The human-technology frontier for next-generation, smart service systems

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ISSIP President

Agenda

1. Report on ISSIP/NSF workshop - March, 2017
2. Emerging themes for research
3. Research questions and proposed initiatives
4. Service Science - some current research

ISSIP
INTERNATIONAL SOCIETY OF SERVICE INNOVATION PROFESSIONALS

Our mission is to “promote service innovation for our interconnected world.”

We help institutions and individuals be successful in our global digital service economy.

Overview of ISSIP

- Founded July 2012
- Individual Members: > 1100+
- Members representation:
  - Universities: 200+
  - Companies 50+
  - Countries: 42+

National Science Foundation (NSF)

- Annual budget of $7.5 billion (FY 2016),
- Funds approximately 24% of all federally supported basic research
- Research is conducted by America's colleges and universities.
- 12,000 new awards per year, with an average duration of three years
- NSF-funded researchers have won some 223 Nobel Prizes.

NSF Programs

7 Directorates

1. Biological Sciences
2. Computer and Information Science and Engineering
3. ***Engineering***
4. Geosciences
5. Mathematical and Physical Sciences
6. Social, Behavioral and Economic Sciences
7. Education and Human Resources.

Service Research

- PFI:BIC Partnership for Innovation: Building Innovation Capacity
- Under Engineering Directorate
- Crossing the "Valley of Death"
- NSF/ISSIP Workshop:
  - Recommend a research agenda for PFI:BIC
  - Identify grand challenges

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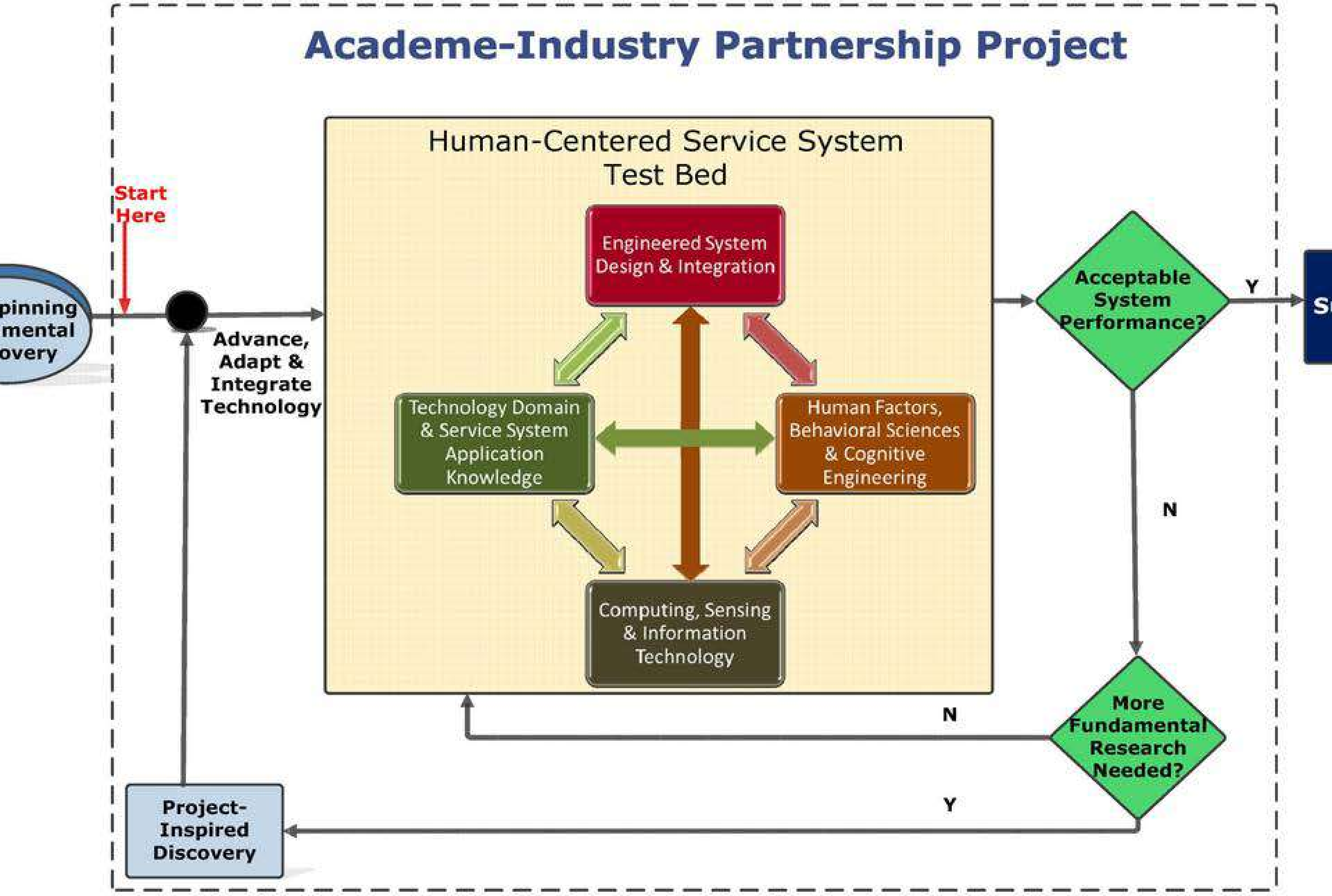
NSF invests $13 million in smart, human-centered service systems

