50 YEARS OF MANUFACTURING AT CAMBRIDGE

IfM Briefing Day

Industrial Resilience & Automation

Distributed Information and Automation

IfM Education and Consultancy Services

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Industrial Resilience & Automation Enhancing Factory Operations

Working with Industrial Partners

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Agenda

- DIAL introduction
- Industrial Resilience
- Automation Assessment
- Information Quality
- Big Data and the Supply Chain
- Working with us

Agenda

- DIAL introduction
  - *Who we are*
- Industrial Resilience
- Automation Assessment
- Information Quality
  - *Tools / approaches successfully applied in industry*
  - *Overview + case studies*
- Big Data and the Supply Chain
  - *In development – with partner*
- Working with us

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- Industrial Resilience
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Introduction - About DIAL (Distributed Information & Automation Lab)

- One of 9 Research Groups within the IfM
- Key DIAL Missions:
  - Smarter, distributed ways of **automating** systems
  - Managing systems subject to **disruption** and **change**
  - Getting better value from **operational information** and quantifying it

Airport Information & Performance

Information & Smart Infrastructure

Resilient, Reconfigurable Manufacturing Systems

Supply Chain Tracking & Tracing

Information Requirements for Engineering Services

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Distributed & Automated Intelligence

What is the challenge?

Development of appropriate solutions for embedding intelligence into industrial products and resources to allow them to interact & steer / influence their own operations

Benefits?

- **Adaptability of resources**
- **Resilience to disruptions**
- **Easy to reconfigure control systems**

What have we done?

- **Disruption tolerant lean production system**
- **Flexible packaging operation**
- **Customer driven logistics solutions**
- **Car paint plant control**

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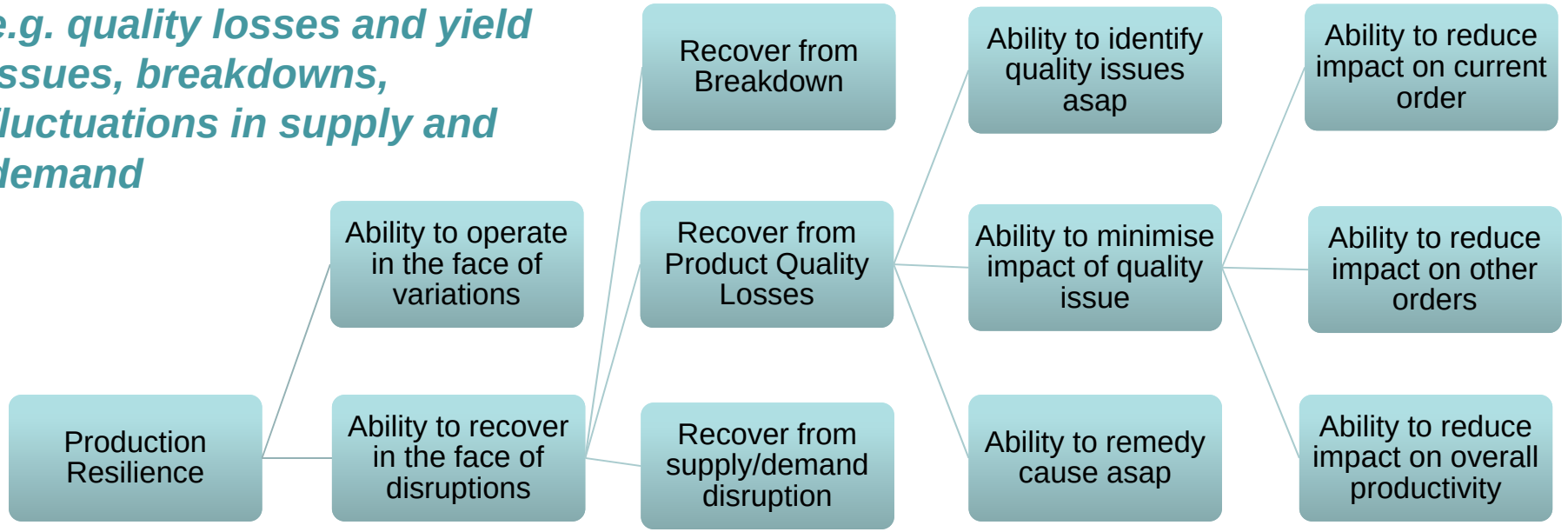
Industrial Resilience

What is the challenge?

To develop systems that have both proactive and reactive tolerance to production disruptions?

e.g. quality losses and yield issues, breakdowns, fluctuations in supply and demand



Why Analyse Resilience?

Affected by operational disruptions?
Unclear exactly why / when things go wrong?

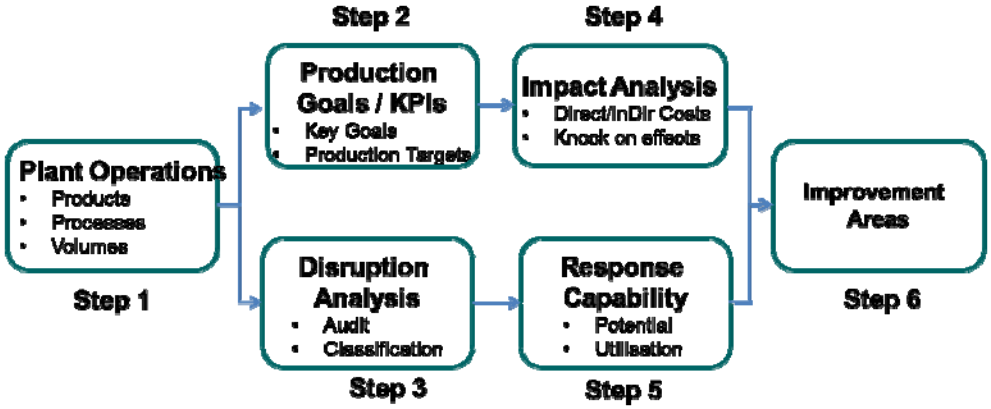
What are the real problems?
What can be done to fix them?
How can operations be more robust?

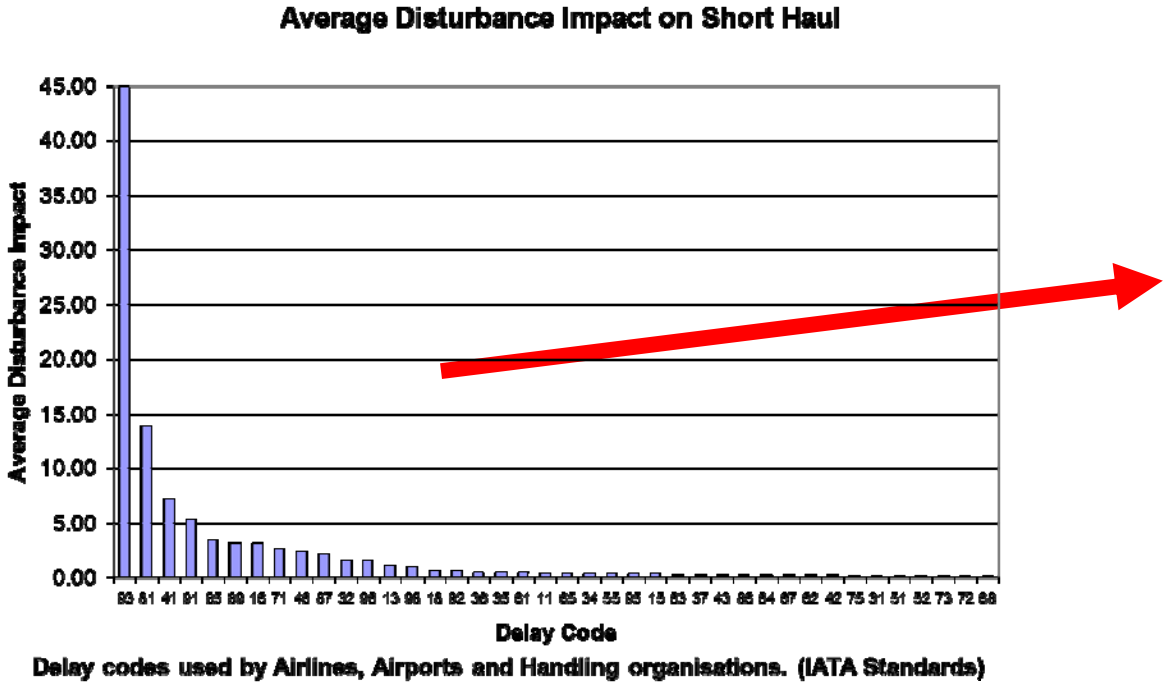
The resilience audit helps to answer these questions and guides the development of more robust operations.

