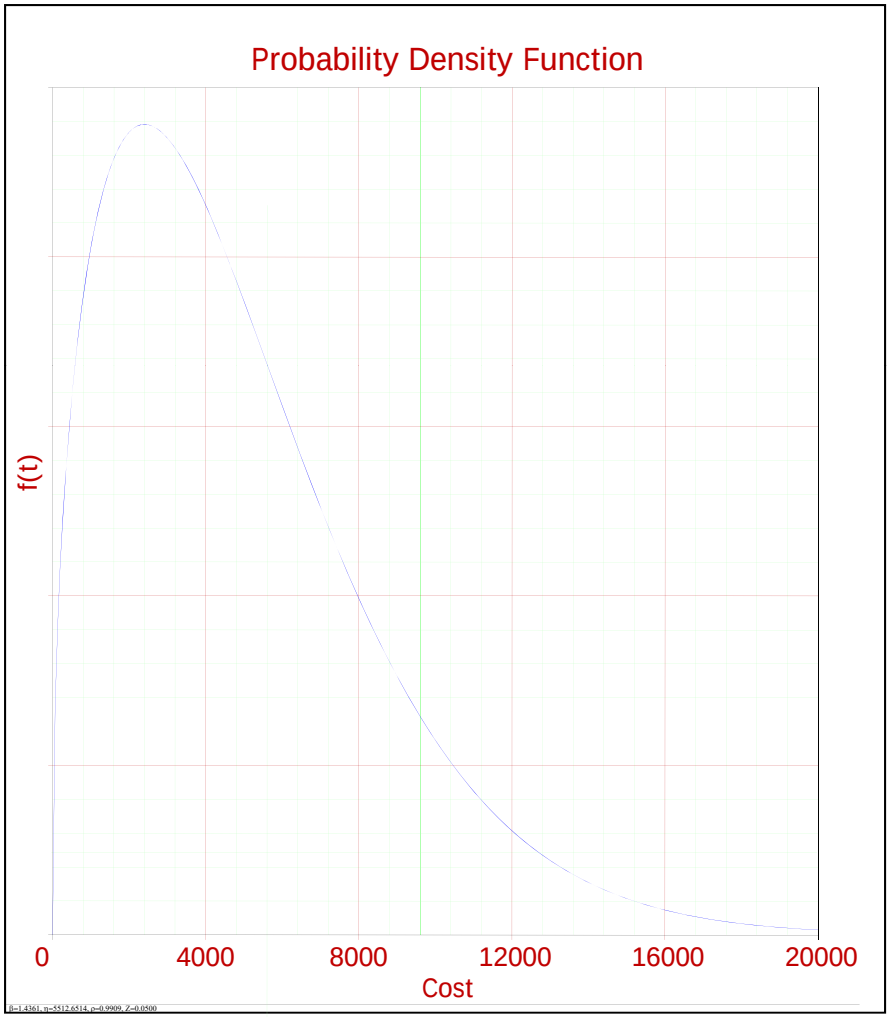
Quantifying Business Process Reliability - 3

Cost Distribution Example

- Distribution output: Entering cost data for 25 errors and zero cost for 475 correct payments into Weibull software gives distribution and average error cost for each payment processed

$$Probability(Cost) = e^{-\left(\frac{\eta}{Cost}\right)^{\beta}} = e^{-\left(\frac{5512}{Cost}\right)^{1.436}}$$



- PDF gives probability of a particular overpayment value
- Error cost per payment processed was $250.

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Business Process FMEA

- ***Business Process FMEA*** – a modified FMEA to address the possible failures of a Business Process and their effects.
- FMEA can be most effective tool for assessing business processes.
  - It is low in cost,
  - Easy to understand by non-engineering personnel
  - quickly identifies weaknesses in a process.
- Essential purpose of this FMEA is
  - to identify business process weaknesses
  - provide an organized methodology to correct weaknesses with prioritization.

Business Process FMEA -2

- Business Process FMEA is performed by a team consisting of process owner, the process supplier(s), process customer(s), and a facilitator
  - use of a team assures broad spectrum evaluation of potential failure modes.
  - facilitator offers an impartial arbiter of disputes and keeps team focused on task at hand.
- *Business Process FMEA Team* can be constituted uniquely for each process evaluated.
  - Process owner usually manager or delegate from same department
  - Supplier to process is provider of inputs to the process
  - Customer of process uses output of process as inputs to subsequent process.
  - Suppliers and customers of a process can be numerous
  - Facilitator is usually independent of process

Business Process FMEA - 3

- Business Process FMEA methodology is virtually identical to Manufacturing Process FMEA
  - Differences are types of failure modes and mechanisms, and classification and scoring of Occurrence, Severity, and Detection factors which should be customized to particular business, and may be modified for different departments within a company.
- Failure modes can vary from process to process as well as from business to business for the same process
- *Failure Effects* **-** Typical failure effects translate as costs to the bottom line
  - failure to meet schedule
  - failure to deliver proper quantity
  - cost overrun

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Business Process FMEA - 4

- *Occurrence* - should be related to frequency with which failure mode appears per number of opportunities to occur
- *Severity* - should be presented as a preventable cost
  - scoring can be specific to particular business ; expressed as a range in dollars.
  - For a small business, a cost of $10,000 might score a 10
  - For a large business, a cost of $100,000 or more might score a ten
- *Detection* - related to likelihood that process will be able to detect failure mode before impact of failure effects are noticed
- *Risk Priority Number (RPN)* – a numerical value that is the product of Occurrence, Severity and Detection developed in the FMEA to evaluate the relative importance of the various failures and prioritize corrective action.

