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Maximizing Logistics Efficiencies

Artificial Intelligence and Self Learning: Paving the way to improve Logistics Automation

September 30th, 2024

Agenda

01. **Why** Logistics Automation? 5-6 Mins

02. **What** are **"Healthcare Ready"** Options for Logistics Automation? 5-6 Mins

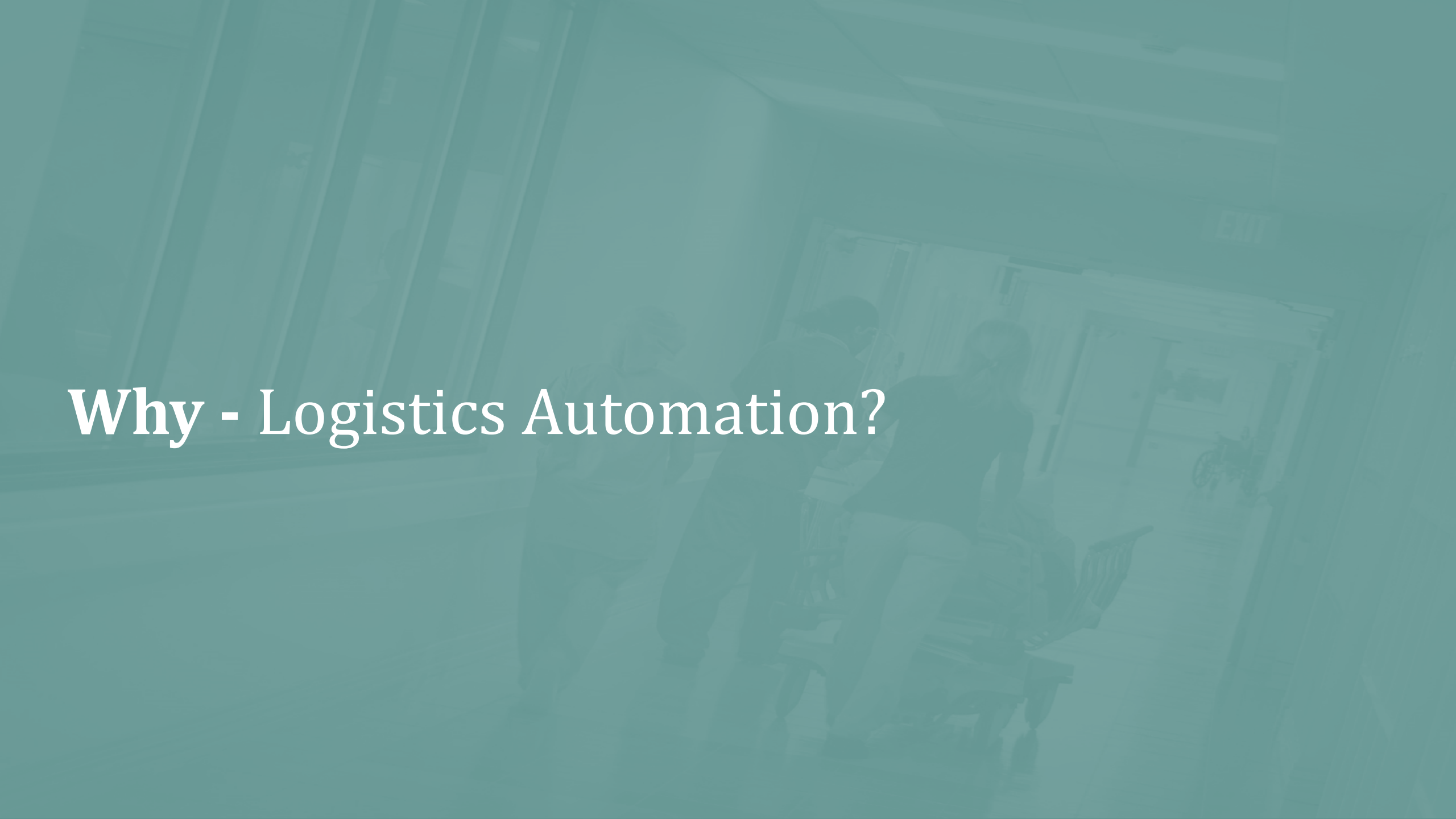
03. **How** is AI impacting future of Logistics Automation 7-8 Mins

04. **Pre-planning & Building Consensus** for adoption of technology 6-7 Mins

05. **Code & Planning** challenges 6-7 Mins

06. **Business Case** Example 7-8 Mins

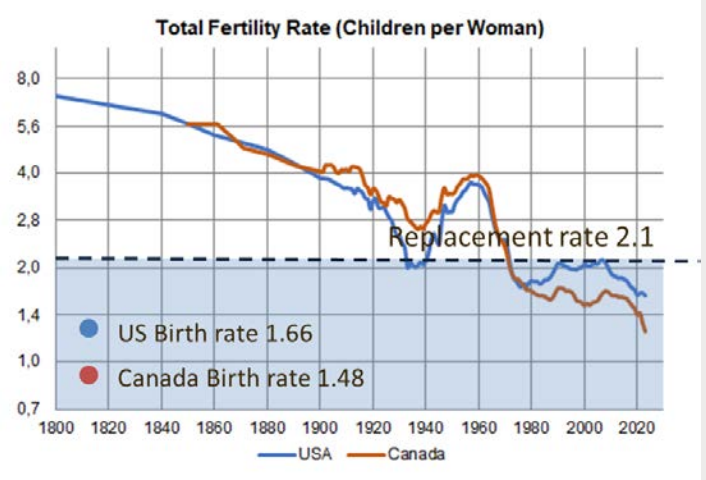
07. **Summary** & Questions



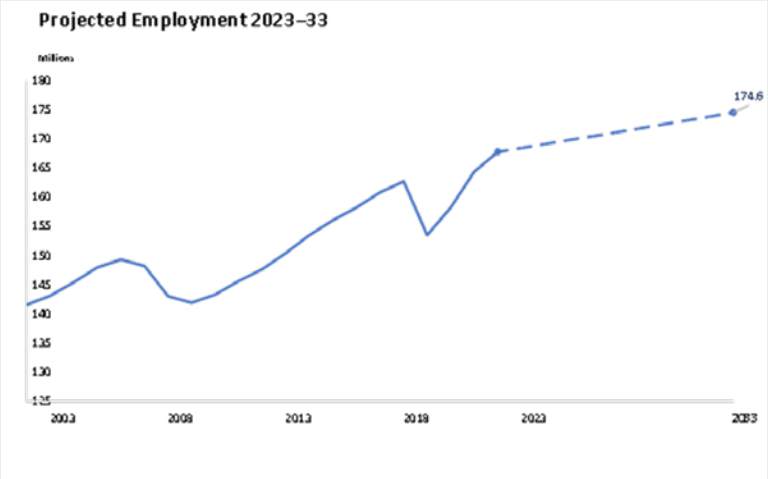
Why - Logistics Automation?

Key Influential Macro Factors

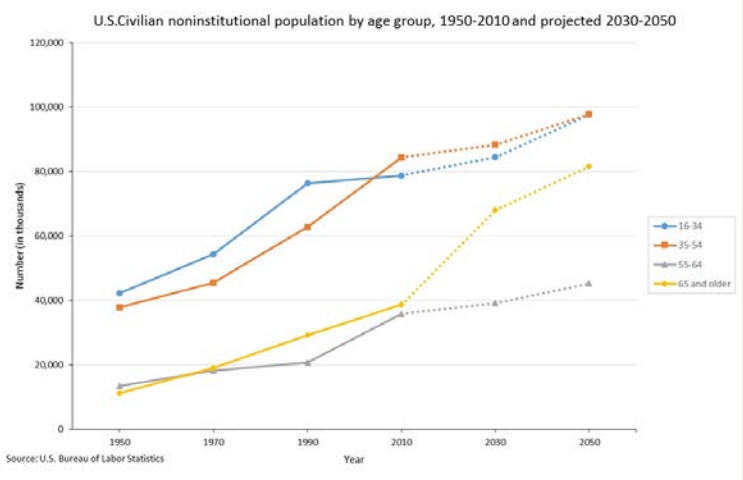
Perfect Storm Leading to Labor Shortage



Birth Rate Decline (CBC)



Employment Growth (BLS)

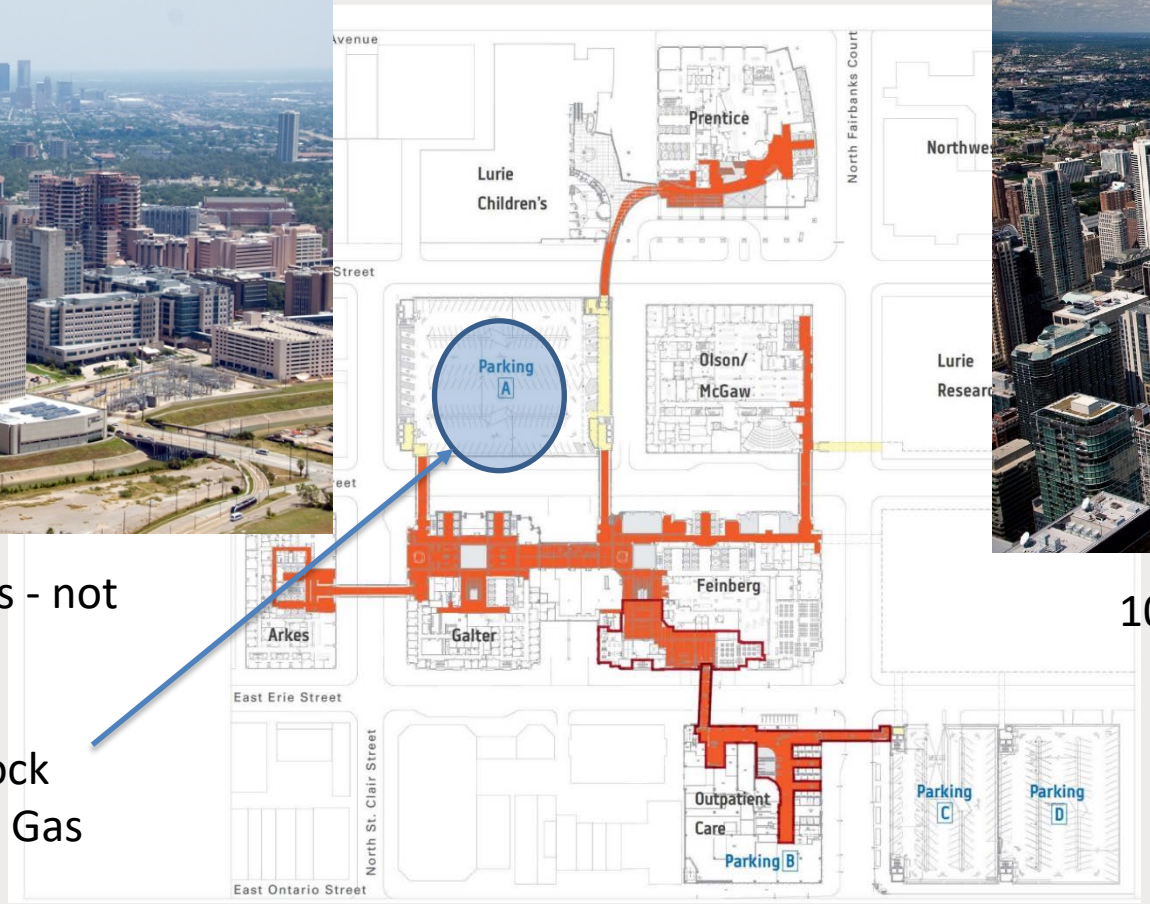


Aging Workforce (CDC)

4.5MM fewer US babies born in the second decade, combined with **6.7MM job growth** over the next decade and Employment of **workers aged 65 or older has grown by 117%** within past 20 years will inevitably lead **to sever labor shortages**

Campus Expansion, Distances and Connectivity

50 million SF in a campus - not connected



Central Loading Dock (13 bays) and Med Gas Tank Farm.