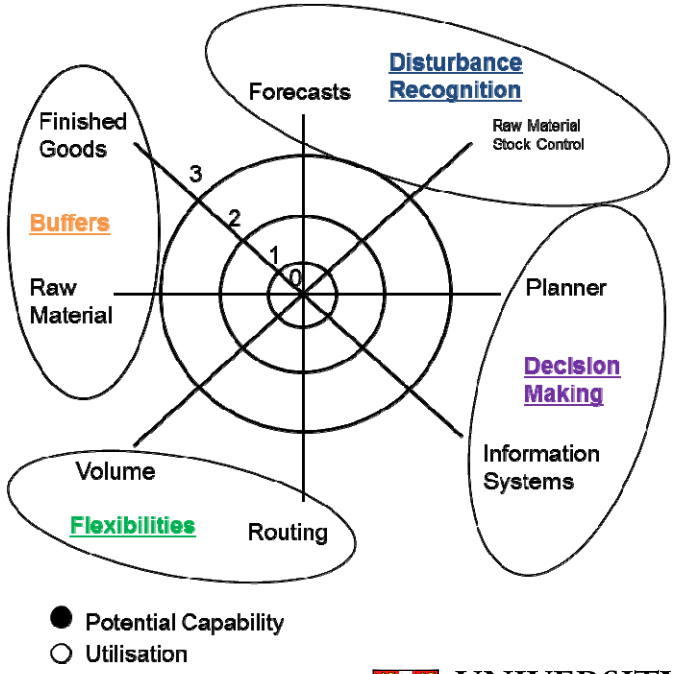
Industrial Resilience

How do we tackle the challenge?

- By measuring and quantifying the tolerance to disruption
- By identifying the capabilities for detecting, managing and responding to disruption







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Resilience Audit

The Resilience Audit identifies:

- Problems or disruptions that cause processes to underperform
  - e.g. supply chain delays leading to reschedule requirements
- How frequently processes suffer from the identified disruptions
- The effect or impact of the disruptions on process performance
  - e.g. efficiency losses, time delays, yield reduction
- The capabilities of processes to recognise and handling the disruptions

Resilience Audit

The output of the Resilience Audit can help:

- Prioritise improvements to current processes

(Process Capabilities, Operational Adherence & Stability, Material Specifications.)

- Identify the requirement for new process capabilities to better cater for disruptions.

Internal Actions

- Focus the development of next generation processes.

Providing flexible production capabilities for new products, using new technologies and with changing business demands.

Longer Term Actions

Resilience Audit Case Studies
Summary of Approaches

	Automotive Manufacture	Aerospace Manufacture	Airport Operations	Agriculture
Aims	Understand the impact of typical order changes. Assess existing response capabilities. Identify opportunities for improved response.	Improve disruption tolerance of loosely coupled manufacturing job shops implementing lean philosophies. Identify the type and scale of disturbances impacting production operations.	Identify disruptions impacting turn-around. Evaluate ability to handle disturbances. Examine how enhanced data sharing between turn-around partners could help.	Use production responsiveness tool to assess the resilience of a supply chain to disruption.
Overview	Operation & process review	Factory review + workshop	Operation review	Operation & process review
Disruption Analysis	Operation & process review	Data analysis	Data analysis	Operation & process review
Impact Analysis	Data analysis	Data analysis + workshop	Data analysis + workshop	Data analysis + workshop
Capability Analysis	Data analysis	Workshop	Workshop	Discussions + workshop

Previous Work

Resilience analysis tool has been applied to a range of operations:

Manufacturing Processes

Britvic, Alcatel, Unipart, ASW, Henkel

Airport Operations

EasyJet, Luton Airport

Agriculture:

G's Growers

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Automation Assessment

- Overview of Approach
- Case Studies
  - Foxconn
  - Jaguar Land Rover
  - Schlumberger

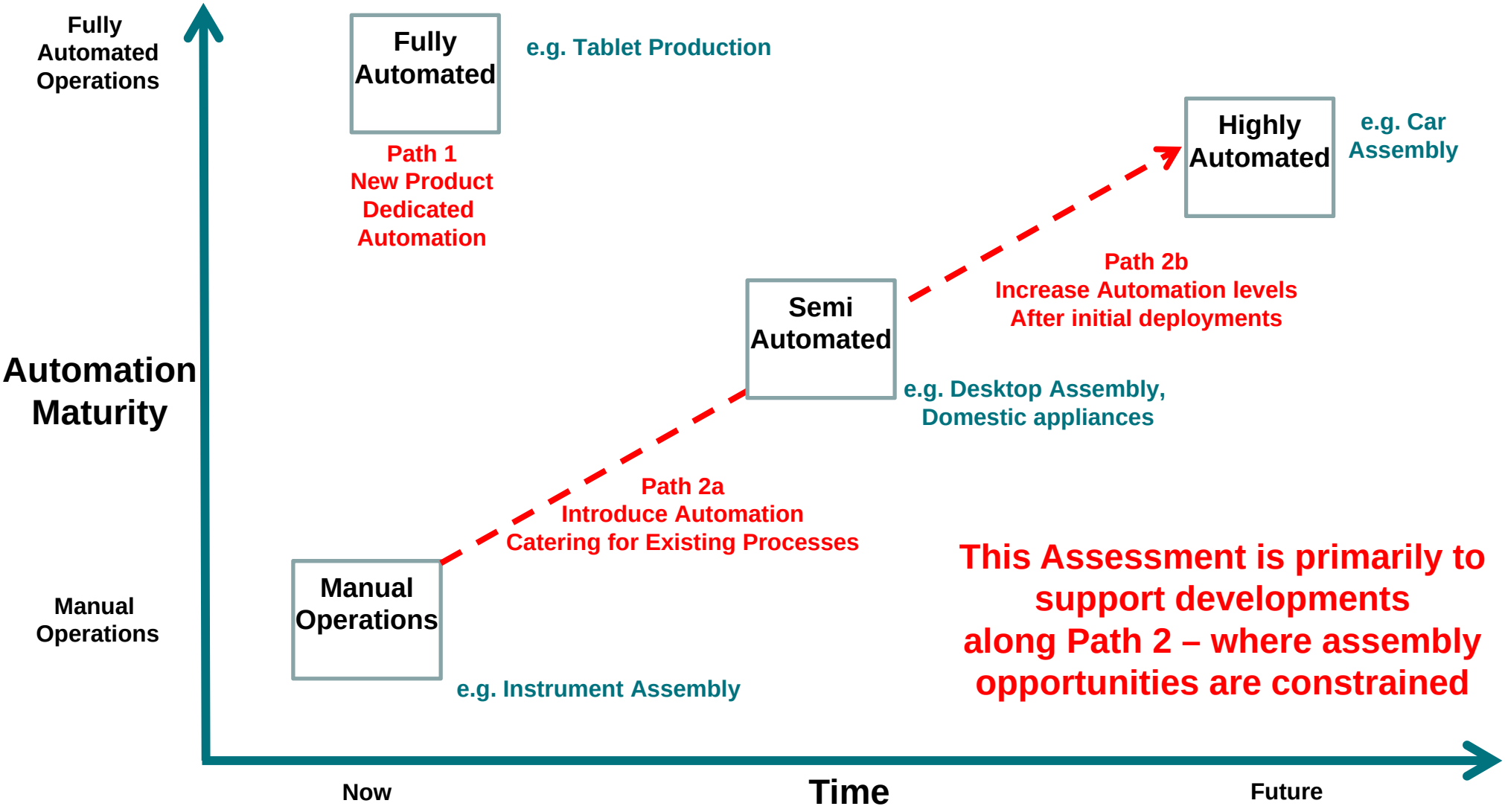
Motivation

- Increase customer demand
- New product launch
- Joe wants me to look at some new robot

- Labour costs keep going up
- Jack is off with strain injury again
- Keep get product returns with quality issues
- Bill & Fred retire at the end of the year!
- Industry 4.0 ? Data Sharing ?