PFI:BIC awards to spur innovation for smart health, manufacturing and infrastructure
Credit and Larger Version

November 9, 2016

[Originally published September 7, 2016, and updated to correct broken link]

From healthcare to transportation to advanced manufacturing, service systems make our lives safer, easier e Foundation (US) https://www.nsf.gov/eng/iip/pfi/bic/AnatomyofPFI_BIC.jpg Search



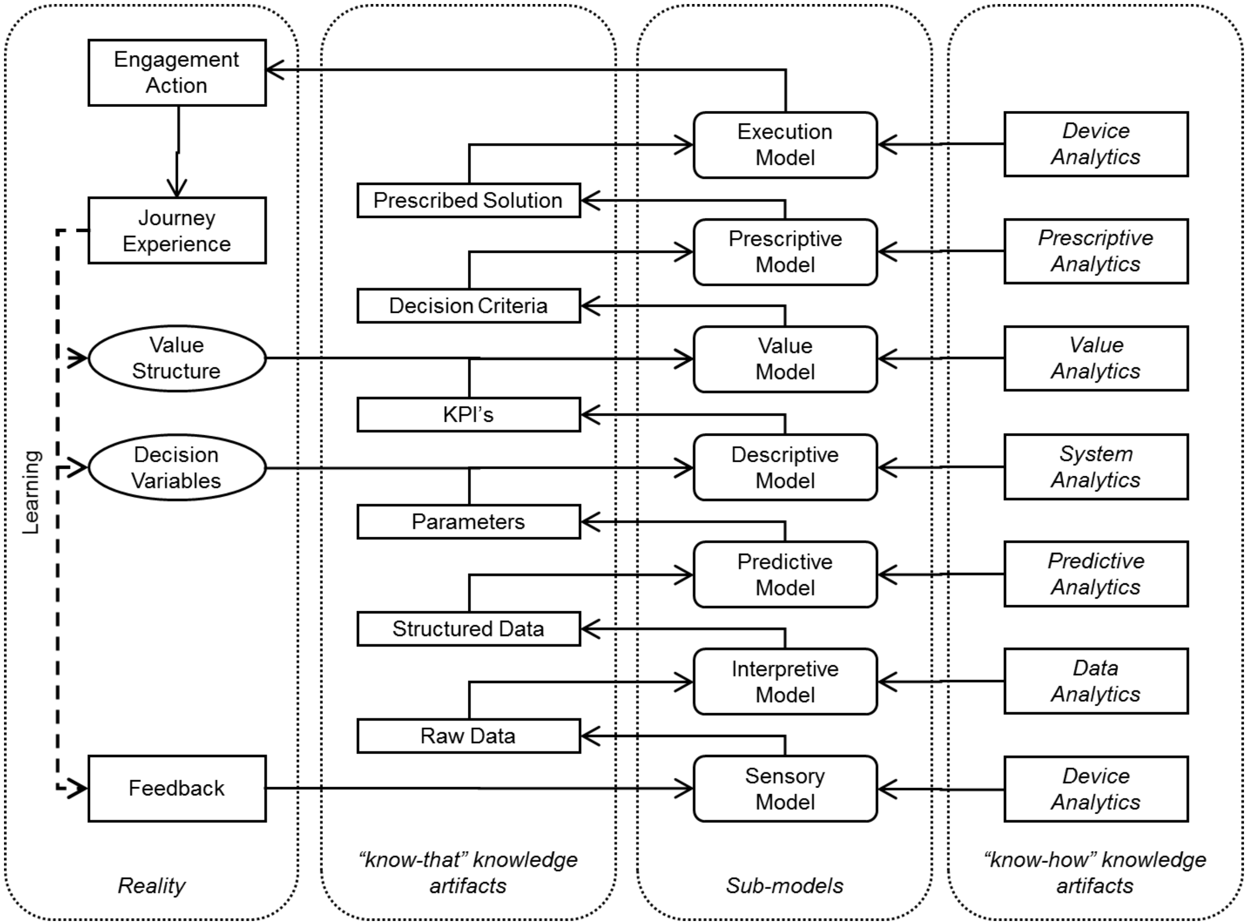
Workshop – perspectives

1. Technology
2. Verticals
3. Human Factors/Effects
4. Business Models
5. Public Policy & Economics
6. Science and engineering
7. Service systems and value co-creation

1. Technology – *its uses*

- Moving
- Sensing
- Communicating/Connecting
- Data managing
- Interpreting
- Analyzing/Deciding
  - ***Predictive***
  - ***Descriptive***
  - ***Prescriptive***
- Conversing
- Learning/Adapting/Cognition
- Empathizing
- Creating

Modeling relationships



2. Verticals

1. HEALTH CARE service
2. Consulting service
3. Product support service
4. Education service
5. Financial Service
6. Retail service

– obsolete definitions

Service ecosystems

3. Human Factors/Effects

- Education/Training
- ***T-Shapedness***
- Culture shock of AI
- Employment
- Machine-augmented human vs. human-augmented machine
- User models
- Workforce virtualization