10 million SF - connected

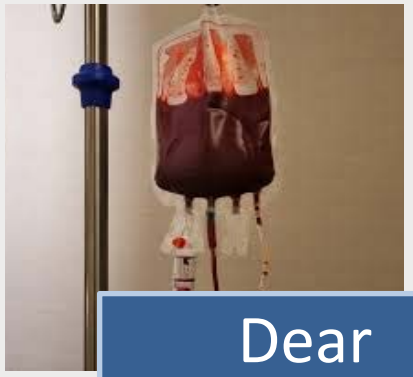
1000 carts per day traveling appox. 250 miles

6

Peter Gilgan Mississauga Hospital – Ontario, Canada

2.8MM SQFT 950 Beds - Designed by Stantec

5Ds of Automation Qualifiers



Dear

Dirty

Dull

Difficult

Dangerous

What - Various “Healthcare Ready” Automation Alternatives

Logistics Automation Solutions in Healthcare

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Vehicle Systems

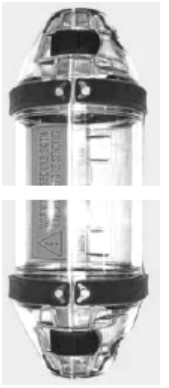
AGVS

ATVs
Autonomous Transfer Vehicles

AMR- Service Robots

Tube Systems

PCS



PTS

AGVS And ATVs

- Transport heavy payloads/carts 1,000- 1300 lbs
- Speeds up to 200 feet per minute
- Interfaces with elevators & doors
- Recharges intermittently as needed
- Operational 24/7

Transports:

- Linen
- Food trays
- Central supplies
- Bulk Food
- Pharmacy
- OR supplies (Case Carts)
- General waste
- Medical waste
- Recyclable Waste







Service Robot (AMR)

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Suitable for Existing Facilities

- Includes autonomous delivery vehicles (similar to AGVs) and service robots
- Service Robots suitable for Meds, small patient equipment, and Lab specimen
- Some AMRs are **capable of self-learning modules (AI)** that enables them to improve productivity and reduce interruptions once in operation
- **Appropriate for Retrofitting in existing facilities**

Biometric Authentication Capability Makes The AMR Technology Ideal For Transfer Of **Meds, Specimen and Blood.**

Biometric Authentication

Speed - 150-200 feet per Minute
Payloads – 1000-1400 lbs

Logistics Automation- Healthcare Readiness

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Travel paths shared by:

- Clinicians
- Patients/Families
- Service Staff
- Other Equipment

Patient Experience:

- Alerts
- Speed and Safety
- Noise levels

Evolution of Logistics Automation & Healthcare Readiness

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First Generation AGVs and Monorail systems

1970

< 10 Installations
2-4 Vendors

Second Generation AGVs

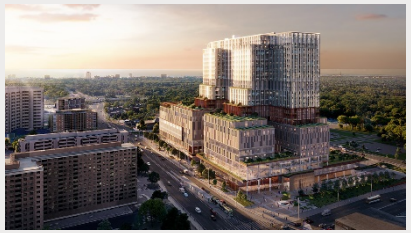
1985

15- 25 Installations
3-5 Vendors

Fully Monitored AGVs

2000

30- 40 Installations
5-8 Vendors



New Generation ATVs/AMRs

2020

Over 100 Installations
20+ Vendors

Guided Systems (Legacy)

Autonomous Systems

Autonomous Transfer Robot (ATR) **Vs** Automated Guided Vehicles(AGV)

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	Autonomous Transfer Vehicles (ATVs)	Automated Guided Vehicles (AGV)
Navigation	Autonomous / **Artificial Intelligence**	Line-guided navigation
Safety	**Navigates around obstacles**	Stops for obstacles
Installation	Fast and easy	Requires Infrastructure Changes
Flexibility/ Reprogramming	**Fast and easy to change/scale**	Difficult to change/scale
Reliability	**More Reliable**	Reliable
Speed of Delivery	Faster	Slower
Interface Capability with other systems	Readiness to communicate with **many Hospital Systems**	Limited (Doors, Elevators)
Investment/Space	Higher acquisition costs; Reduced space needs	Acquisition costs low; plus construction/infrastructure costs

Powered/Pneumatic Chute/Collection Systems (PCS)

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- Automated Soiled Materials Transfer & Collection
- **Fosters separation of soiled and clean and reduced elevator use**
- **Helps reduce Hospital Acquired Infections (HAIs)**
- **Lower floor space requirements on most patient areas**
- Typically uses double doors for better safety
- Typically uses 16” or 20” shaft

Appropriate for transfer of **soiled linen, regulated waste and recyclables.**

Pneumatic Tube Systems (PTS)

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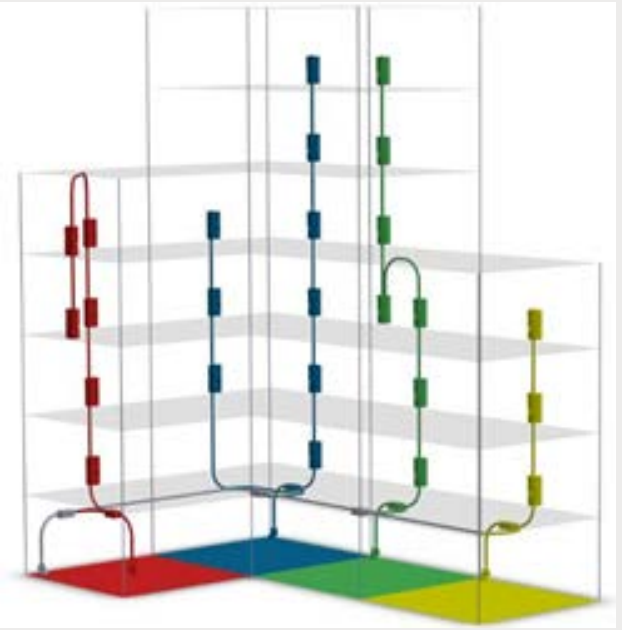
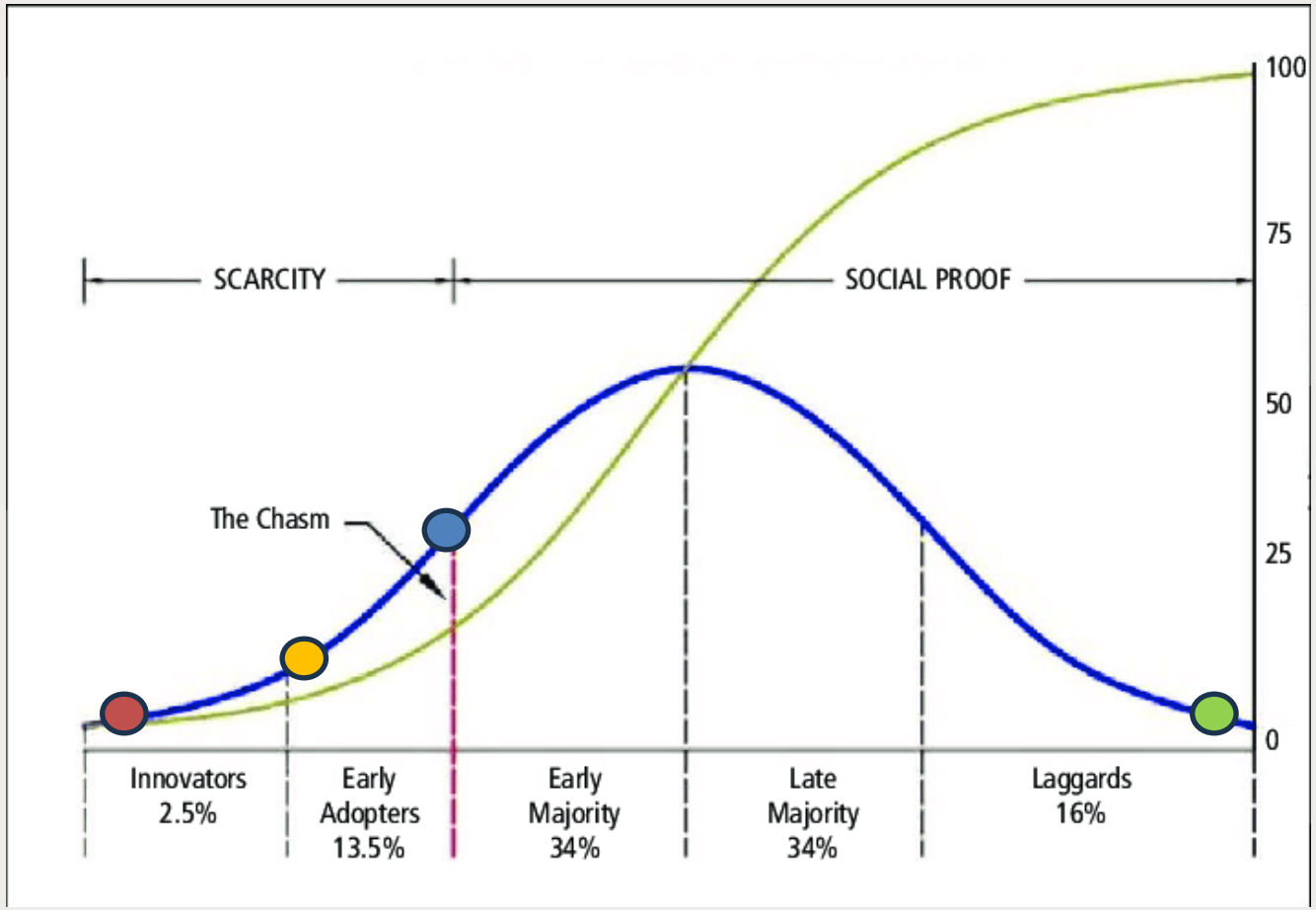
PT Systems

- Promotes patient safety and privacy
- Protects sensitive medical materials with fast and reliable delivery
- An expandable, long-life system
- **25 fps High Speed Transport**
- **Payloads up to 15 lbs**
- Transports lab specimens, medications, sensitive items, IVs, patient records



Pneumatic Tube System (PTS) is the most commonly used logistics automation system in Healthcare facilities.

Law of Diffusion of Innovation – Logistics Automation



- Humanoid Robots
- ACS
- AGV/AMR
- PTS

Logistics Automation by Numbers

PTS

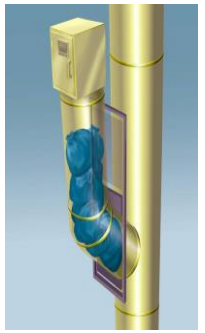
Pneumatic tube system

2024	**>90%**
2030	**>90%**

AGV/ATR

Automated guided vehicles/ Autonomous mobile robots

2024	**<2%**
2030	**>40%**



PCS

Powered chute system

2024	**<0.5%**
2030	**>5%**

Some form of **Logistics Automation** should be a consideration in almost all facilities planning projects.