- **Develop / Support a company's automation strategy**
- **Identify Automation Opportunities & Feasibility Challenges**
- **Tailored to enhance existing production capabilities**
- **Collaborative approach with in-house production engineers**
- **Deliver a structured and prioritised implementation pathway**

Automation Maturity Approaches



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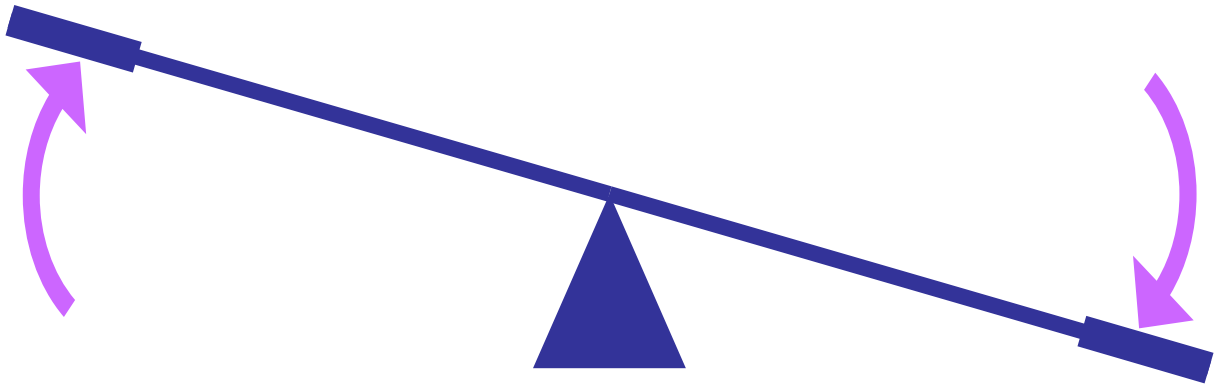
The Automation Challenge Opportunity Balance



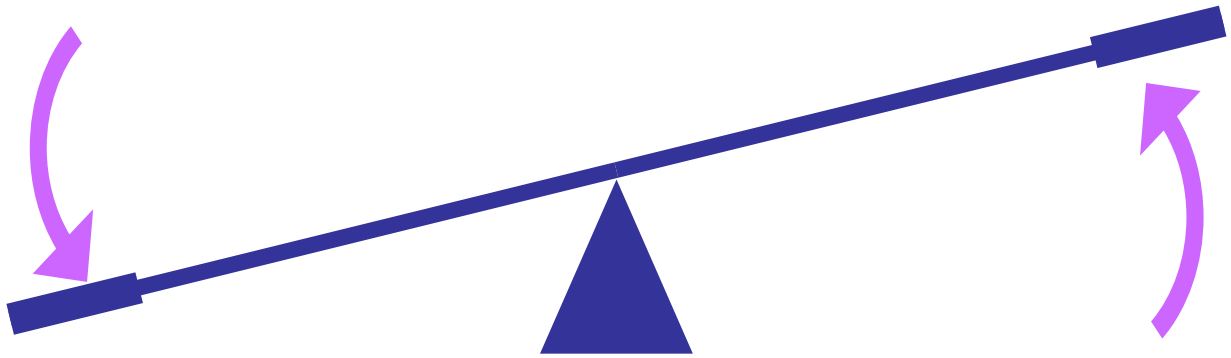
Automation Opportunities

Many benefits of automation

Automation downsides

These benefits may come at a price….

The Automation Challenge
Feasibility Balance



Implementation Issues

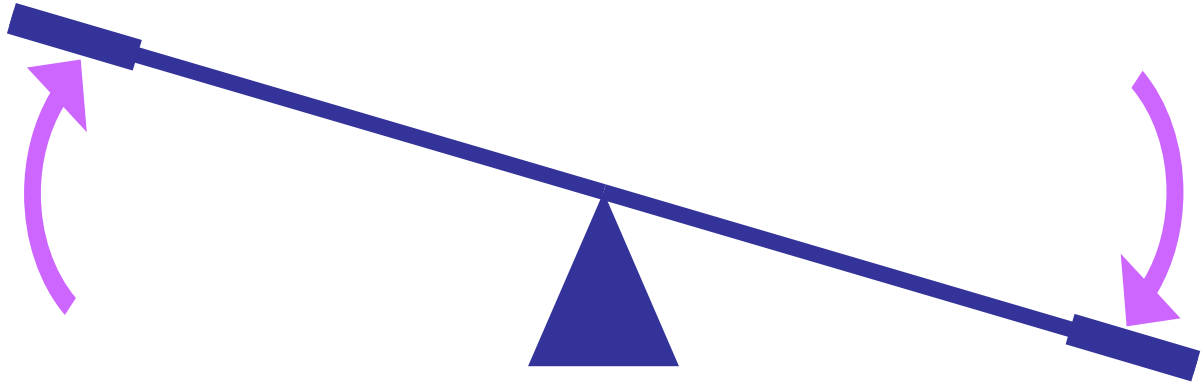
Other factors may make automation hard or impossible

Feasibility Easy

Solutions exist

Processes are “automatable”

The Automation Challenge
Opportunity / Feasibility Balance



Automation Opportunities

Improve operator safety
Reduce labour cost
Increase production rate
Reduce floor space requirement
Improve product quality
…

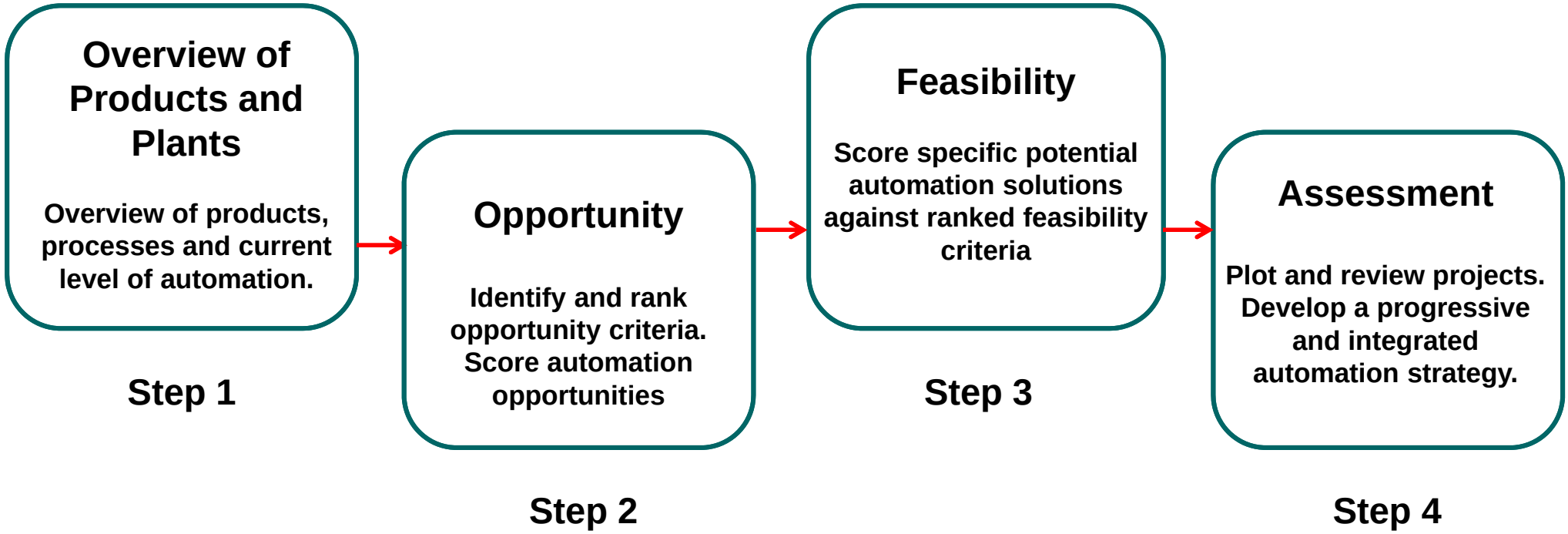
Feasibility Issues

Number of assembly operations
Complexity of assembly operations
Ease of Automation
Material delivery (logistics)
Ease of integration
…