4. Business Models

- Commercialization support, venture capital
- Servitization
- Collaboration as a service (CAAS)
- Serverless computing
- Micro services
- Virtual workforce
- Value specification and assessment
- Agile design of service systems
- Open innovation

5. Public Policy and Economics

- Government as a platform
- Socio-technical systems
- Service ecosystems
- Government – Industry - Academe collaboration
- Privacy and data ownership (HAT)
- Standardization
- Legal constraints
- Cultural norms
- Sharing economy
- API economy
- Open sourcing
- Technology transfer/adoption
- Rapid application development

6. Understanding a Human's Perception, Intent, Context

- What technologies can improve a machine's ability to perceive a human's position, mood, attitude?
  - *Big data analytics*
  - *Context data analytics*
  - *Advanced sensors*
- What technologies can improve a machine's ability to understand a human's intent?
  - *Predictive analytics*
  - *Non-verbal communication*
- What technologies or models can improve a machine's ability to understand a human's context?
  - *Big Data analytics*
  - *Common sense cognition – Freebase, DBpedia, Watson News*

6. Understanding a ***Machine's*** Perception, Intent, Context

- What technologies can improve a *human's* ability to perceive a *machine's* position, mood, attitude?
- What technologies can improve a *human's* ability to understand a *machine's* intent?
- What technologies or models can improve a *human's* ability to understand a *machine's* context?
  - *MTH communication systems*
  - *MTH communication standards, protocols*
  - *Error trapping, diagnosis and translation*
  - *Human factors*
  - *Affective computing*

6. Control and Stability

- What architectures or systems can maintain control over a a network of autonomous MTM interactions with humans on the periphery
  - *Networked command and control systems*
- How can a large network of autonomous machines produce a desired emergent outcome without a command and control system?
  - *Swarm intelligence*
  - *Robots conflict resolution*
- In a large network of machines and humans how can stability be achieved in consideration of limitations on:

  context awareness, intent awareness, command and control
  - *Systems science - Models of emergent phenomena*

6. Wisdom Computing

Wisdom (Data > Information > Knowledge > Wisdom)

The power of intuition, ethics, culture on decision making

- How can wisdom be transferred to machines?
- How can machines develop their own wisdom?
- How can machines be controlled by human wisdom?
  - *Society 5.0 (JST)*

7. Maturity Level of Society wrt AI

- How can human's adapt to the rapid and relentless introduction of AI applications?
  - *Design of innovative campaigns to instigate and control the debate about the implications of new technologies and systems*
  - *Design of programs for popularizing Service Science and Service Innovation*
  - *Design of education in technology, AI*
  - *STEM to STEAM to SHTEAM*
  - *Popularizing T-Shaped learning*

7.Ubiquitous Smart Service Systems

- Can human's take over when needed? – No!

  E.G., The 3 Deadly D's of cockpit automation

  - Distraction
  - Dependency
  - Daring

- *System design/engineering for fail-safe, fault-tolerance, resilience*
- *Standards engineering for safety, recovery*

7. Challenges of the New Human Identity

Human and Non-Human identity, Individual identity blending into network identity

- How can humans control their identities when connected to technology and service systems that augment their abilities?
- Will the technologies that we use determine our sense of identity?
- When actions, decisions and performance are managed at a network level how should resources and value be distributed? (e.g., driverless cars)
- What cultural norms may need to be adjusted to live in a world of controlled networks?

7. Governance

- What governmental structures will be needed to be changed or created to align more accurately with the new class and community identities?
- How can governments or society manage the adaptation of individuals to sudden power, enablement, competition – legal restrictions or comprehensive entitlement?
  - *Data Analytics*
  - *Sociology*
  - *Psychology*
  - *Economics*

7. Social Complexity

- What changes will take place in society and in economies as networks form, change and die?
- How can societies and governments address the phenomenon of narrowing of political views as a result of the leveraging of networking?
- When and how should technology be forced on humans? How can individuals maintain a right to "go native"?
- How can individuals adapt sudden power, enablement, competitive advantage that comes from technology adoption?
  - *Political science*
  - *Economics*
  - *Sociology*
  - *Psychology*

7. Humanism

Will we marry robots?

Can robots love, empathize?

Retail analytics research

Proceedings of the 2015 INFORMS Workshop on Data Mining and Analytics
M. G. Baydogan, S. Huang, A. Oztekin, eds.