How -Artificial Intelligence Impact and Business Case Process

AI Influence on Automation - Benefits & Challenges

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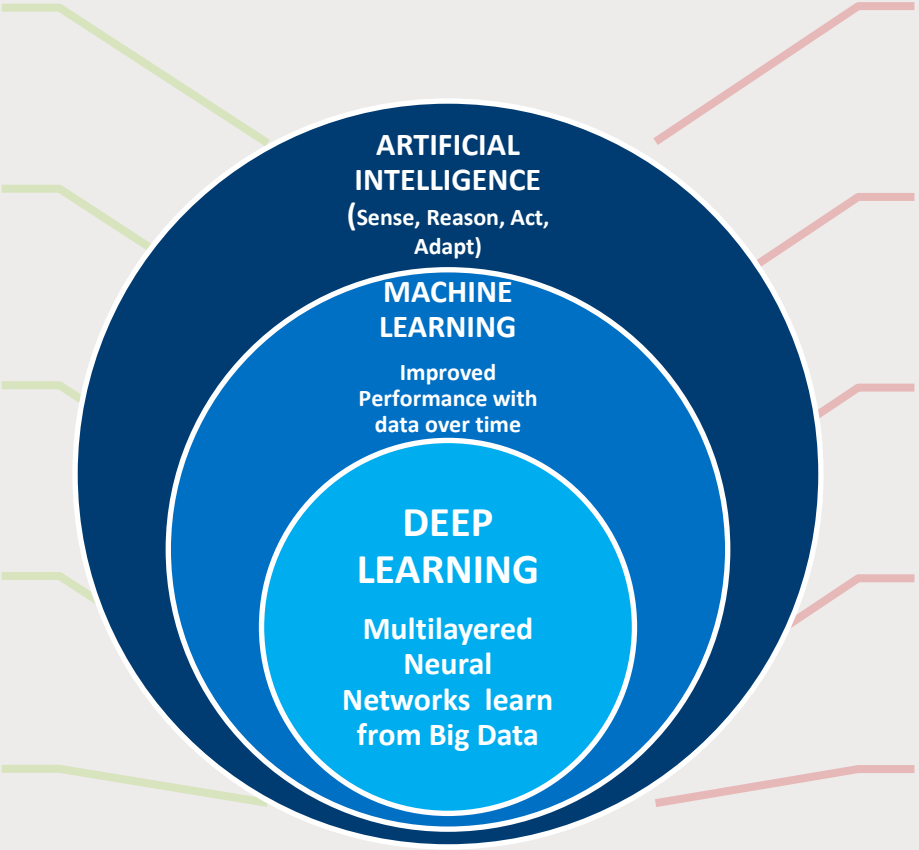
Benefits

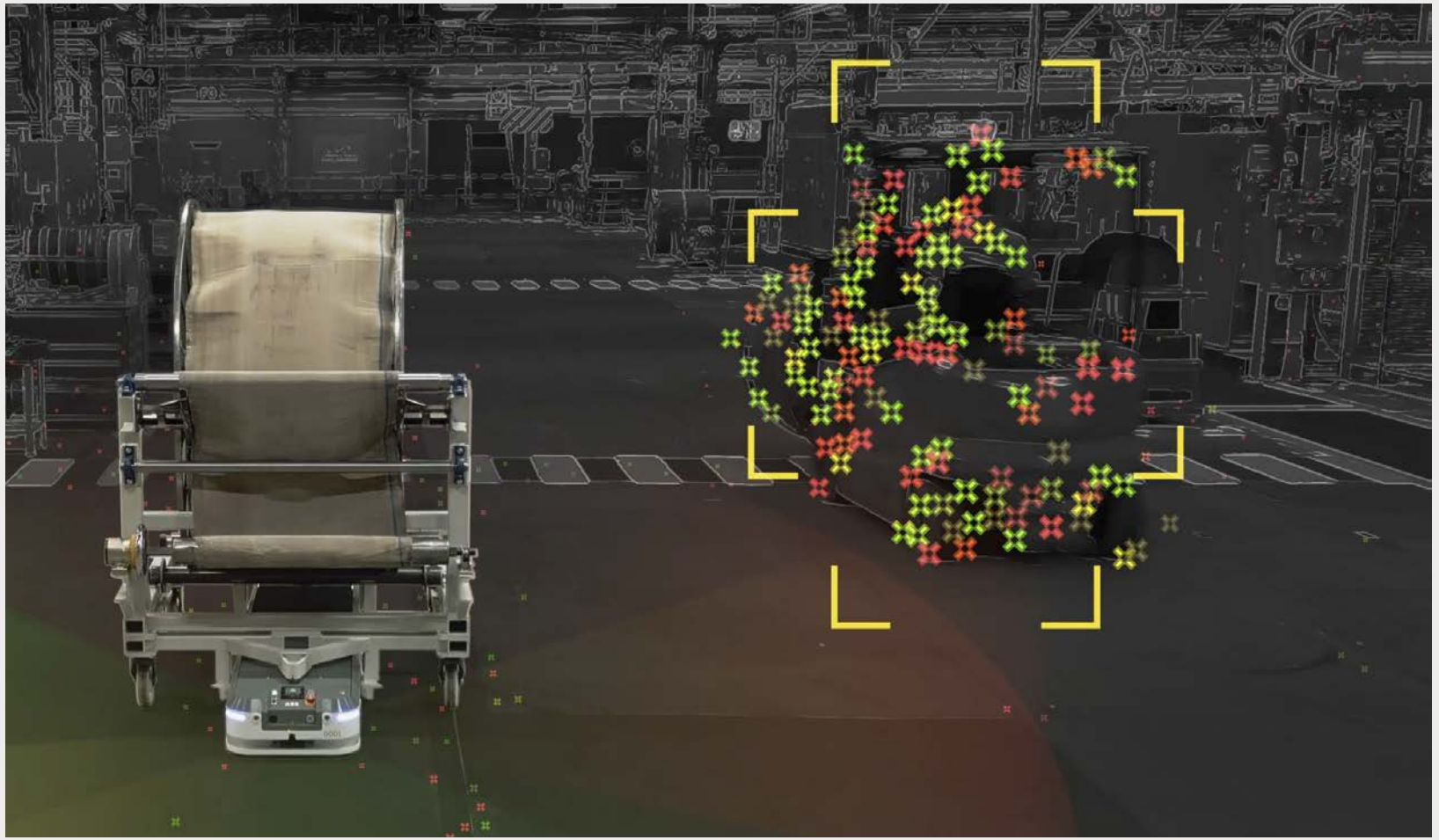
- **Automation of repetitive tasks**
- Optimization of processes through data analysis
- Ability to process data from multiple systems
- **Predicting outcomes using predictive analytics with complex data**
- Enhancing decision-making efficiency.



Challenges

- **Bias created by incomplete data**
- Computing power
- **Integration with multiple systems**
- Lack of explainability/ rationale
- Transparency and expectation management

Navigation using Visual Simultaneous Localization and Mapping (SLAM)



The system uses AI to differentiate between features that are **likely to stay in place and those that could move**.

Visual SLAM Functioning

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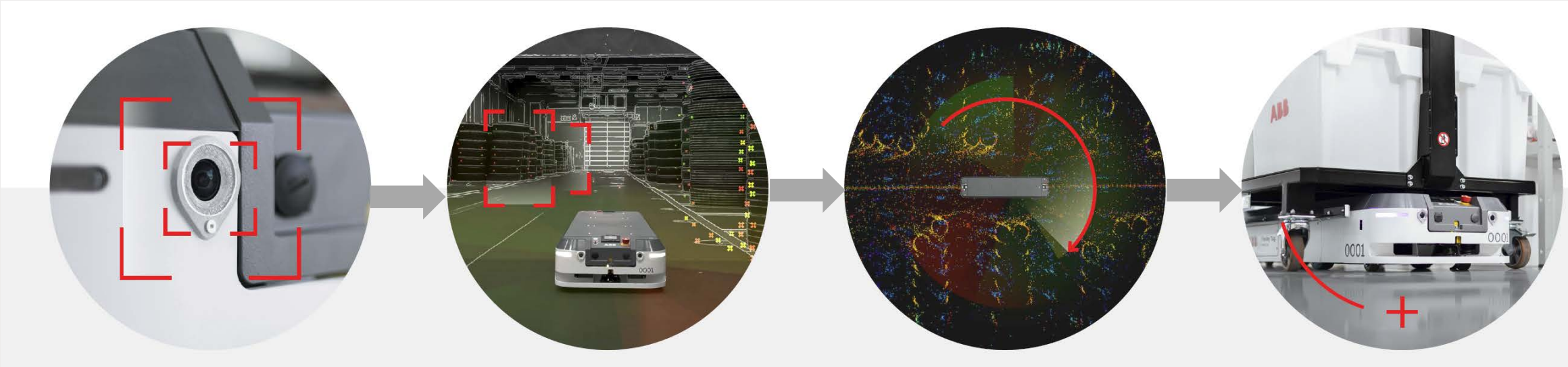

PERCEIVE THE WORLD ACCURATELY

AMRs with VSLAM are able to see the real world accurately in real time.

RECOGNIZE THE ENVIRONMENT

Differentiates between immovable objects **floors, ceilings and walls**, movable objects like **people or vehicles.**

BUILD A 3D MAP

AMRs are equipped with 3D mapping capabilities and data from other systems **elevators, doors, and other cameras.**

OPTIMIZE OPERATIONS

AMRs operate at full efficiency to optimize overall operations.

Central Command and Intelligent Hospital Systems

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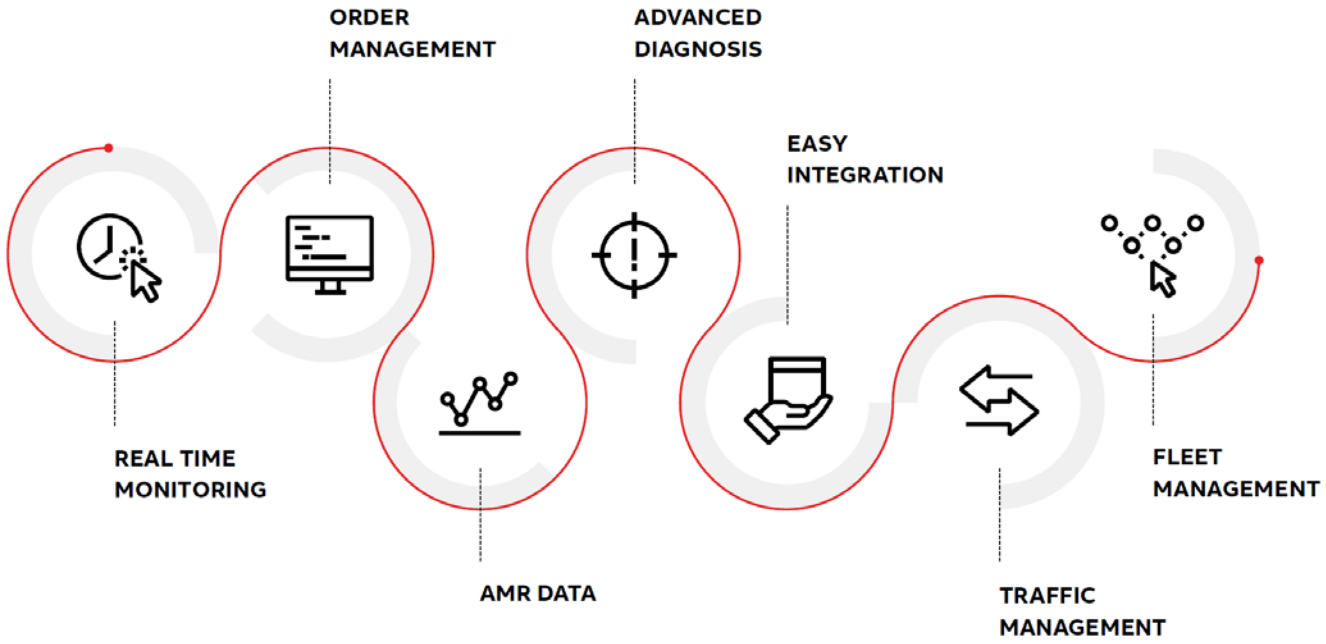
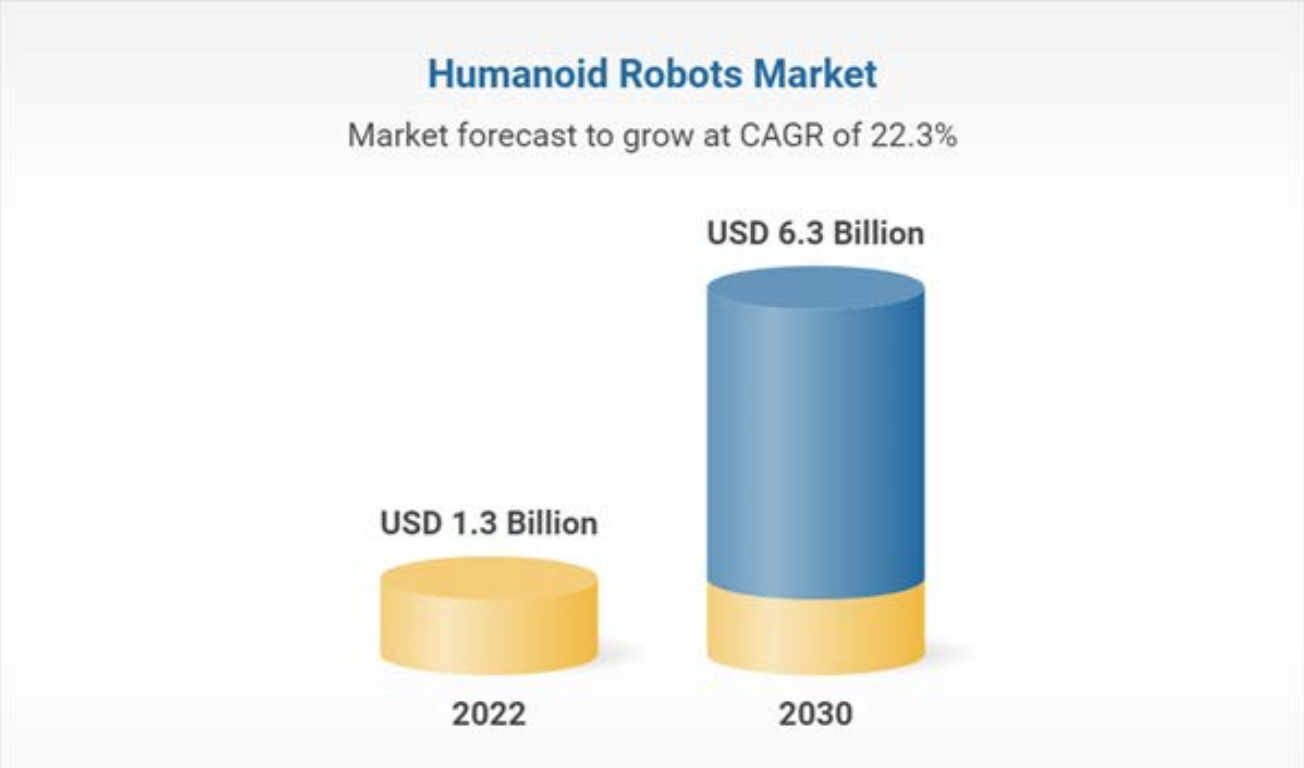
Intelligent order assignment Traffic management algorithms are exceptionally powerful, ensuring that **orders are always distributed with maximum efficiency** and the **best possible routes.**