Automation Assessment

- Building a model so that projects can be plotted and compared

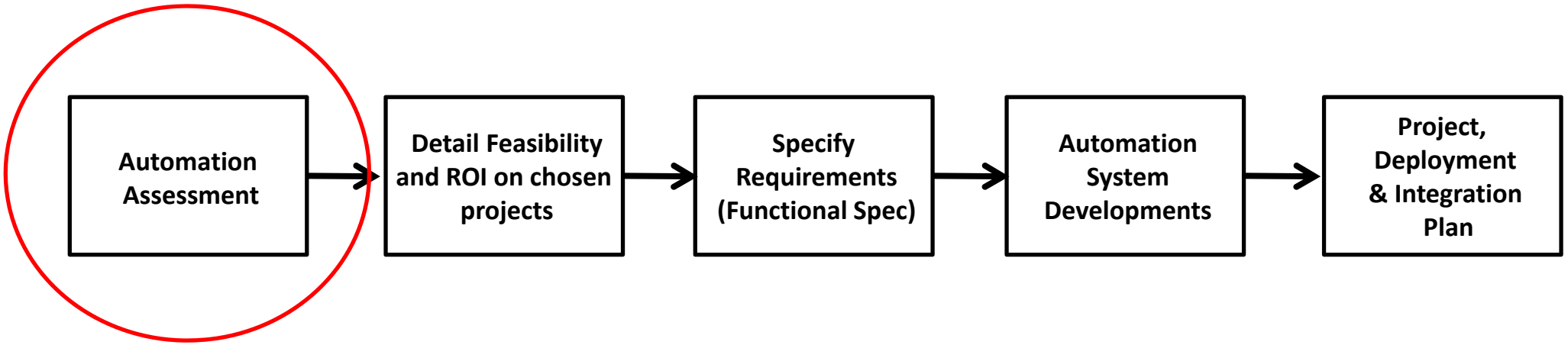
Automation Assessment Methodology



Overview of Automation Assessment Tool

Top Level Business Aim:

To identify, develop and implement appropriate automation solutions across the business.



Foxconn Automation Project

- Foxconn aspiration to improve operations and reduce head count
- Context of:
  - Rising labour costs
  - More automation capability (external)
  - Demanding customers
  - Limited design input
  - Multi-site manufacture – flexible and changing footprint
- External facilitation
  - Step back / overview
  - Stimulate higher level view of automation benefits and issues
  - Structured assessment

Foxconn Automation Project

“set up an effective platform among Foxconn GFO facilities to evaluate Automation potential”

“a guiding path for further steps of the project”

- Clarified automation objectives and gave focus and direction to the international automation team
- Stimulated higher level discussion of automation benefits and issues
- Structured assessment approach adopted across global operations
- Highlighted important differences between sites and products
- Company-wide picture enabling consistent analysis for multi-site manufacture
- Foxconn now rolling out assessment approach across 6 plants

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Jaguar Land Rover Automation Project

- Experienced and expert automation team

"Which project should we do?"

- 3 material handling projects
- Each with some different solution possibilities

What does the tool do?

- Identifies the best fit solutions
- Prioritises the work

JAGUAR | LAND ROVER

Jaguar Land Rover Automation Project

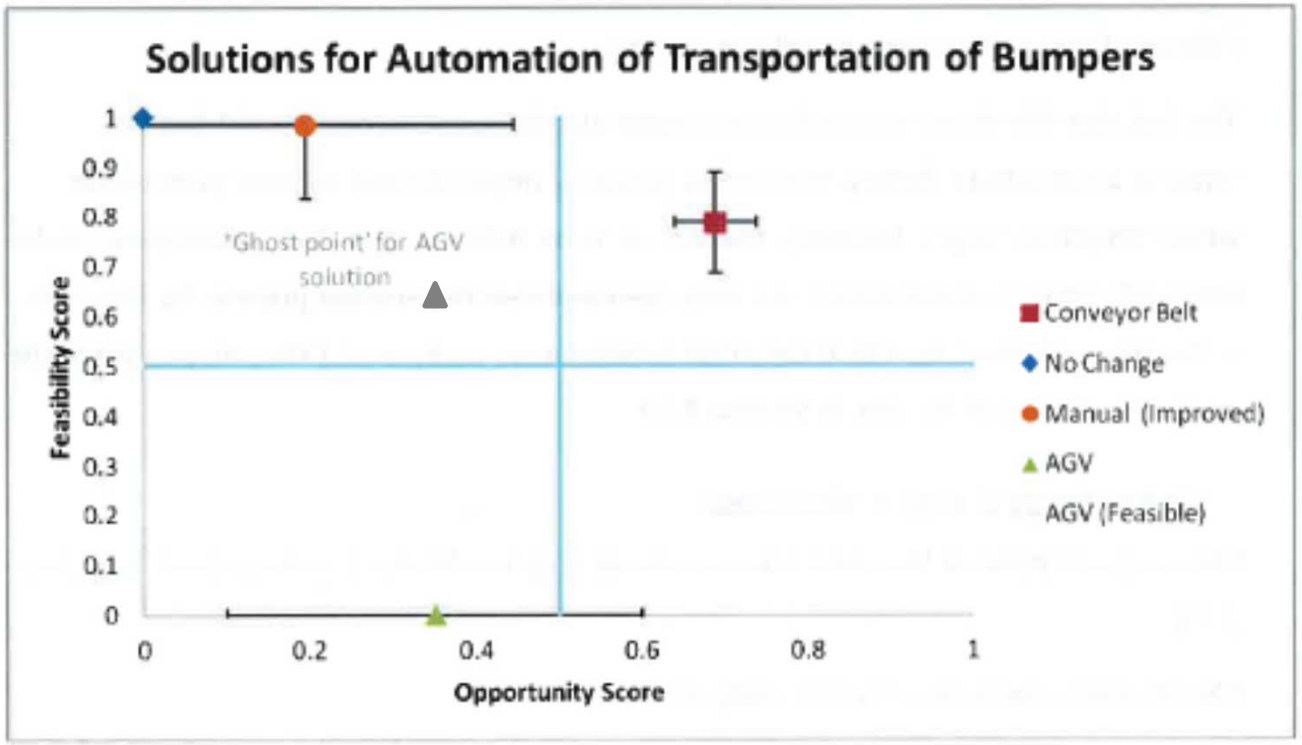


Figure 3.2 – %Opportunity v. %Feasibility for each automation 'solution'