MERGING BUSINESS KPIs WITH PREDICTIVE MODEL KPIs FOR BINARY CLASSIFICATION MODEL SELECTION

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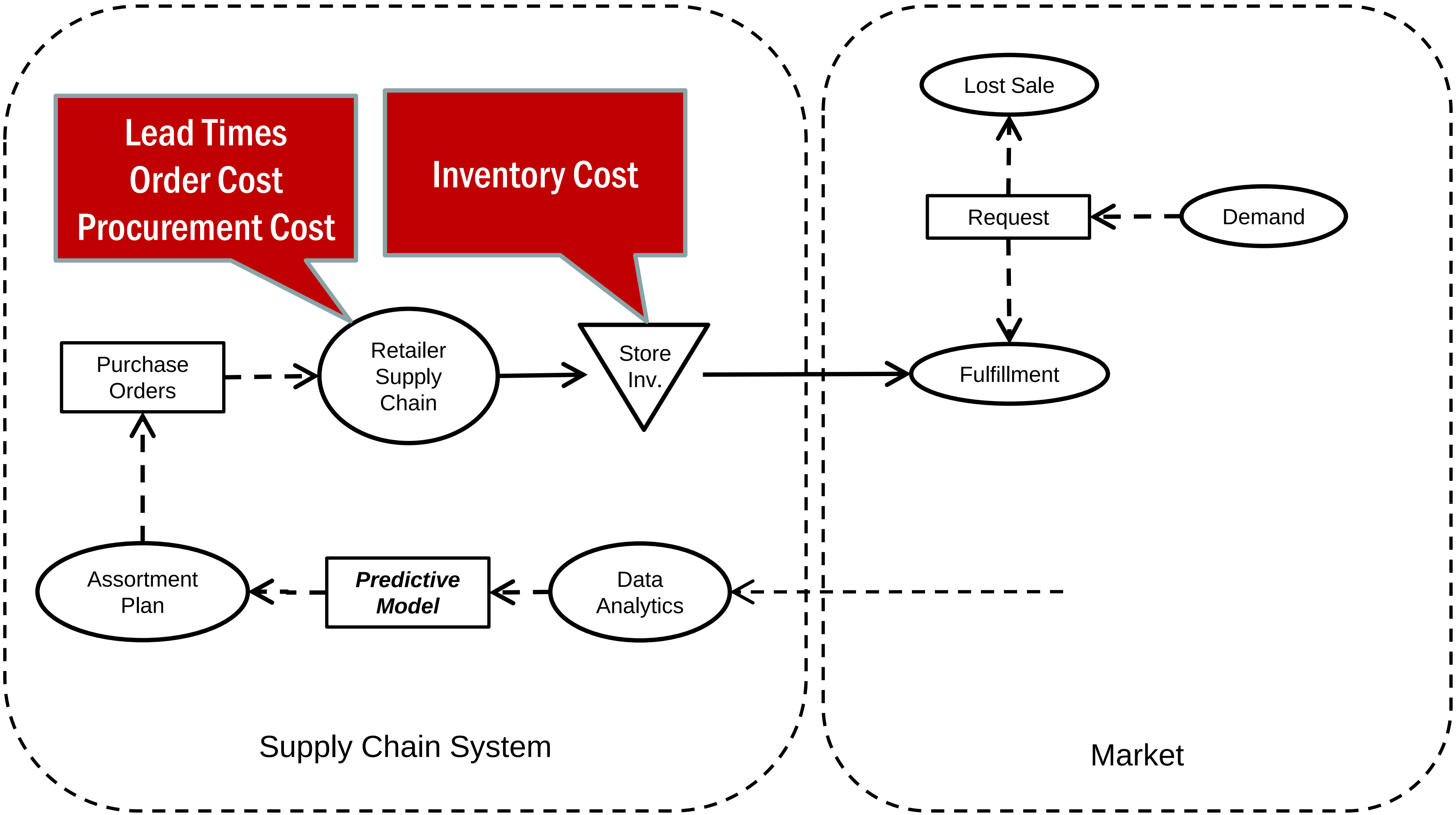
Lead Times
Order Cost
Procurement Cost
Inventory Cost
Purchase Orders
Retailer Supply Chain
Store Inv.
Assortment Plan
Predictive Model
Data Analytics
Supply Chain System
Lost Sale
Request
Demand
Fulfillment
Market

Servitization Research

IoT for Servitization
(working paper)