Customer-centric interface: Its intuitive navigation empowers user levels to manage the fleet, allowing them to be fully autonomous in their daily operations.

Full data traceability: Thanks to AMR's real-time visualization and monitoring of data, it is possible to have full control of what is happening on each work area.

Humanoid Robots & Healthcare Applications



Healthcare service support applications

- Decontamination
- Simple human tasks that are dangerous
- Areas difficult for AMRs to access

Key Factors in Business Case Development

- Conveyance options by material type
- Movement summary
- Impact on elevators & corridor widths (BGSF)
- Processes and flows
- System configuration modeling
- Planning factors and assumptions
- Qualitative factors for consideration

Initial feasibility analysis determines if Business Case is warranted.

Business case should always be developed by **an unbiased Automation Consultant, not a Vendor.**

Impact of Logistics Planning on Automation

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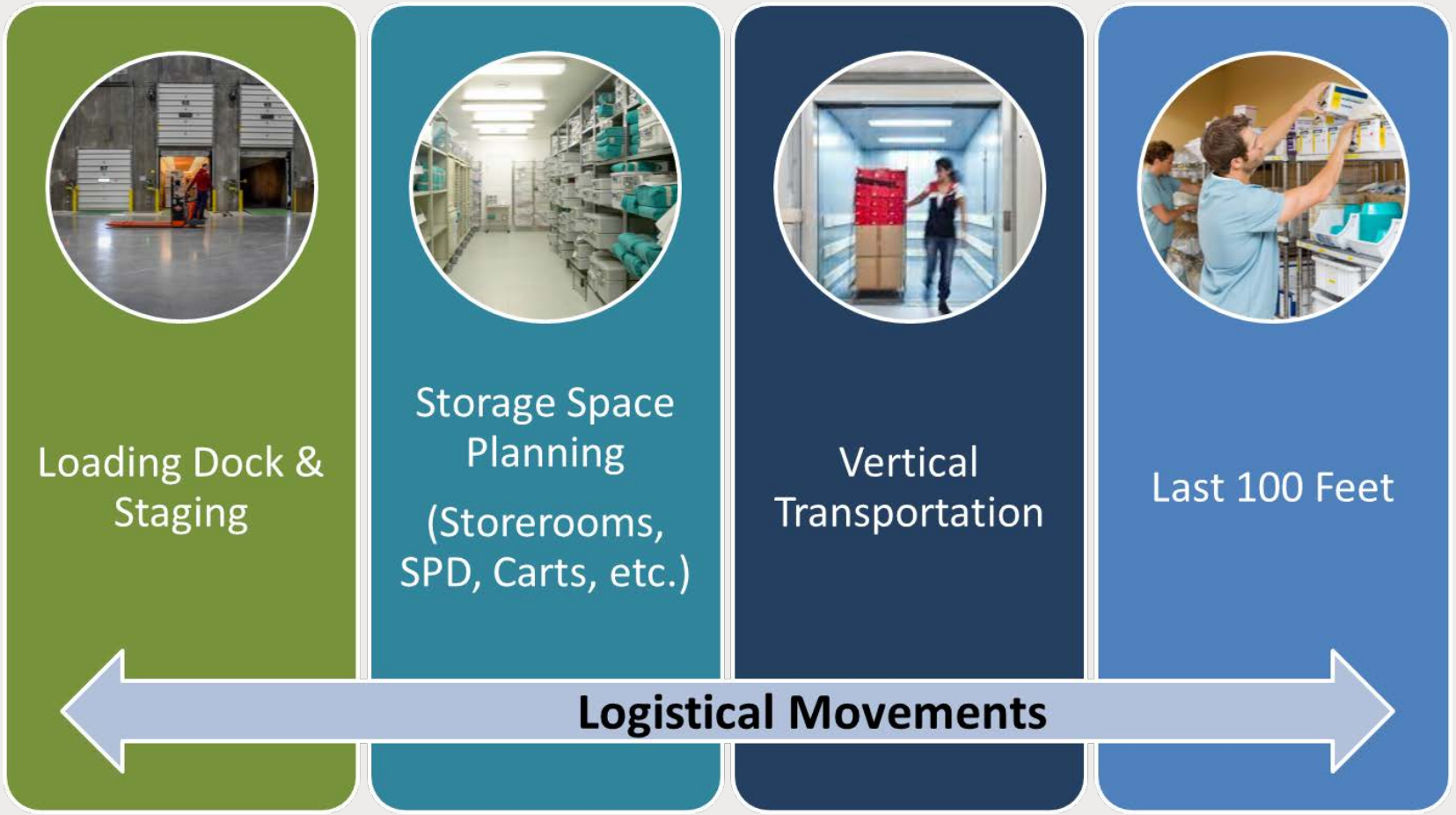
Overall logistics planning has direct impact on **the logistics cost over Life of the New Facility**



Business Case Inputs & Outputs

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INPUTS

- **Programming data**
- **Volumes**
- **Assumptions**
- **Capital costs**
  - Equipment
  - Elevator
  - IT
  - Building
- **Ongoing costs**
  - Labor
  - Utilities
  - Maintenance
  - Cost of money
  - Replacements

OUTPUTS

- **System Configuration**
- **Space configuration**
- **Payback**
  - Breakeven
  - Financial Outlook
  - Variations

Materials and Conveyance Systems

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Category	Material Type	Manual	AGVS	AMR	PCS	PTS
Supplies	Med/Surg -JIT	X	X			
	Med/Surg – Routine Orders	X	X	X		
	Med/Surg – STATS	X		X		X
Reusables	IPU (Impatient Unit)	X		X		
	Surgical Case Carts	X	X	X		X
	Crash/Specialty Carts	X	X			
	Reusable Medical Equipment	X		X		
	Rental Equipment	X		X		
Linen	Linen - Clean	X	X			
	Linen - Soiled	X	X		X	
Food Service	Patient Meals	X	X			
	Patient Supplements	X	X			

Category	Material Type	Manual	AGVS	AMR	PCS	PTS
Waste	Non-Infectious waste	X	X		X	
	Mixed recycling	X	X		X	
	Medical infectious waste	X	X			
	Hazardous waste	X	X			
	Cardboard	X	X			
	Other recycling	X	X			
	Organics	X	X			
Pharmacy	24 Hour patient meds	X	X			
	Routine ADC replenishment	X	X			
	STAT/ First dose	X		X		X
Lab	Specimens	X		X		X
	Blood & lood products	X		X		X

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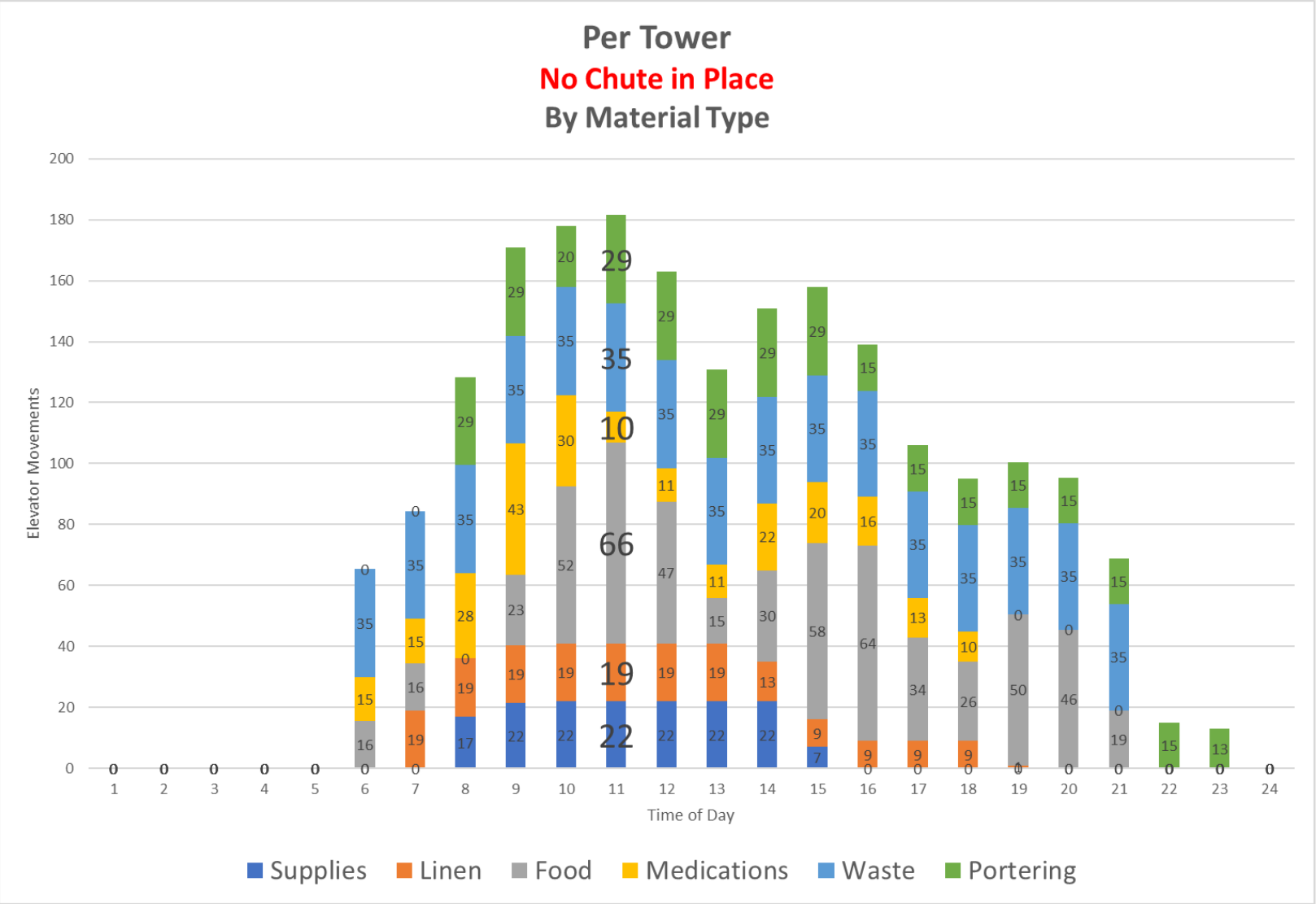
Movement Summary Example



Peak Hour determines Number of System Resources

Project Management Advisors, Inc.