Jaguar Land Rover Automation Project

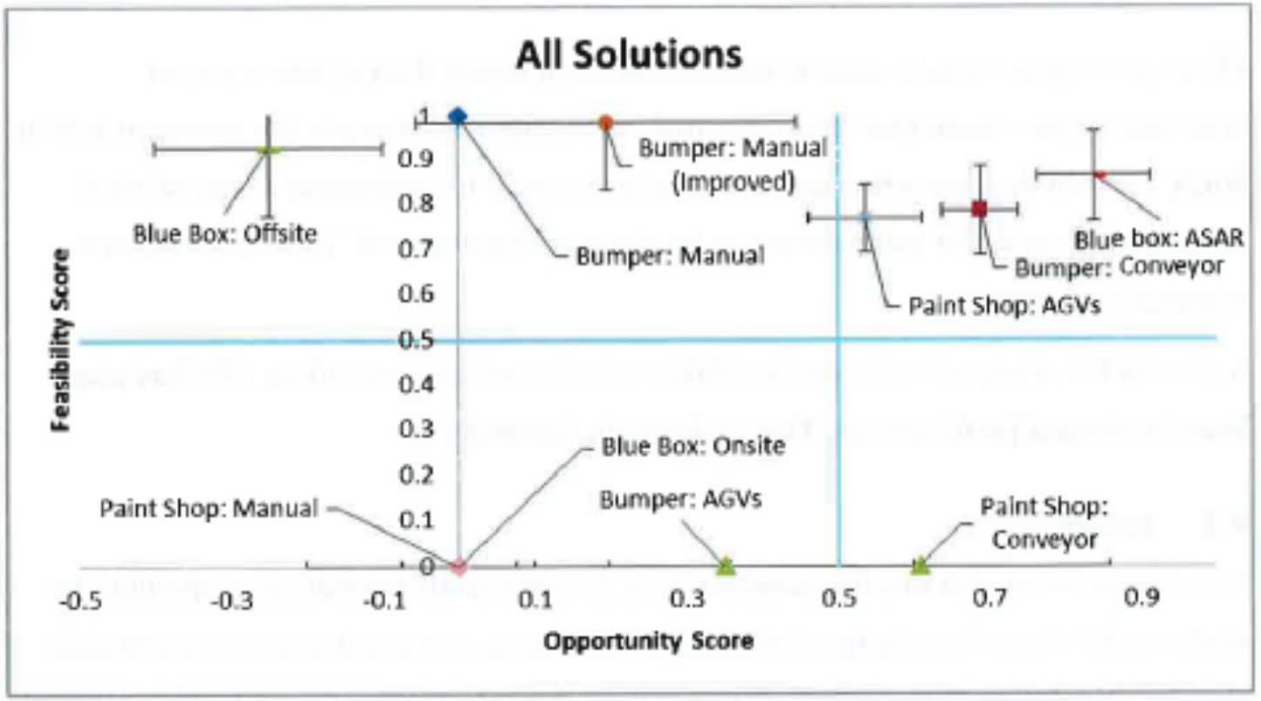


Figure 3.5 - %Opportunity v. %Feasibility for all solutions from all studies

Jaguar Land Rover Automation Project

- Managers' view of the Automation Assessment:
  - useful resource for JLR
  - first step when considering the implementation of automation
  - logical and structured way of considering automation opportunities
  - highlights benefits and drawbacks that were previously unconsidered

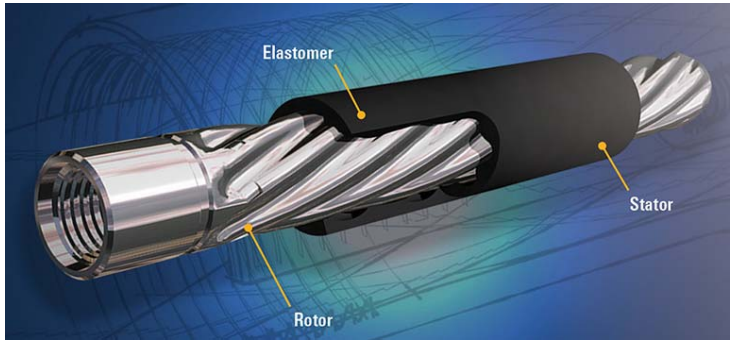
- Final graphical presentation of data *"a good visual method of summarising the findings of the study"*

Schlumberger
Automation Assessment Project

- Schlumberger automation aims:
  - Modernise manufacturing and identify automation opportunities
  - “too many opportunities” – need a method to categorise and prioritise
- Key business drivers:
  - Cost reduction
  - Geographical expansion
  - Demand for refurbishment close to drilling activity
  - Mobility of manufacturing / refurbishment activity
- External facilitation
  - Step back / overview
  - Stimulate higher level view of automation benefits and issues
  - Structured assessment
- Company-wide picture and consistent approach
  - Share experience and knowledge gained

Automation Assessment output
Key points from Schlumberger

- Center & Product Line Overview
  - Provides plant structure and context
- Opportunity and Feasibility criteria and rankings
  - Highlights center-level priorities
- Opportunity / Feasibility Plots
  - Key output
- Decision Support
  - Understand individual project positioning
  - Understand project interdependencies & benefits of combining projects
  - Compare different centers



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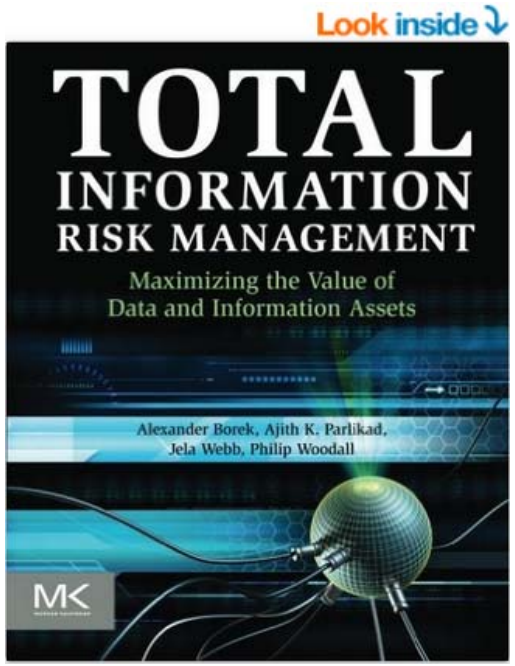
Information quality risk assessment tool

- Introduction to the problem
- The Total Information Risk Management (TIRM) process
  - Including the supporting software tool



Motivation

Information provides competitive advantage … digital age … Big Data …

Utility company: *"errors in meter readings … errors in customer database … incorrect bills … overcharged customers … loss of customer confidence … … regulator fines … customers leave to competitor*"

A major UK supermarket: *"incorrect inventory data … errors in supplier database …*

… stock-outs … lost sales … dissatisfied customers … customers leave to competitor"

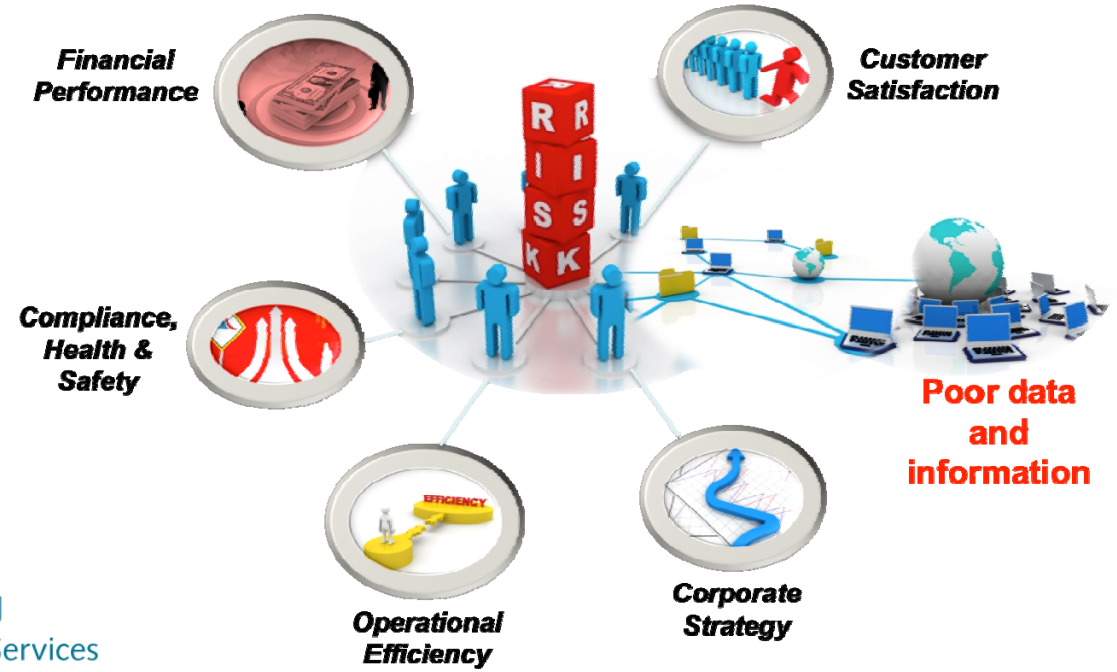
Poor quality information has a direct adverse impact on business performance

Key questions for industry

"… what is the impact of poor quality data on my business?"