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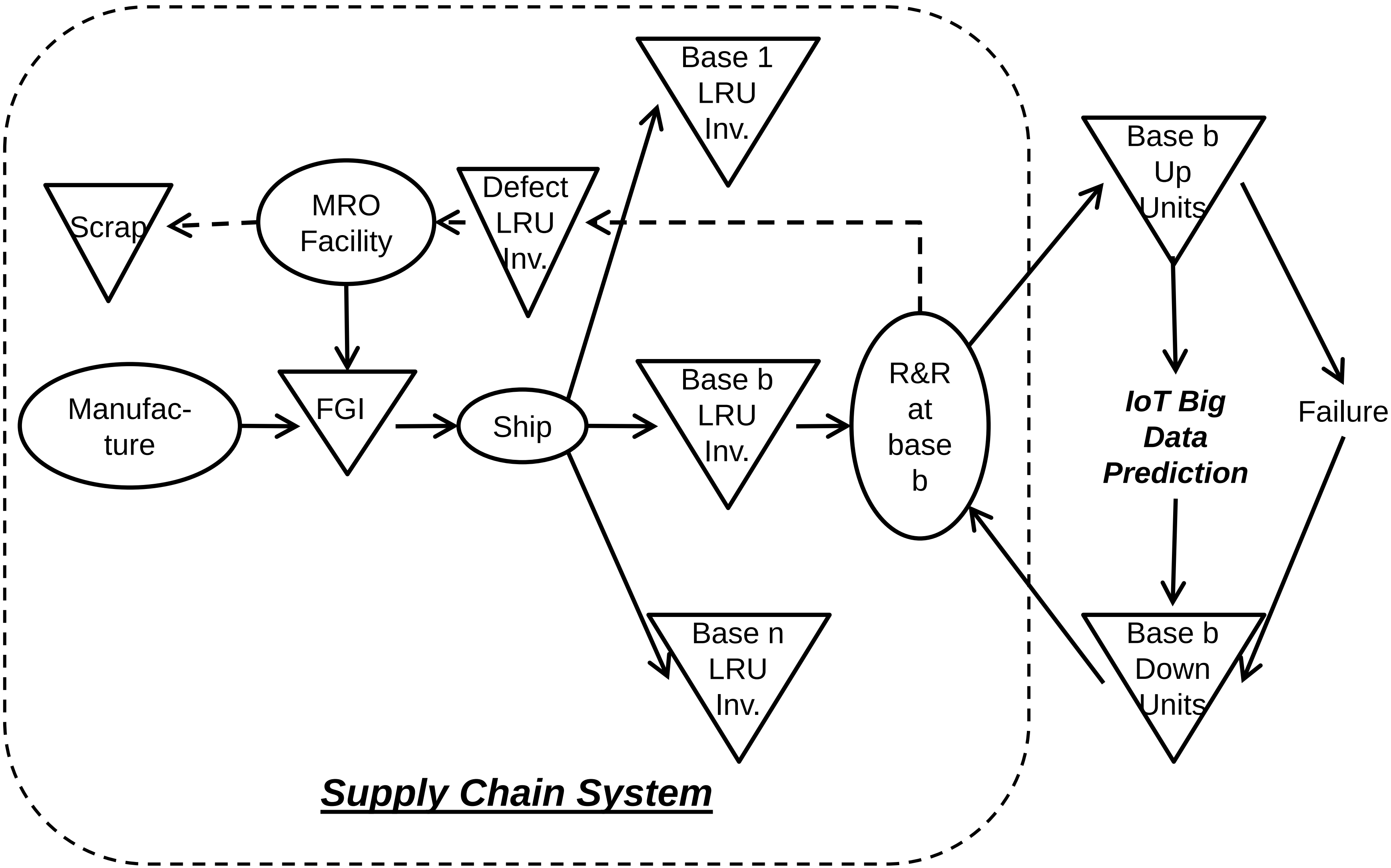
Prashant Tyagi, Saurabh Thapliyal

Abstract

This paper exposes the opportunities for the application of IoT in supply chains. Although it is well-known that IoT has a strong role to play in manufacturing and supply chain management, the connection between IoT and servitization has not been explicitly defined. This paper reviews the recent developments in these two domains and provides a model of the benefits of IoT in achieving servitization. Challenges and opportunities of the use of IoT in servitization are discussed.


Scrap
MRO Facility
Defect LRU Inv.
Base 1 LRU Inv.
Base b Up Units
Manufac- ture
FGI
Ship
Base b LRU Inv.
R&R at base b
IoT Big Data Prediction
Failure
Base n LRU Inv.
Base b Down Units
Supply Chain System

5th Naples Forum on Service 2017

Integrating the Internet of Things and Big Data Analytics Into Decision Support Models for Healthcare Management

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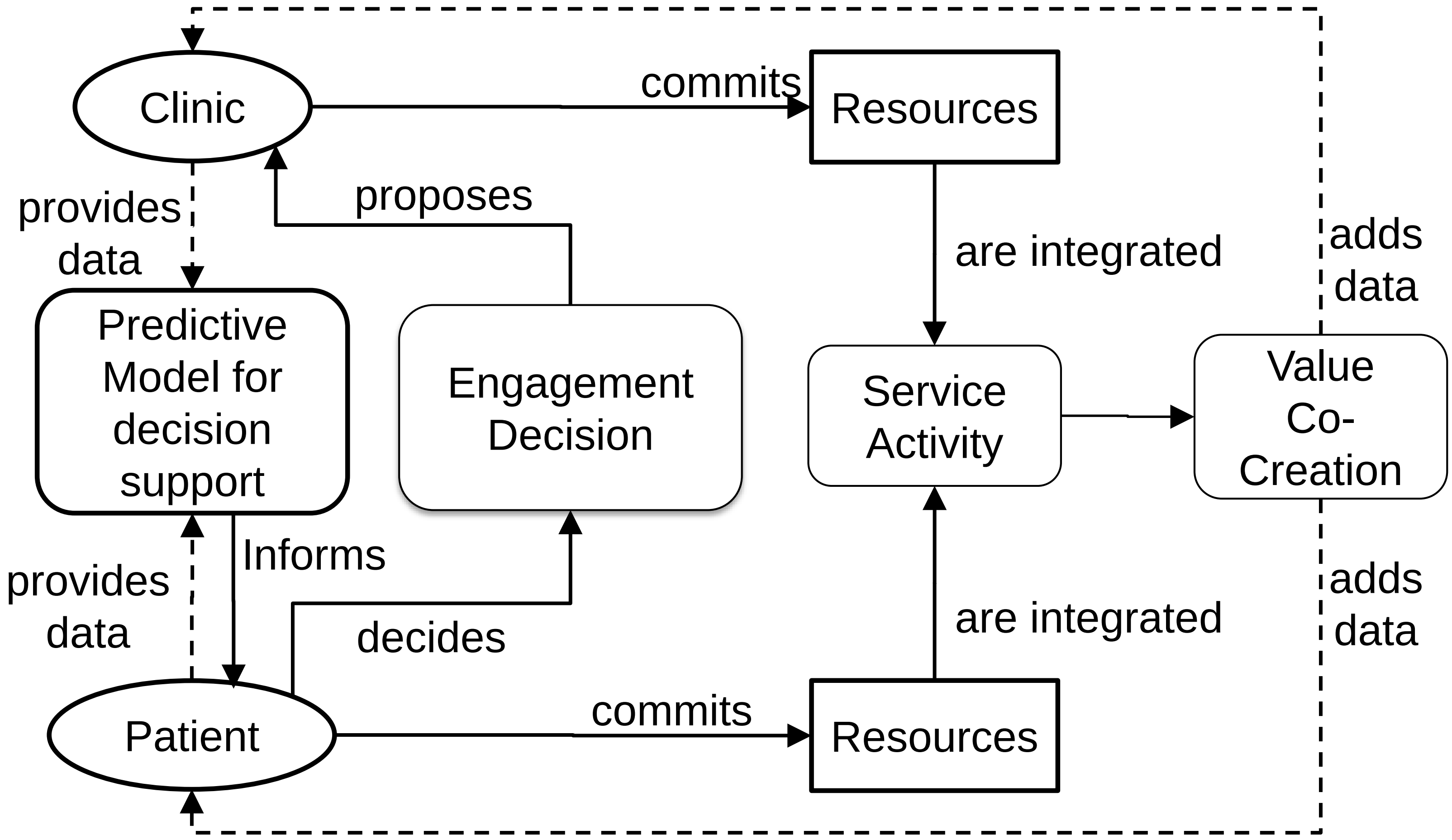
Value Cocreation in Healthcare System