Discrete Event Monte Carlo Simulation Modeling

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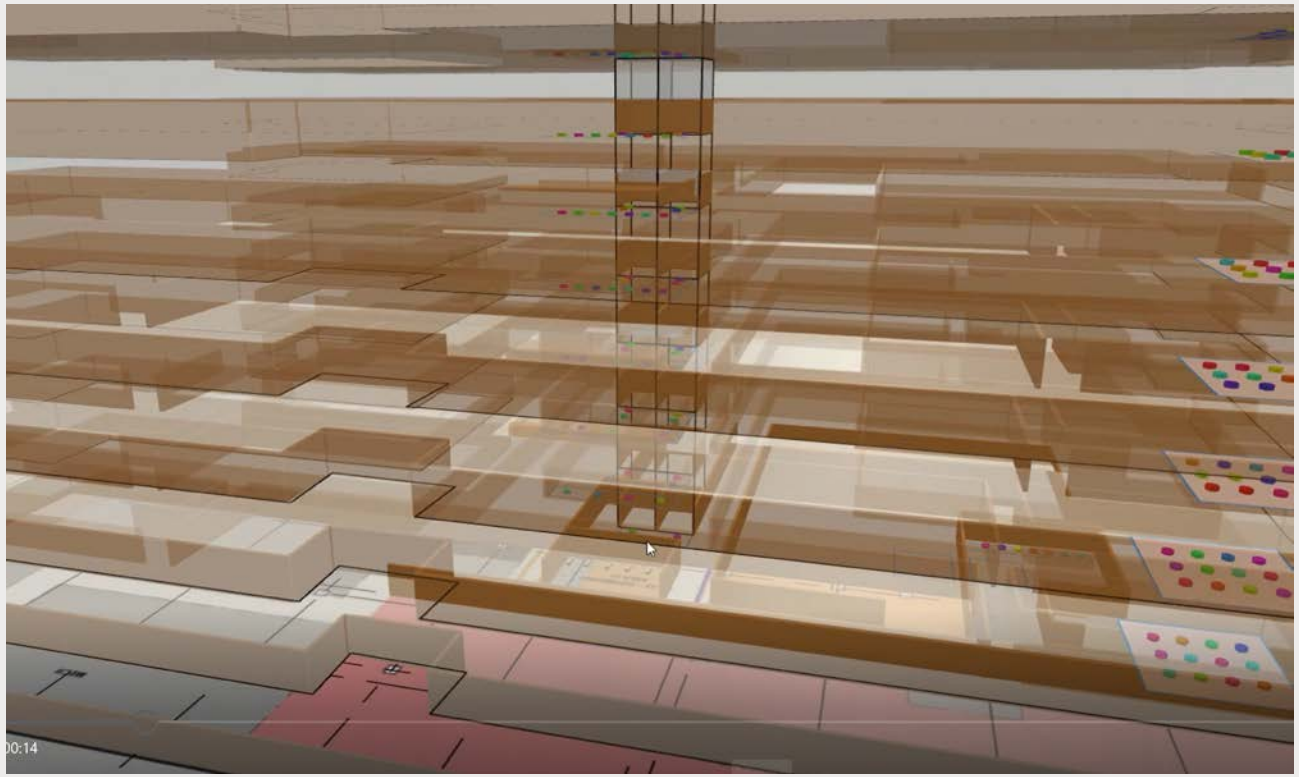
To evaluate system configuration

- Number Of Vehicles (AGV/AMR)
- **Impact of Corridor Width**
- **Impact of Elevator Configuration***
- **Staging Spaces**
- **P&D And Waiting Spots**
- Scheduling Impact
- Charging & Maintenance
- Delivery Locations
  - Elevator Lobby
  - Patient Care Areas



***Elevators are one of the most constrained and critical resource** in planning of a Healthcare facility.

Pre-planning & Building Consensus for Technology Adaptation

Planning, Design and Construction – Project Arc

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DD 250+ drawings

Construction 20,000 Shop Drawings

5 to 8 Years

Space and Adjacency

Look, Block and Stack

SD 85 drawings

Design and Define

Scope, Budget and Schedule Aligned?

CD 2000+ Drawings

Build and Activate

Celebrate and Operate

Best time to consider Logistics Automation – **Sooner the Better**

Planning for Automation Technology

- Baseline- Standard Automated Technology (often included)
  - Pneumatic Tubes
  - Laboratory / Pharmacy Equipment
  - Elevators
  - Electronic infrastructure

- **Functional Programming** addresses the ‘standard’ space required for the future operations, and **does not provide space for ‘innovative practices**

Start early preferably before Functional Programming

- Pre-planning Considerations:
  - Logistics demand for multiple programs
  - Resulting space impacts on both the programming as well as the building spaces
  - Impact on the overall Building Gross Spacing Factor (BGSF) – For ex. extra elevators, staging spaces
  - Architectural and Engineering Specifications for early costing
  - Consideration for existing facilities

Administrative Perspective

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Ministry of Health

- P3 Operating Models
  - Design-Build-Finance-Maintain (DBFM)/DBFOM)
  - Progressive
- Communications
- Budgeting- Funding formulas
  - Capital funding up to 90% of the construction and up to 100% for Planning shared with MOH
- Challenges
- Approval

Hospital Administration

- Overarching Goals
- Administrative buy-in
- Assigning internal stake holders and project team for automation evaluation
- Communications with other hospitals
- Budgeting
  - Equipment is funded 100% by the Owner
  - Contingency planning

Proactiveness and intentionality on Hospital Administrative end is a key to success

Staff and Operational Team Buy-in and Participation

Teams and Participation

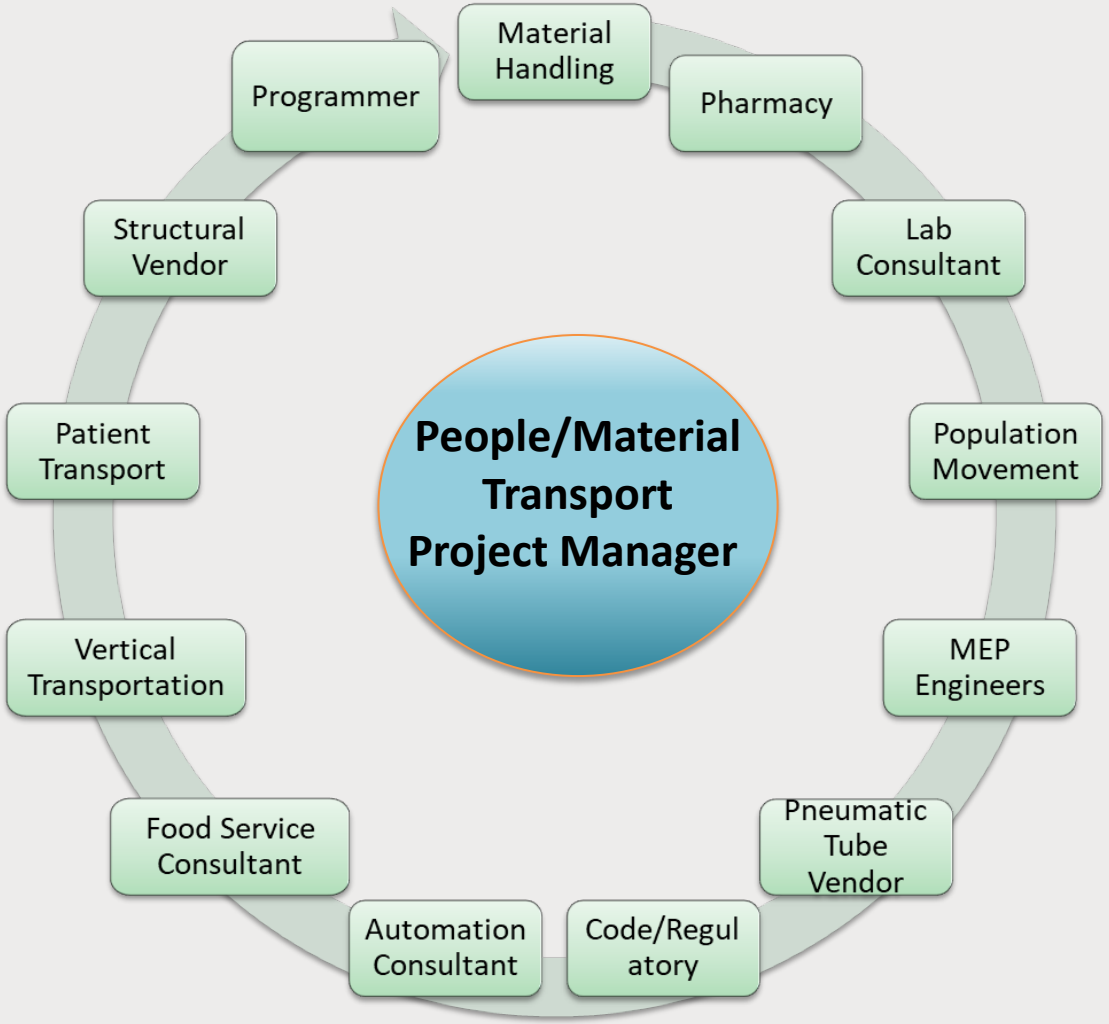
- Current Processes
- Current Volumes
- Current staffing
- Future Processes to include automation
- Future volumes
- Buy-in and participation
- Education
- Tours of facilities using automation

Internal Buy-in, participation and education is a key to creating environment to adapt new technologies

Without automation FTEs required in future state is **well beyond the current FTE count**

Co-ordination with Planning and Design Project Team

Early engagement & internal team participation are critical for project success



Multi-disciplinary Integrated Project Team

Identifying an SME to assist with feasibility, business case and education

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The Do's

- ✓ Assigning a project manager/Liasson
- ✓ Clearly defined objectives, scope and deliverables
- ✓ RFI and RFP process to identify an automation SME
- ✓ Operational team awareness & participation
- ✓ Availability of current data and process details
- ✓ Vetting process to ensure SME firm is equipped with most recent technology knowledge
  - ✓ Technical knowledge
  - ✓ Healthcare domain knowledge
  - ✓ Experience

Assigning a Liasson as a conduit between hospital team and SME is a key to a successful evaluation & transition

The Don'ts

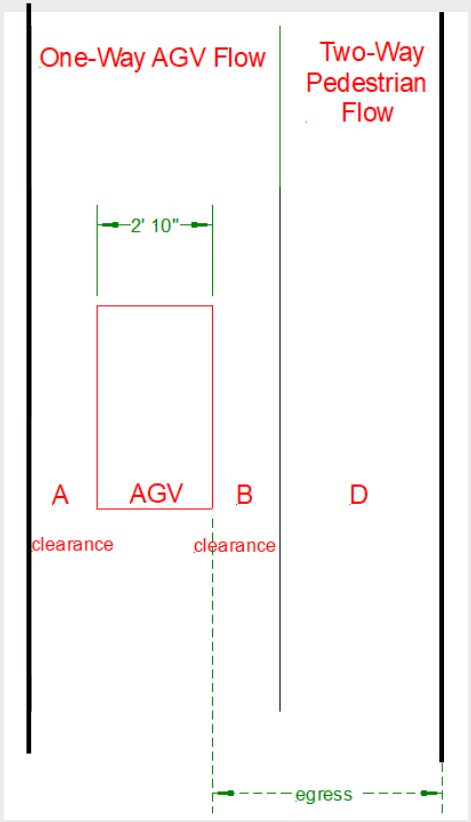
- x Technology vendor not recommended
- x Elevator consultant not best suited to evaluate conveyance systems
- x Consultant familiar with only legacy system such as AGVs not recommended
- x Operations team non-participation
- x Rigidity in adapting new processes needed to adapt technology both by operators and clinical staff
- x Waiting too far into planning process