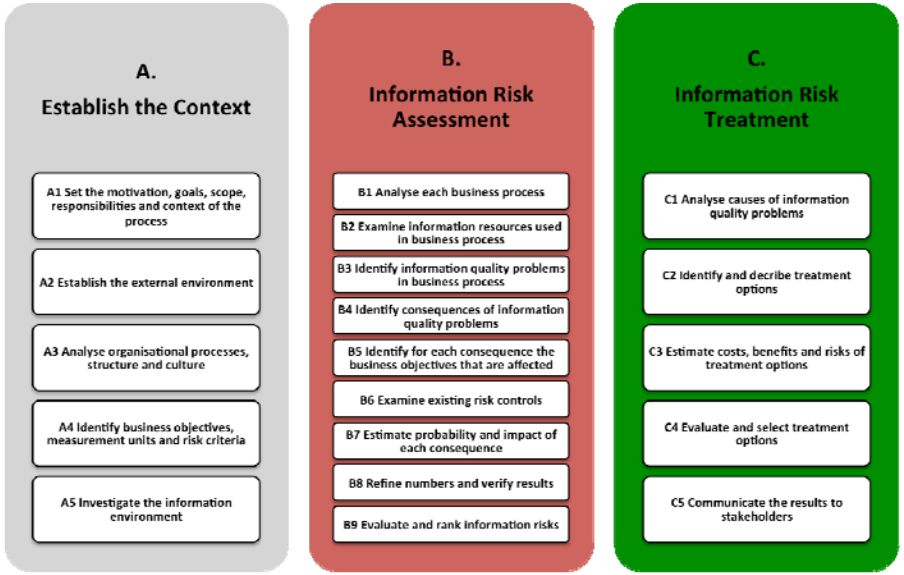
"… I have lots of problems with my databases… how can I prioritise my improvement projects?"

"… is it worth investing in new IS/IT?"