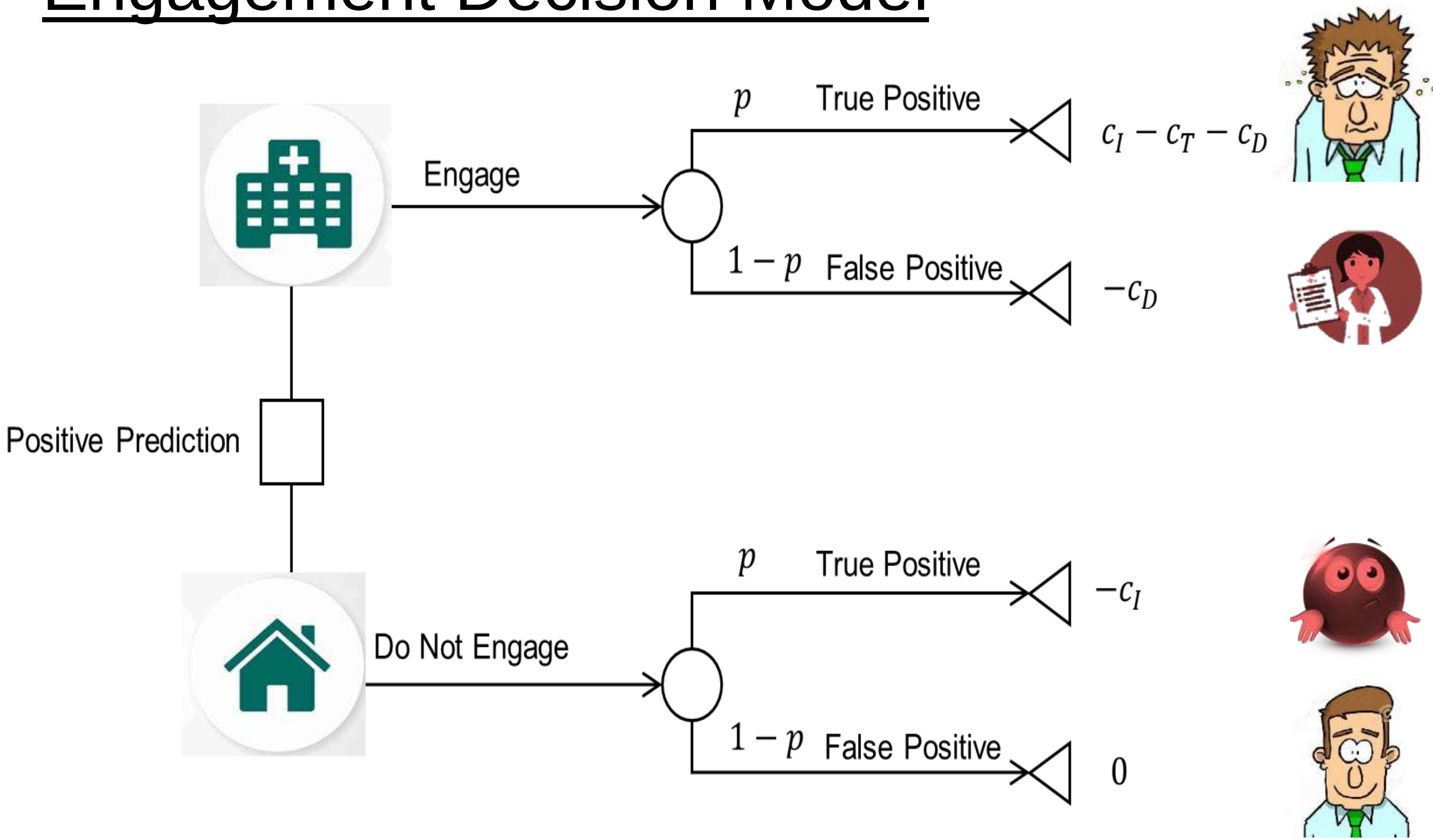
Patient engagement decision

- Cost to the patient of an accurate diagnosis performed at the clinic. (c_{PD})