Regulations and Planning Challenges

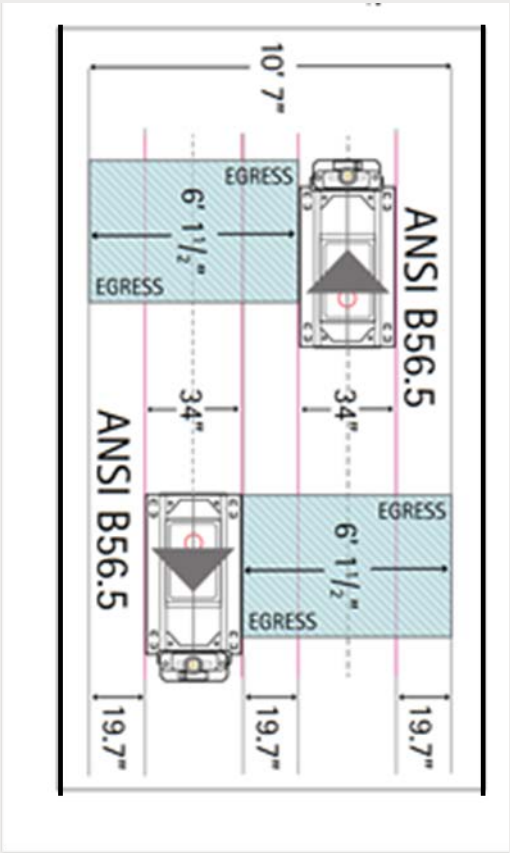
Codes and Regulations – Current State

PTS	AGV/ATV/AMRs	PCS
NFPA® 654 Standard For Pneumatic Conveying Systems	**ANSI/A3 R15.08-2-2023** -for IMRs (Industrial) **ANSI B56.5/RIA 15.8** **HCAI- PIN 69.09-03-2020** State of California AGV Guidelines	**NFPA® 82** Standard on incinerators and Waste and Linen Handling Systems and Equipment

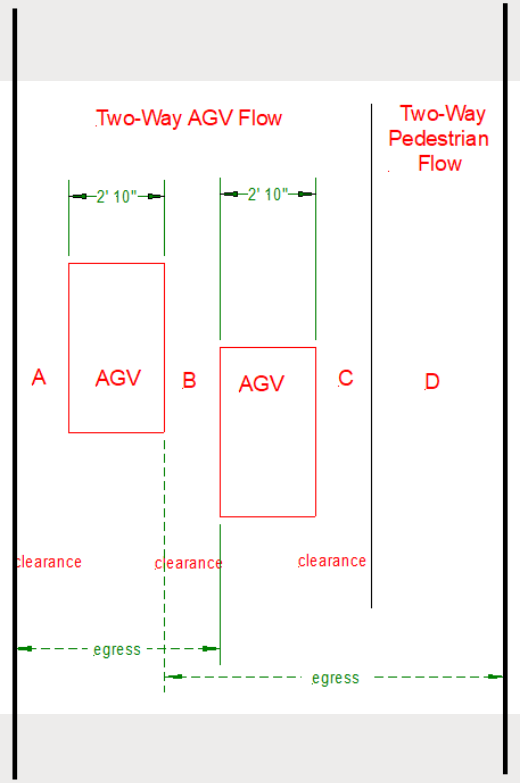
Service Corridor Widths



8' Patient Floor Corridor



10'7" Service Corridor



12' Service Corridor

- Layout (one way/Two way)
- Volumes
- Schedules

Industry Guidelines –American National Standards (ANSI) and their guideline B56.5 - Safety Standard for Driverless vehicles

Safety Concerns – about the mingling of pedestrian (staff and patient) traffic with an AGV/AMR

Emergent Event Concerns – such as a fire or other emergency where traffic patterns are altered temporarily

Service Floor–Volumes and Flows

The issues are:

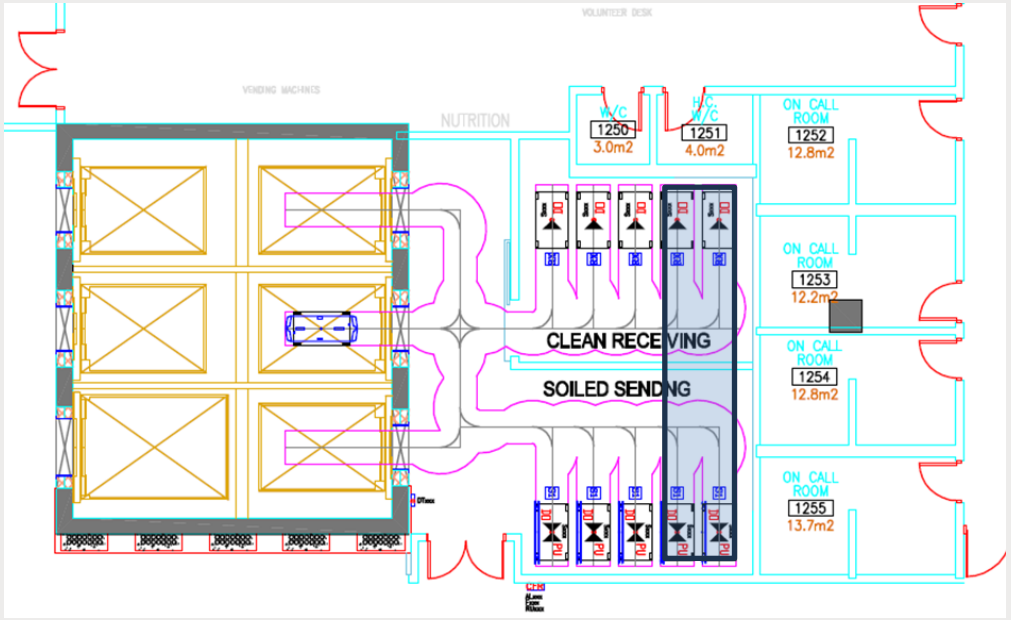
- **Corridor width**
- **Separation of Clean and Soiled**
- **1-way versus 2-way flows**
- **Pathways**

- Circles are preliminary number of carts (based upon **1,500 per day to illustrate order of magnitude**)
  - Clean flows (including patient meal collection) **(784).**
  - Soiled linen and all waste **(706).**
  - Green are the source/destinations.

Last 100 feet - Corridor Widths

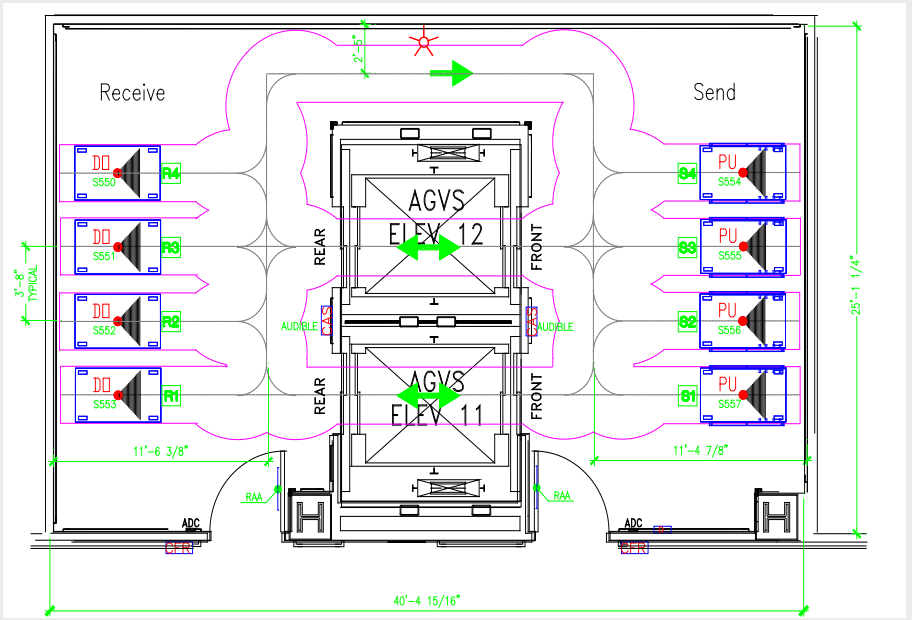
8- foot corridors on patient floors may be sufficient depending on projected volume at any given hour. In this example, **maximum of 2 vehicles during any 15 min interval**

Elevator waiting lobby configurations



Single Side Access

Ideal/Preferred



Pass Through Access – **Saves up to 40 seconds per trip**

How - A Case Business Study

South Niagara Hospital – Ontario, Canada

1.2MM SQFT, 469 Beds - Designed by Stantec

Key Objectives

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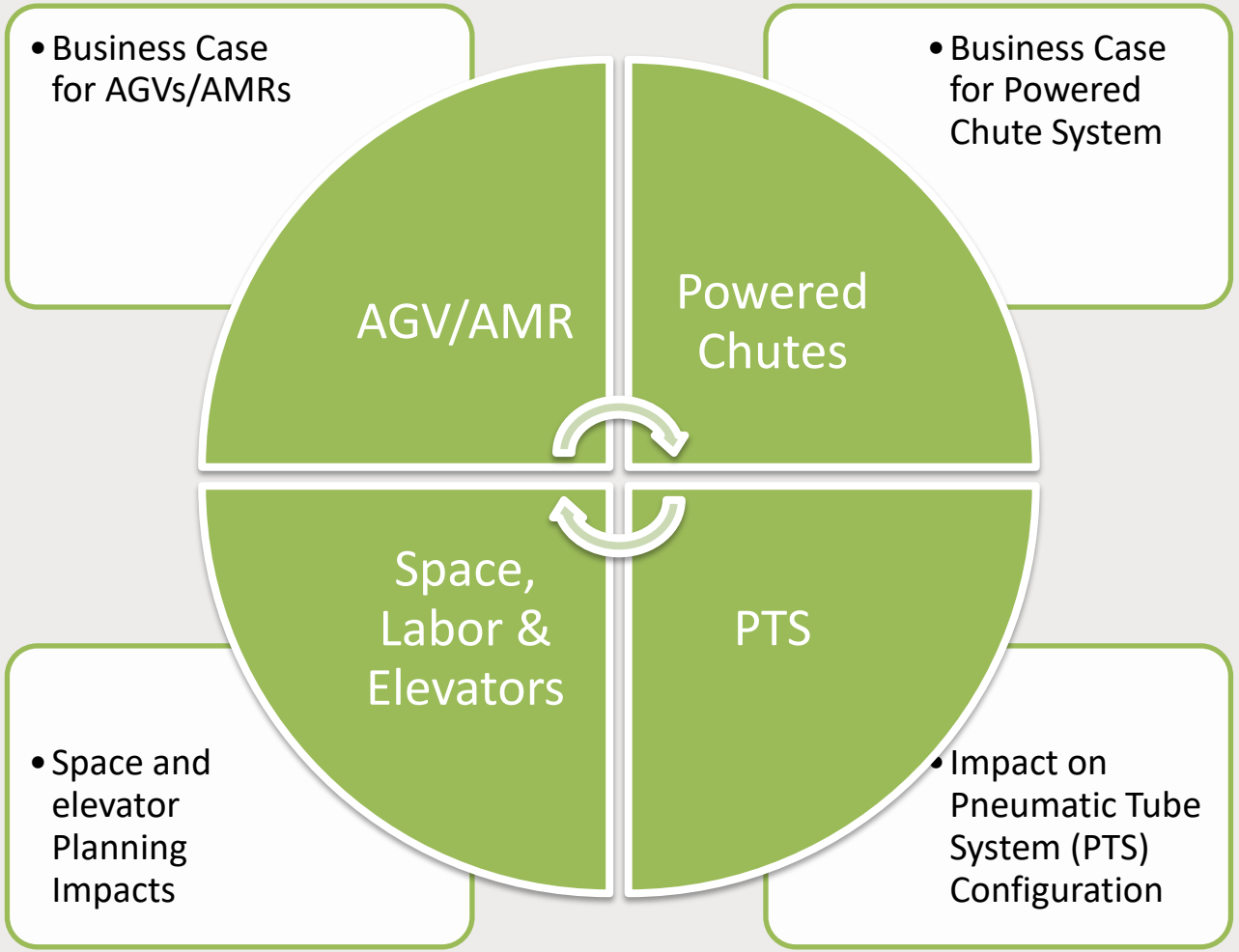
AGV/AMRs