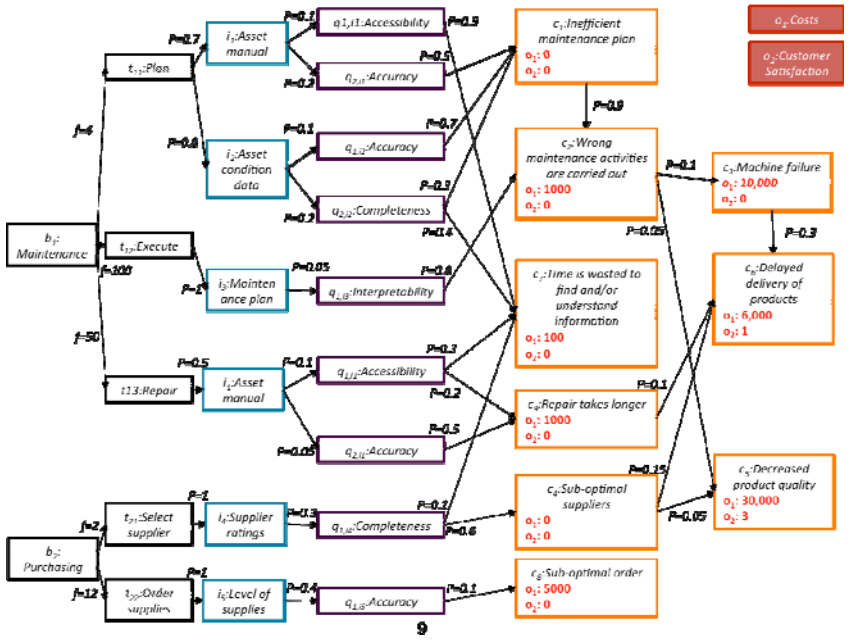


Total Information Risk Management

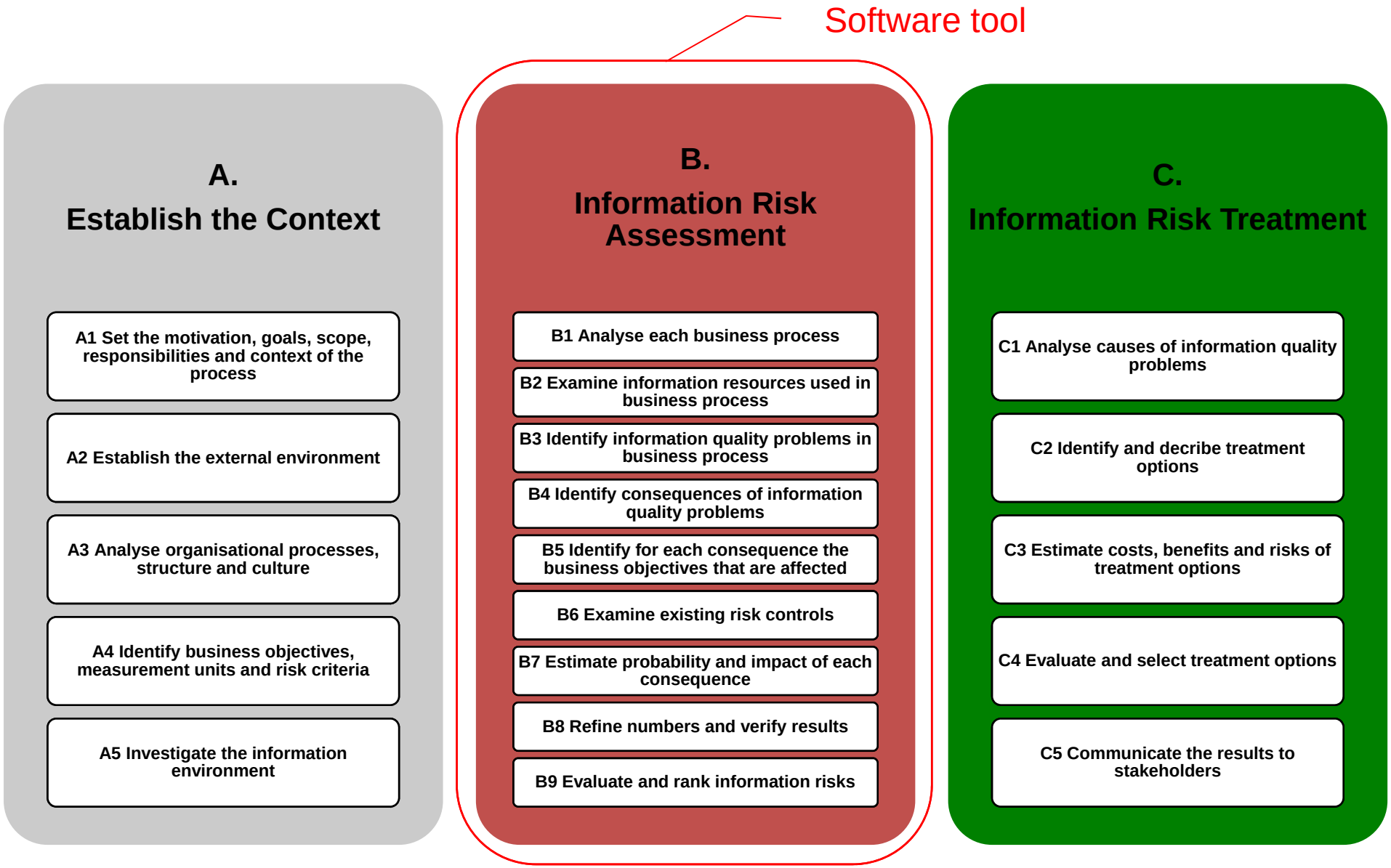
A structured process…



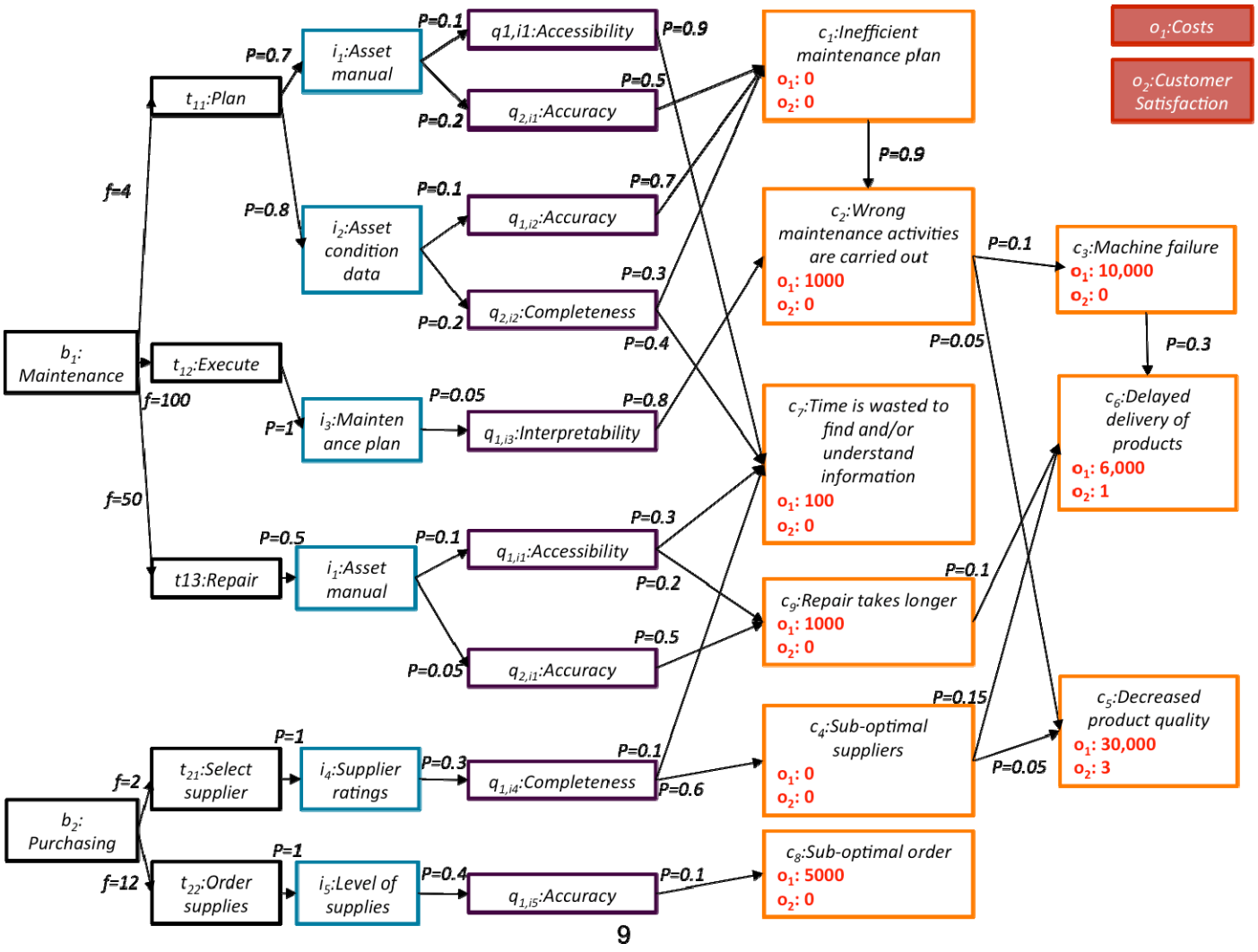
… supported by a rigorous model



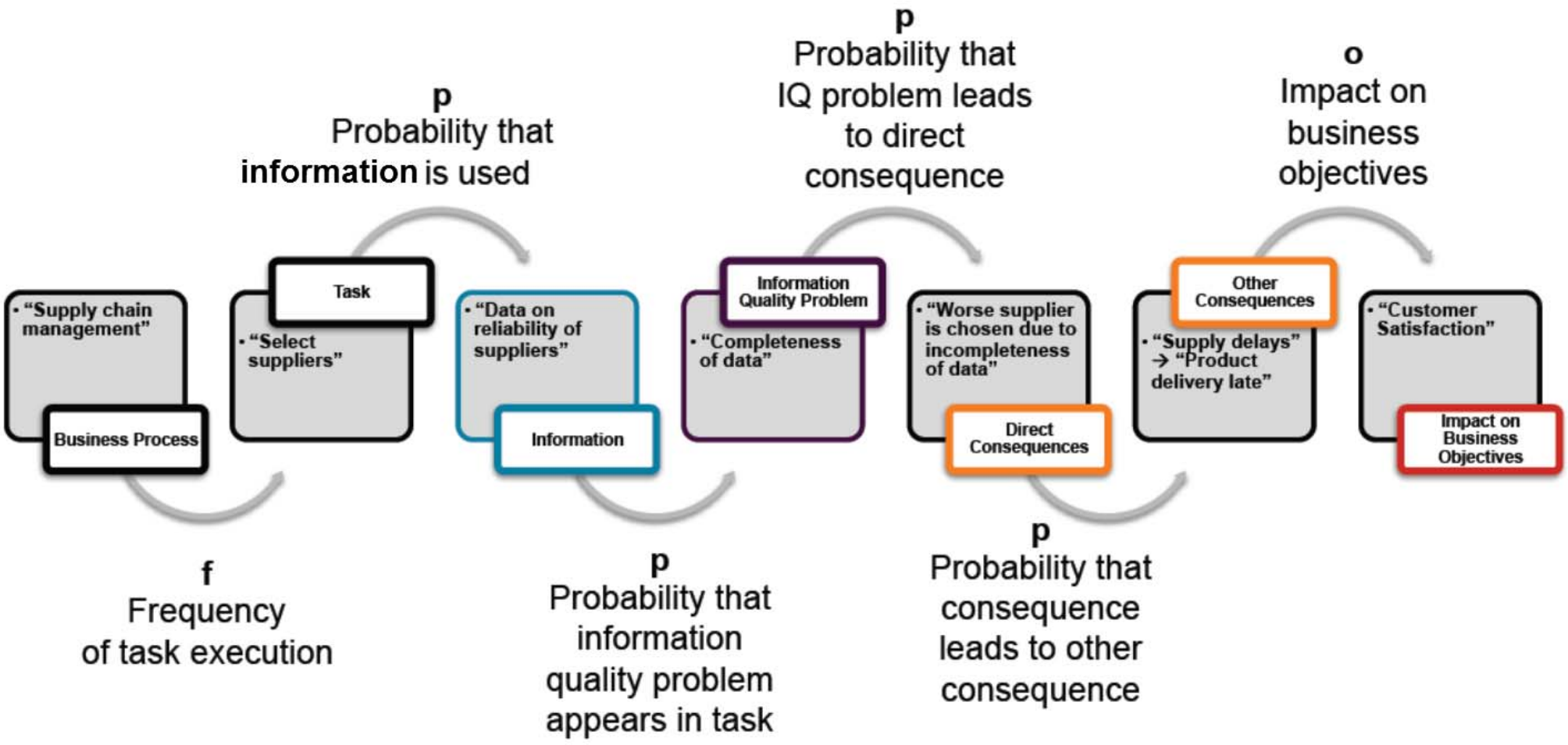
The TIRM Process



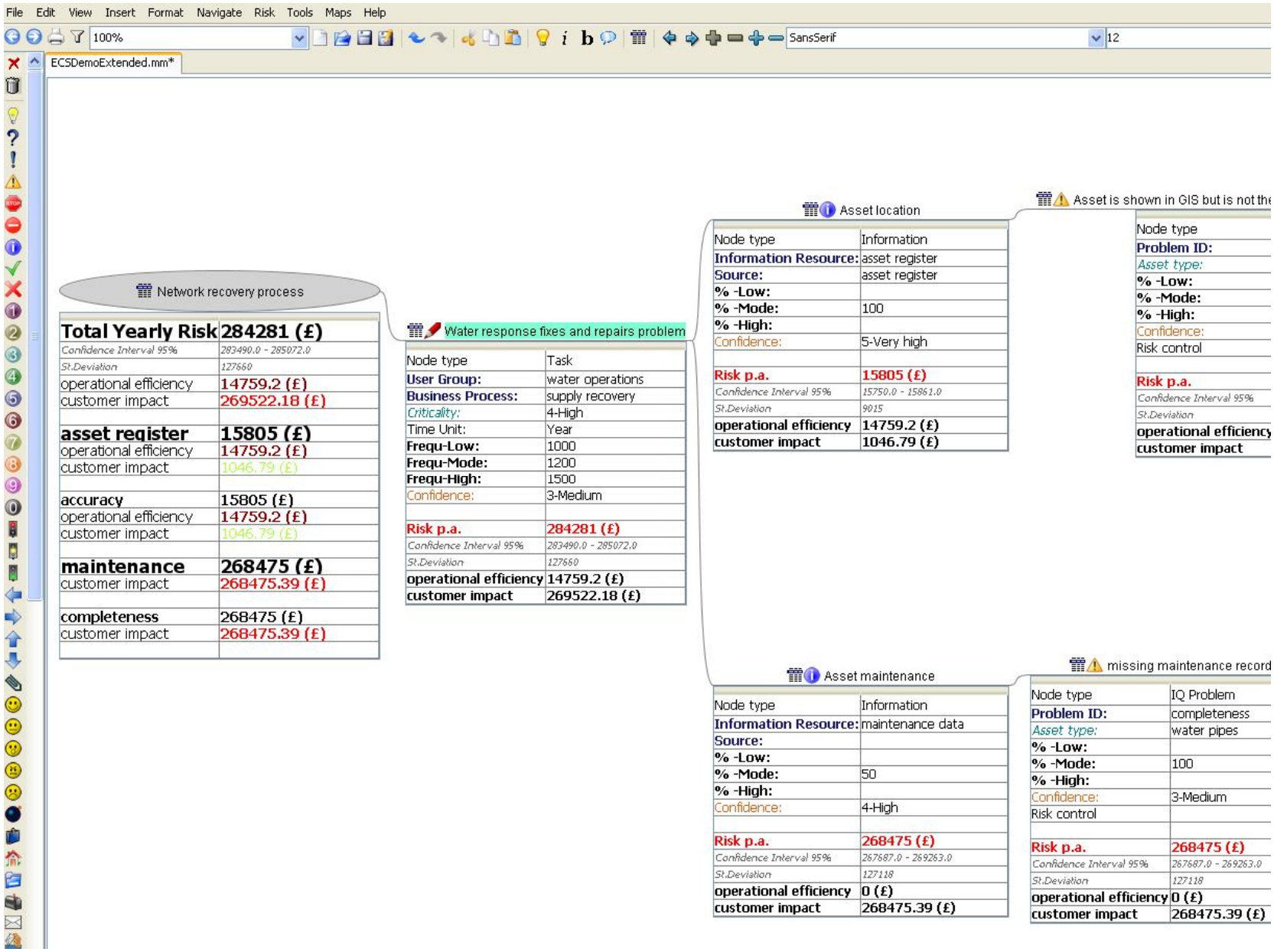
Information Risk Model



Information risk model

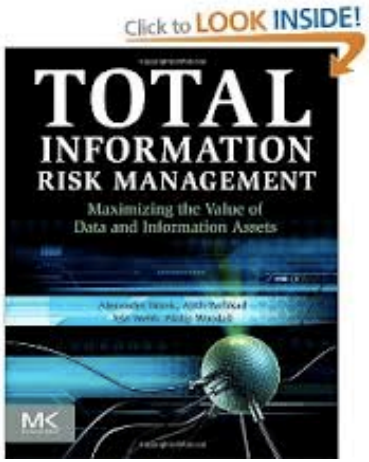


Supporting software tool



Total Information Risk Management

- Based on ISO 31000:2009 – Risk Management
- Adapted to suit “information risks”
- Process follows well established techniques such as FMECA, RCA, etc.
- Tested and refined in industry
- More information in our book (available via Amazon)



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[Industrial] Big Data

What is the challenge?

Data quality**, **Data value** and **Data sharing

Efficiently collecting, aggregating and analysing large data volumes originating from many different sources

Benefits?

- Reduced manual data management
- Access to new data sources
- Leverage data analytics techniques e.g. machine learning

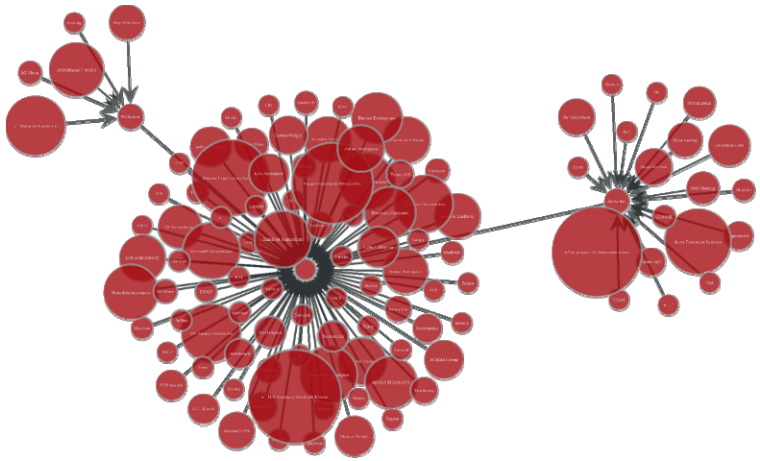
What have we done?

- Developed tools and techniques for cleaning and combining data
- Developed market mechanisms for evaluating data value
- Developed recommender systems for acquiring industrial data
- Reconstructing supplier data from third party data
- Developed next generation warehousing and logistics information systems

Big Data to Enhance Supply Chain Operations

Aim:

To develop a system to make predictive interpretations about potential supplier operational non-performance.



Challenges for manufacturers

Large manufacturers can have enormous numbers of parts shortages per day, for a variety of reasons:

1. suppliers being overloaded by orders from other customers,
2. day-to-day delays during transportation of goods,
3. suppliers not being able to satisfy manufacturing demand.

These can result in significant production delays.

Addressing the Challenges

The Virtual Intelligent Production, Procurement and Prediction (VIPr) project aims to address these issues by:

- Using public data to model the supply chain
- Utilising data analytics to make predictive interpretations about potential supplier operational disruptions.

Project collaborator:

BOEING

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ITALI - IT Architectures for Logistics Integration