- Cost to the patient of treatment of the ailment after a true positive diagnosis. (c_{PT})

- Cost of ignoring the presence of the ailment until a more reliable diagnosis emerges. (c_{PI})

Engagement Decision Model



Patient's Decision Rule

If $p > p_c = \frac{c_{PD}}{2c_{PI} - c_{PT}}$ then engage, otherwise wait until the next epoch. (1a)

A corresponding analysis of the case of a negative prediction results in the decision rule.

If $q > p_c = \frac{c_{PD}}{2c_{PI} - c_{PT}}$ then engage, otherwise wait until the next epoch. (1b)

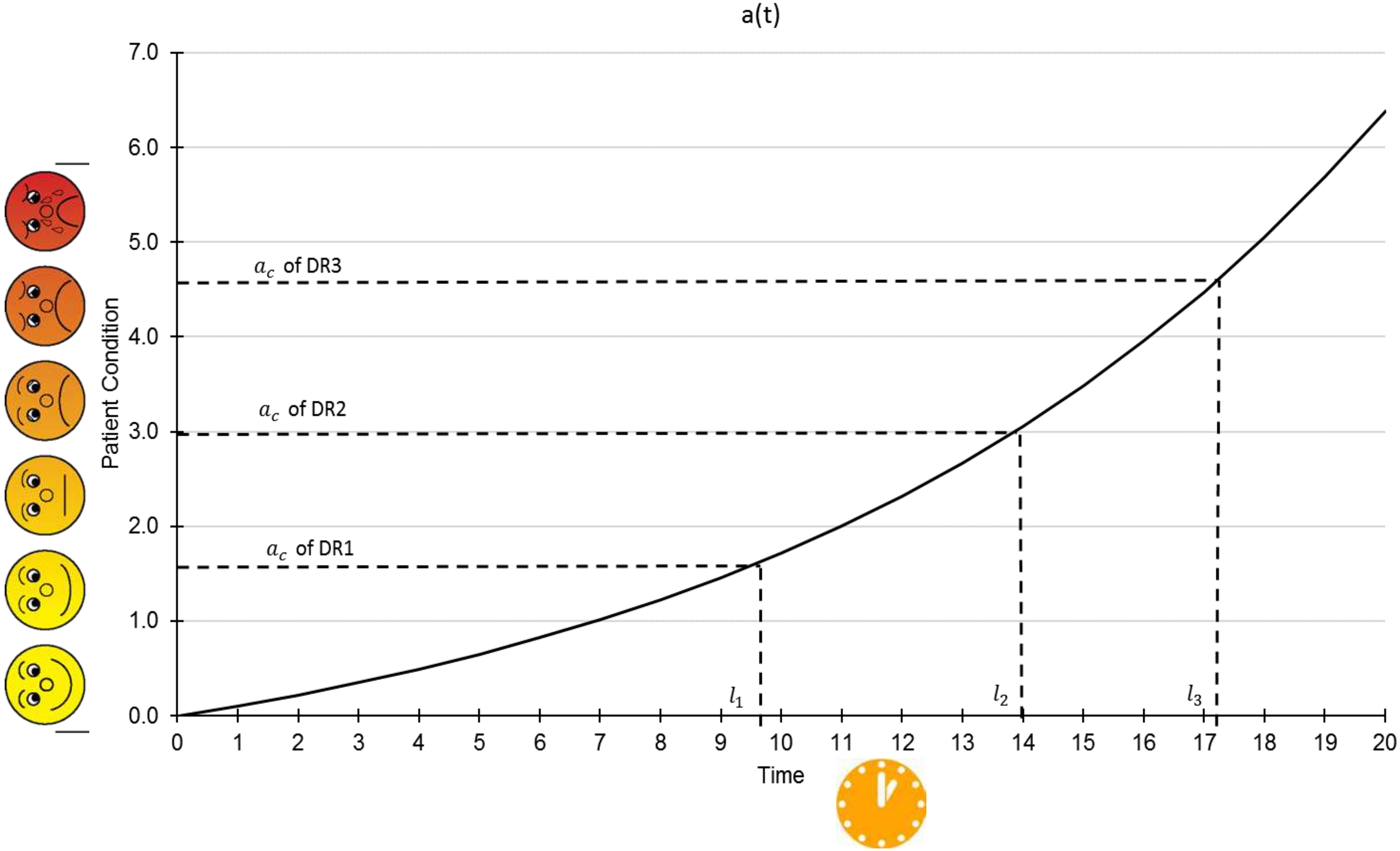
3 predictive models = 3 strategies

- DS1: regular visits to a clinic for examinations

- DS2: IoT/BDA tracking of health conditions at regular intervals, or even on a near real-time basis.