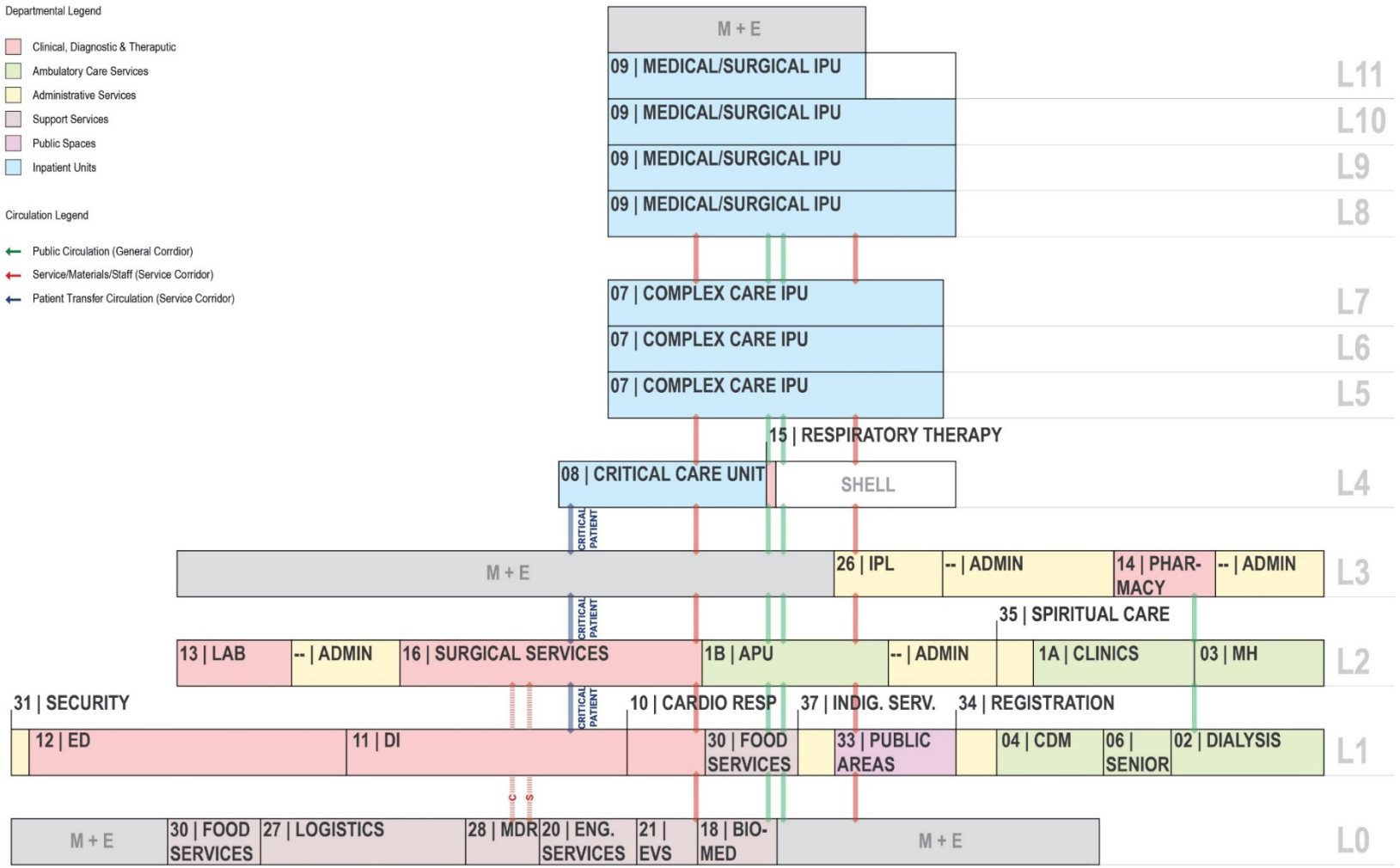
- Impact on Elevator counts
- Dedicated elevator or shared with other service elevators
- Size of the AGV lobby
- Size of corridors
- Service level planning
- Implementing now or planning for future



Powered Chutes

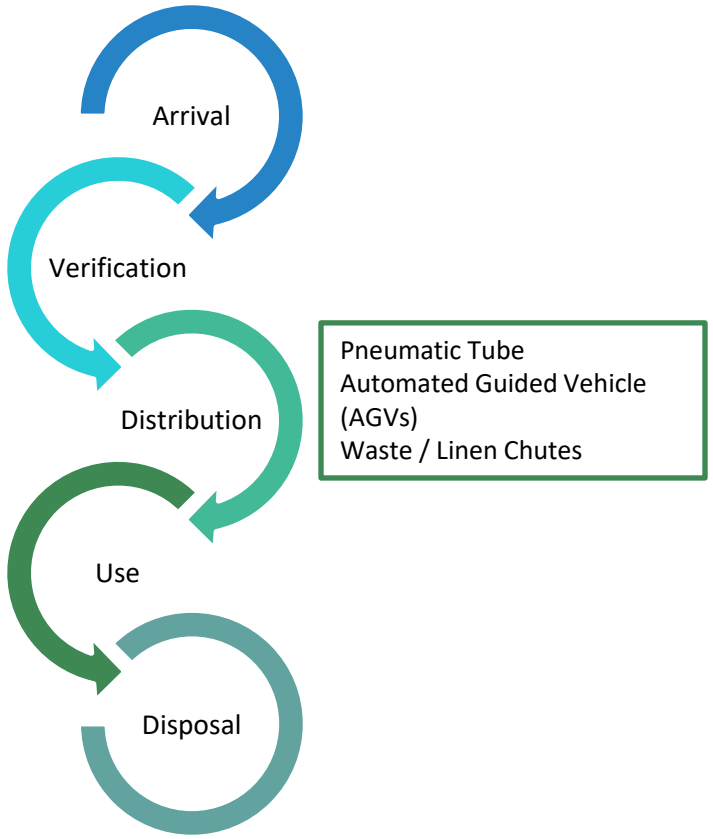
- Impact on Elevator counts
- Fire rating
- Stacking and location of Chutes
- Service level planning
- Acoustical issues

Stacking Diagram

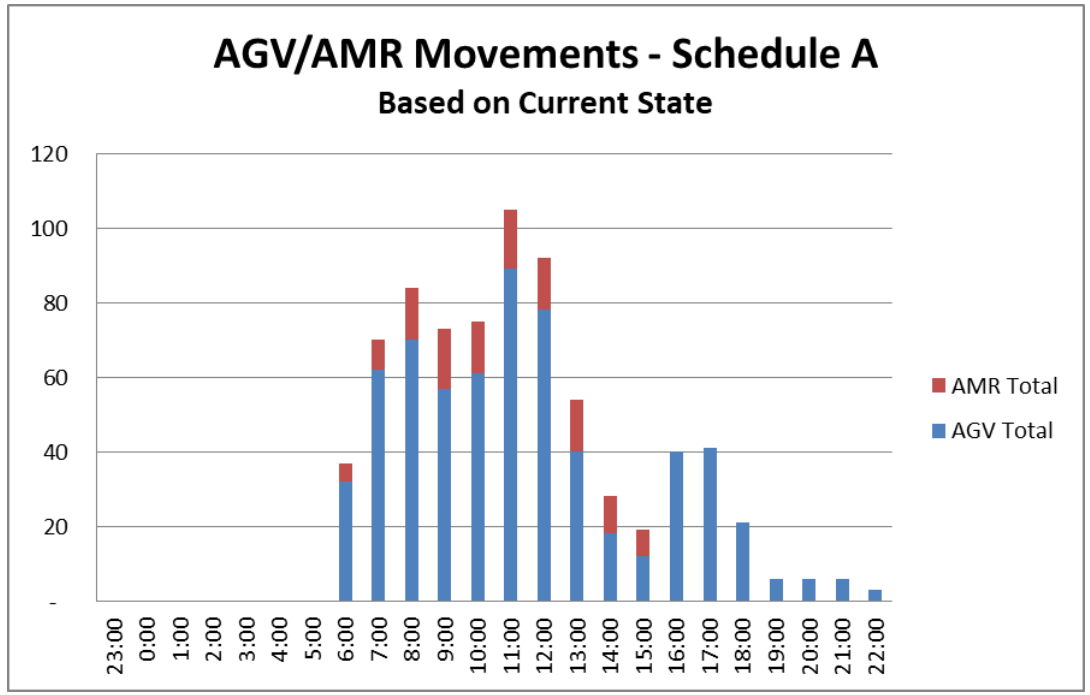


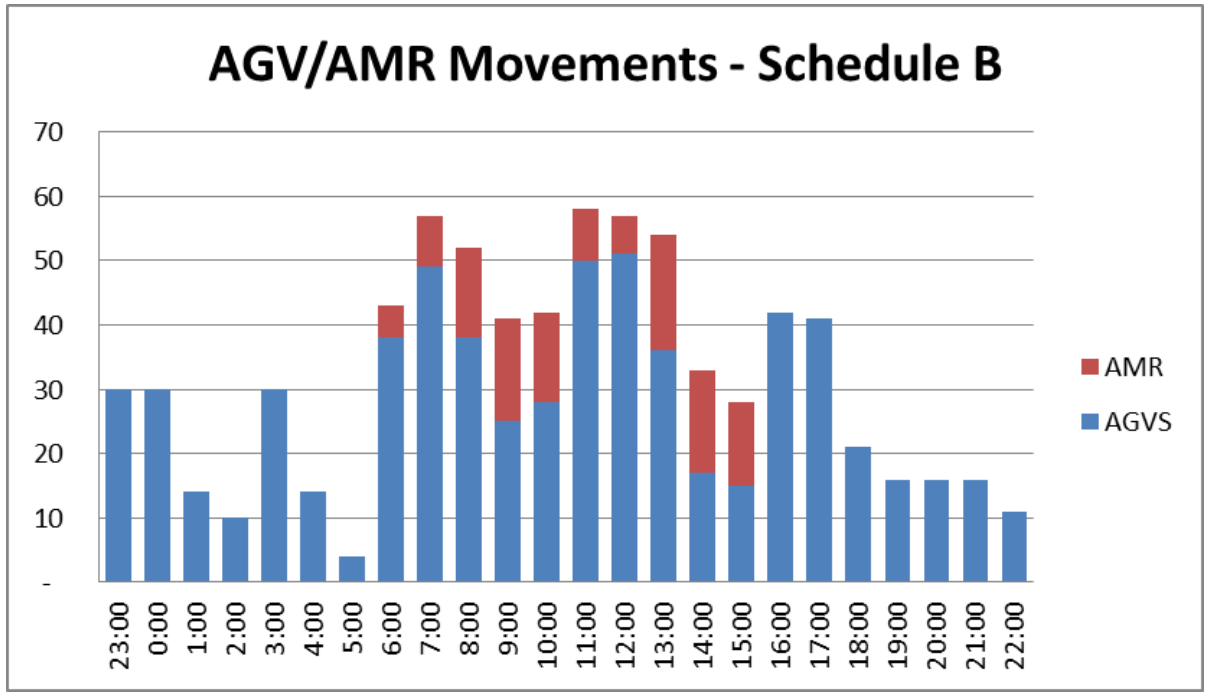
Flow of Supplies – Clean & Soiled Flows

- Linen
- Consumable Supplies
  - Just In Time
  - Direct Orders
  - Medical Gases
  - Dialysis Supplies
  - Courier / Mail
- Hazardous Supplies
- Lab / Pharmaceutical Supplies (refrigerated)
- Waste:
  - Garbage
  - Recycling – cardboard
  - Recycling – other (plastics, organics)
  - Biohazardous waste
- Pandemic / Disaster Supplies
- Staff Uniforms