IfM Distributed Information and Automation Laboratory

ITALI aims to…

…investigate how existing logistics-related information systems must evolve to address future logistics needs

YHGlobal 越海全球物流

Project sponsor

…by exploring three logistics themes

A: Mismatches between physical operations and data

B: Difficulty in offering integrated logistic services to clients.

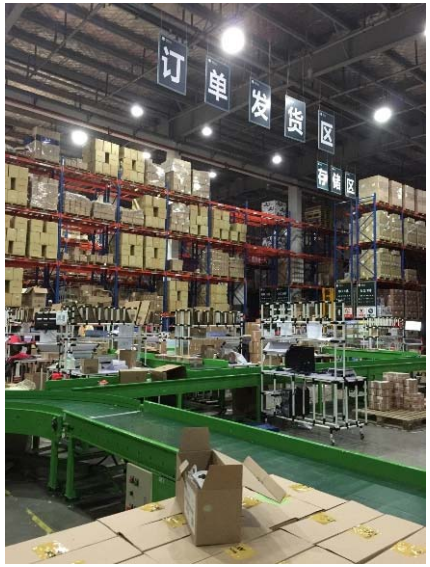
C: Dealing with differing B2C and B2B commerce requirements.

Potential outputs

A: An IT architecture for next generation warehousing and logistics

B: An automated approach to keep the data aligned with the physical process

C: A framework illustrating how to transition from B2B to B2C-like commerce.



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If you are interested in any details related to this project, then please contact:

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Introduction - About IfM ECS

IfM Education and Consultancy Services Ltd (IfM ECS) provides a rapid dissemination route for research and education outputs developed at the Cambridge University Institute for Manufacturing (IfM).

- Industrial practitioners help companies of all sizes in all industries to apply research-based improvement techniques.
- Practical solutions based on the latest applied research
- Live feedback to help set the agenda for new research
- An income stream to support future research activities

- Single point of access to relevant expertise from the University of Cambridge
- Education programmes configured to client company needs and context

IfM ECS is a wholly owned subsidiary of the University of Cambridge

IfM Education and Consultancy Services

Mechanisms for Engagement
DIAL / IfM ECS

Engagement methods are always tailored to meet your needs:

1. Consulting to meet current needs
   (Direct Impact to Operations)
2. Confidential industrial research for future operational needs
   (3-5 Yr Horizon)
3. Consortium based research for collaborative needs
   (3 Yr Horizon)
4. Direct sponsorship of PhD. Research positions
   (3-4 Yr Programme)
5. Placements for short term Student Projects
   (PhD. / MPhil level)

Working with IfM

- Scoping is key (every company is different!)

- Work with engineers
- Tailor the tool / approach
- Work with available data
- Run workshops

- Equip team for deployment

Typical Project Flow