- DS3: patient waiting until a pain or discomfort manifests itself.

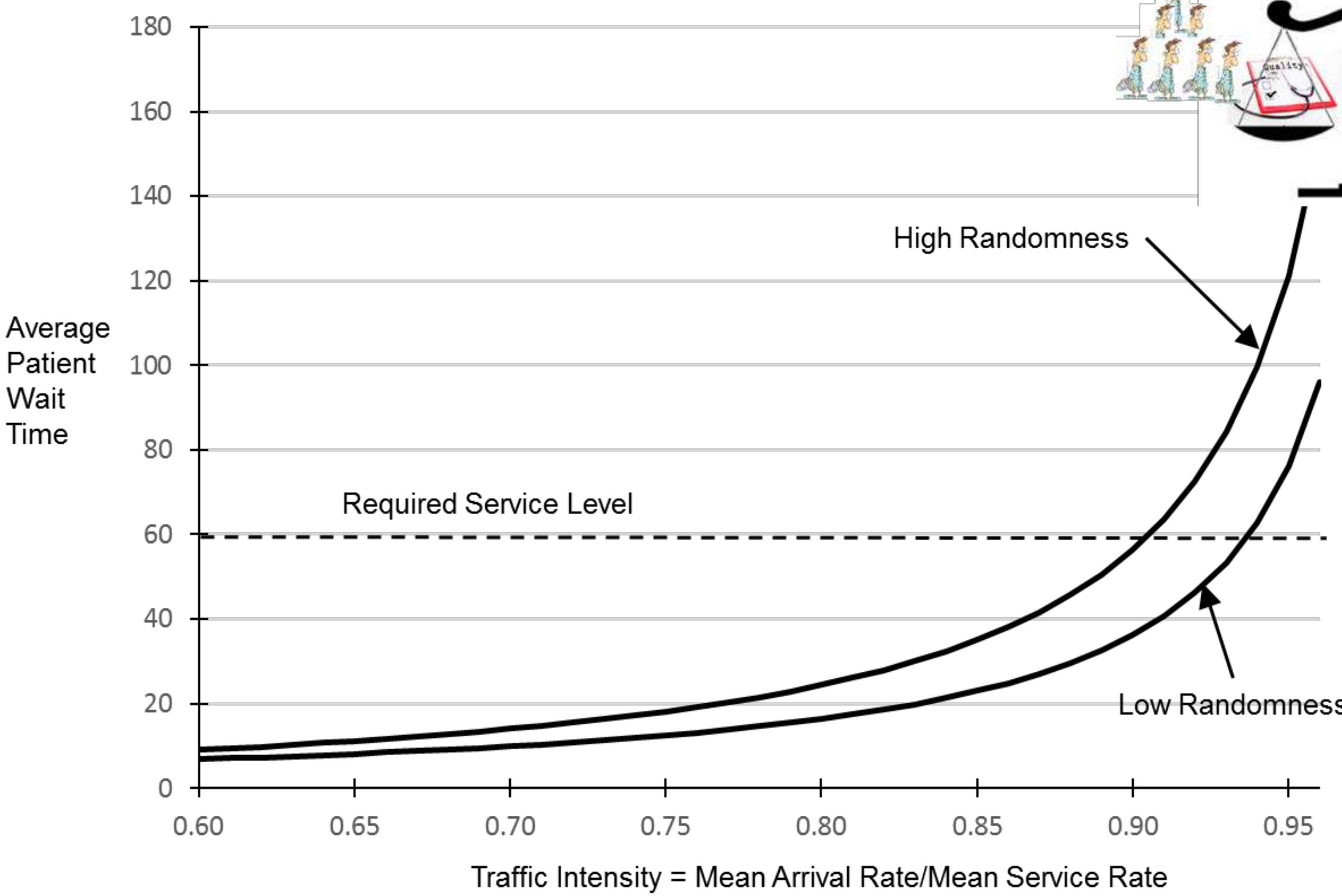
Time to Get Treatment



Long-run expenditures - Patient Strategy

Decision Strategy	Frequency of Visits	Patient Expenditures on Diagnoses	Patient Expenditures on Treatments	Patient Expenditures due to Delayed Treatment
DS 1 	High	High	Low	Low
DS 2 	Medium	Medium	Medium	Medium
DS 3 	Low	Low	High	High

Service level to capacity tradeoff



Long-run expenditures - Clinic Strategy

Decision Strategy	Frequency of Visits	Uncertainty in Timing of Visits	Medical Clinic Ovhd Costs for Diagnoses	Medical Clinic Ovhd Costs for Treatments	Medical Clinic Ovhd Costs for Delayed Treatment
DS 1 	High	Low	High	Low	Low
DS 2 	Medium	High	Medium	Medium	Medium
DS 3 	Low	High	Low	High	High

Clinic's Decision Rule

If $p > p_c = \frac{c_{SD}(\lambda,\sigma)}{2c_{SI}(\sigma) - c_{ST}(\sigma)}$ then engage, otherwise wait until the next epoch.

Implication & Recommendations

- Asymmetric effects of decisions

- Effectiveness of BDA predictions

- Flexibility of resource capacity and scheduling of medical clinic