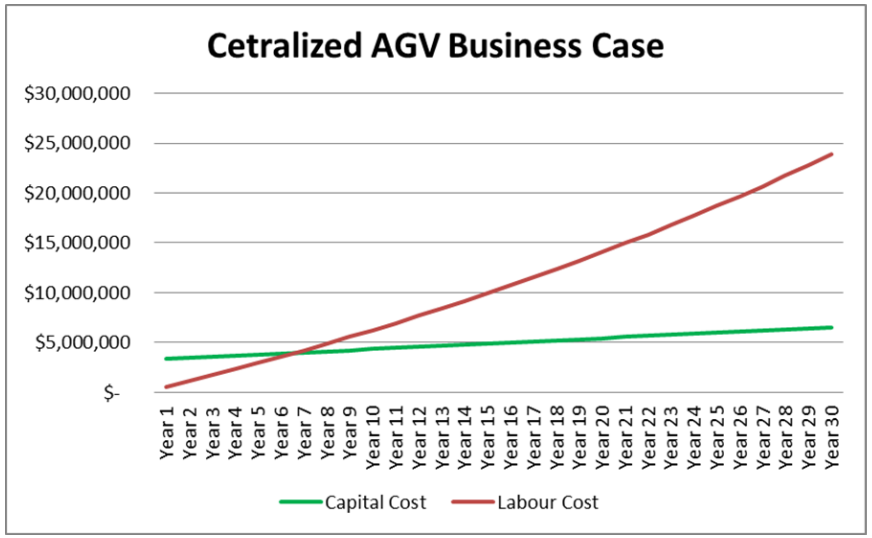
Movement Summary Example



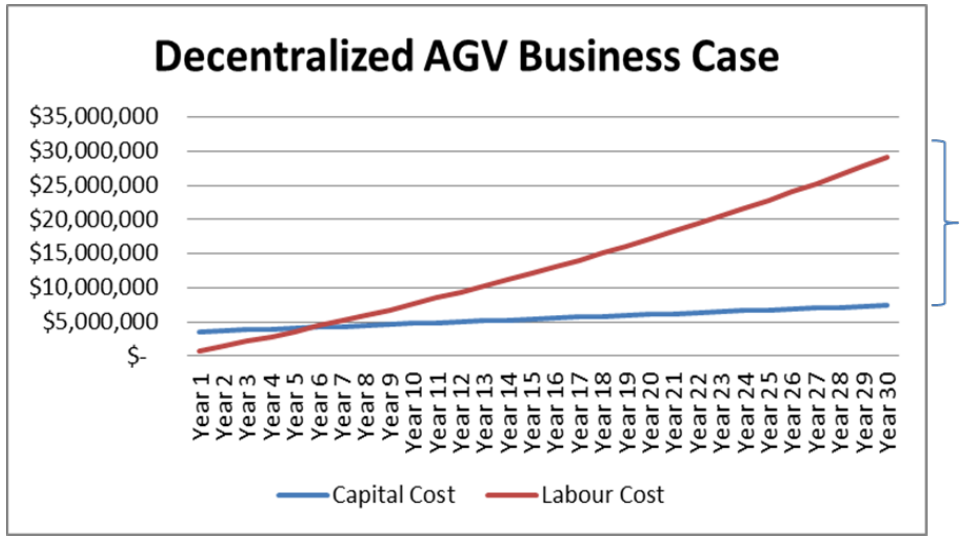


By moving the JIT and linen deliveries to the 3rd shift Peak hour was **reduced from 110 carts** (Schedule A) **to 55 carts** (Schedule B)

Business Case Summary



$17.4MM



$21.7MM

Summary of Scenarios

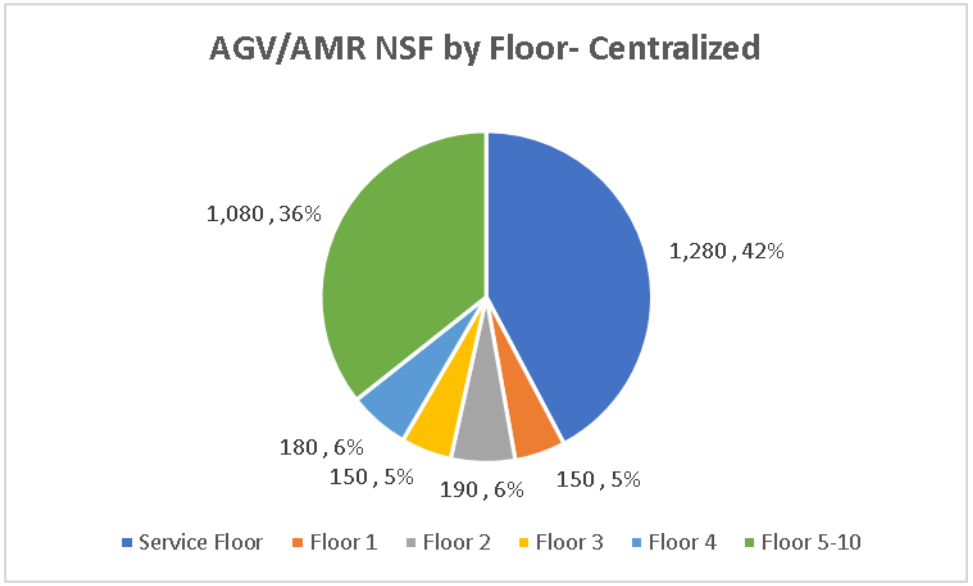
Scenario		Logistics	EVS/Hsk	EVS/ Clean Linen	EVS/Soiled Linen	EVS/Waste	Food Service	Pharmacy	Lab	MDR	Vehicles	Capital Costs ($M)	Annual Maintenance ($K)	Cummulative Savings ($M)	Breakeven Year (years)
A-1	Centralized	X	X	X	X	X	X	X	X	X	15	3.3	110	17.4	7
A-2	Decentralized	X	X	X	X	X	X	X	X	X	17	3.5	135	21.4	6

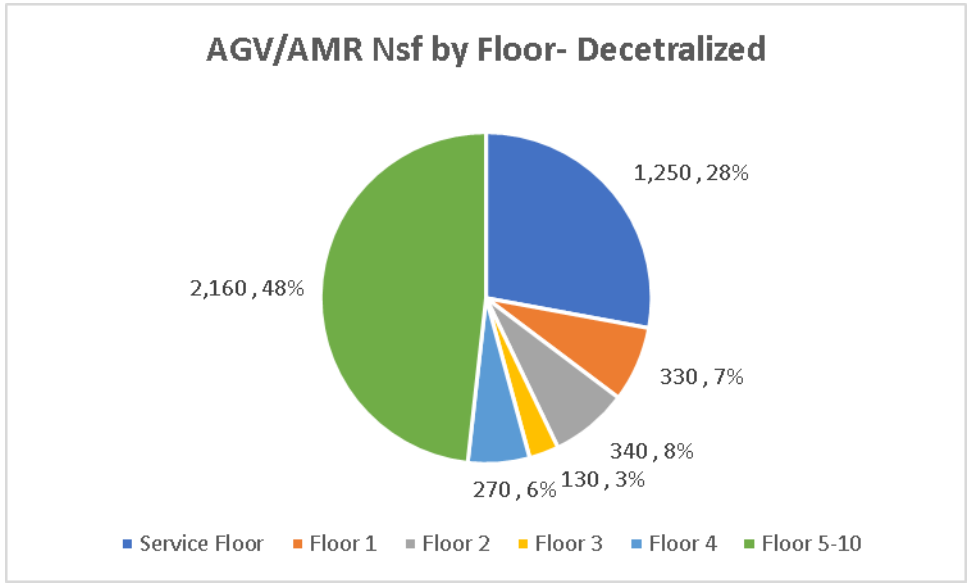
Positive business case AGV/ARM with 6 year breakeven period with total savings of **$21.7MM**

Negative Business case for powered chutes due to longer than acceptable breakeven period .

Additional savings of **$250K** were identified by **reducing 10 PTS stations** with use of AMRs instead of PTS

AGV/AMR Space Summary – Centralized Vs Decentralized





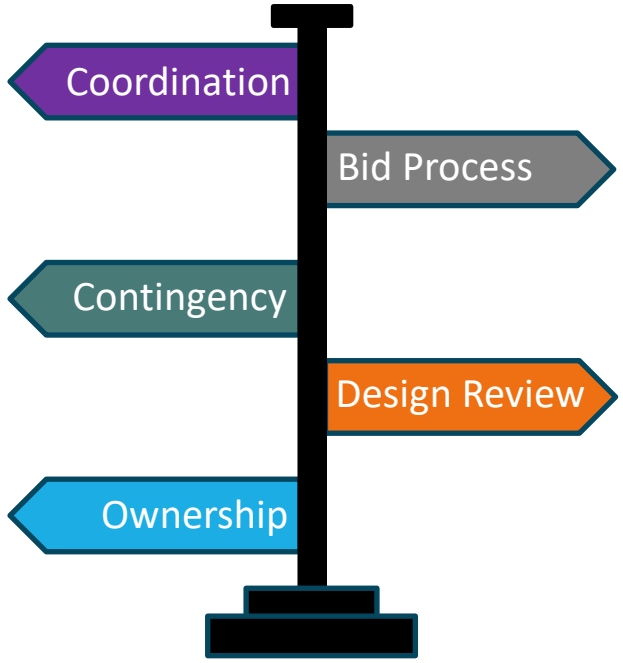
	Centralized	Decentralized
Floors	**AGV/AMR Nsf**	
Service Floor	1,280	1,250
Floor 1	150	330
Floor 2	190	340
Floor 3	150	130
Floor 4	180	270
Floor 5-10	1,080	2,160
Total	**3,030**	**4,480**

For a 1.2MM SQFT facility, total technology space for centralized delivery is **.25%** and **.37%** for decentralized delivery

Originally1250SQFT programmed for AGV maintenance; only 300SQFT needed for AGV maintenance shop

Post Business Case – Key Considerations & Lessons Learned

- A large amount of **coordination is required for the installation, commissioning**, and operations of the AGV/AMR
- **Contingency planning and risk analysis** is needed to address changes past the business case analysis
- **A Sponsor need to be included from the beginning**, and not assigned the program during the transition phase (move-in)
- As the AGV/AMR are used by many departments, **who is the owner of the AGV / AMR?** It will vary from hospital to hospital



Retention of planning and design knowledge inside the hospital organization is recommended

- Vendor Bid process
  - Pre-qualified Vendors
  - Most current technology
  - **Post installation issues with existing installations**
  - **Life cycle (Equipment renewal)**
  - Interfacing with other systems
- **Design review by agnostic SME**
- Intelligent hospital system compatibility
- **Leasing options with ability to upgrade equipment**

Session Summary

- ✓ Regardless of size of facility, consideration for Logistics Automation for **all upcoming Healthcare Facility Projects supported by a robust business case** is recommended(Ideally before functional planning stage).
- ✓ **Use of Autonomous Navigation** powered by **Artificial Intelligence (AI)** will continue to **reduce technology related space needs**.
- ✓ **Healthcare readiness** is a critical factor in selecting a right technology
- ✓ Technology alternatives will continue to get **cheaper, faster and safer**.
- ✓ Interfacing of **Automation with Intelligent hospital systems** will aid improving **employee safety and productivity**

Questions and Answers

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Upcoming Events

- FPC Seminar September 29th, 2024
- AMFP Workshop Chicago- November 14th, 2024

Logimaxx Facilities Planning