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Business Process FMEA - 5

- Corrective Action - should generally be prioritized by RPN (higher RPN selected first)
  - low occurrence failures with very high Severity (cost) should be investigated for economical corrective actions
  - Implementation of Corrective Actions should be structured to reduce Occurrence and/or Severity of the and increase Detection
  - After corrective action(s) have been validated, FMEA should be rescored.
- Living Document - FMEA should be maintained as a living document.
  - Periodically, each FMEA should be reviewed to identify additional potential process improvements.
  - When a business process is changed, existing FMEA should be updated, rather than starting a new FMEA.

Business Process FMEA - 6

Occurrence Ranking Criteria

Likelihood of Occurrence	Criteria: Possible Failure Rates	Rating
Extremely High	>80% of process uses	10
Very High	> 60% and ≤ 80% of process uses	9
High-Very High	>50% and ≤ 60% of process uses	8
High	>40% and ≤ 50% of process uses	7
Moderate-High	>30% and ≤ 40% of process uses	6
Moderate	>20% and ≤ 30% of process uses	5
Moderate-Low	>10% and ≤ 20% of process uses	4
Low	>1% and ≤ 10% of process uses	3
Very Low	>0.1% and ≤ 1% of process uses	2
Remote	≤ 0.1% of process uses	1

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Business Process FMEA - 7

Severity Ranking Criteria

Effect	Criteria: Severity of Effect – Cost per occurrence	Rating
Extremely Costly	>$500,000	10
Very High Cost	>$250,000 to $500,000	9
High-Very High Cost	>$100,000 to $250,000	8
High Cost	>$25,000 to $100,000	7
Moderate-High Cost	>$5,000 to $25,000	6
Moderate Cost	>$1,000 to $5,000	5
Moderate-Low Cost	>$250 to $1,000	4
Low Cost	>$100 to $250	3
Very Low Cost	>$25 to $100	2
Insignificant Cost	<$25	1

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Business Process FMEA - 8

Detection Ranking Criteria

Detection	Criteria: Likelihood of Detecting Potential Cause by Process Controls	Rating
Absolute Uncertainty	CANNOT detect	10
Very Remote	<5% chance	9
Remote	>5 to 10 % chance	8
Very Low	>10 to 25% chance	7
Low	>25 to 50% chance	6
Moderate	>50 to 70% chance	5
Moderately High	>70 to 80% chance	4
High	>80 to 90% chance	3
Very High	>90 to 99% chance	2
Almost Certain	>99% chance	1

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Business Process Fault Tree Analysis (FTA)

- FTA is used for processes with high mean cost per process application.
  - FTA is performed after FMEA identifies failure modes with high cost failure effects
  - FTA is quantitative and driven by top event cost.
  - Probabilistic approach to costs assures isolated failure events don't cause needless change and repeated failures drive change
  - When many failure modes contribute to high cost failure, FTA can direct effective implementation of corrective action.
  - FTA purpose is to examine process characteristics that can be executed improperly and cause unexpected cost.
  - Failure effect(s) with high cost are used as top event(s)

Business Process Fault Tree Analysis (FTA)

- Failure modes identified in FMEA can be used as basic events in FTA
- The interaction of various initiating events to produce top events may assist in selecting which events to address first in Corrective Action

Business Process FRACAS

- Most engineering and manufacturing businesses maintain a formal FRACAS or similar system for design and production
  - Almost none apply same methodology for business processes
  - Properly documenting business process failures can provide valuable insight into removing failure causes and reducing waste.
- When a problem is identified in a business process:
  - Document as many details as possible
  - Importance is no different than documenting a hardware test failure
  - Date, time, process and procedure, person(s) performing process, inputs (including source), detailed description of the failure symptoms, and cost of failure should be documented

Business Process FRACAS - 2

- Root causes usually traceable to inadequate procedures and human errors
  - Use multidisciplinary team
  - Use Problem analysis methods such as Crosby 5-step, Ford 8-D, etc.
  - Graphical methods such as Process Flow Diagrams and Ishikawa (Fishbone) diagrams can prove useful to identify root cause(s)
  - Brainstorming during problem solving process obtains variety of possible failure causes which are then resolved into minimal set of causes.
  - If FMEA was performed, evaluate to identify failure cause (mechanism), and to determine if possible failure causes were missed in FMEA

Business Process FRACAS - 3

- Corrective actions for business processes usually tighten available options
  - Conflict between failure resistance and usability of process may require tighter oversight and review rather than reduction of flexibility
  - Cost analysis of various approaches needs to be made looking at costs of preventing failures against undesirable costs of process failures
  - Use of economic cost analysis against accounting cost analysis

Conclusions and Recommendations

- Reliability methods are useful for evaluating and improving Business Processes
- Bottom line business orientation works with reliability methods
- Implementation of these methods is cost effective and a positive influence on business
- This methodology provides effective use of reliability engineering skills during slack times