Astellas' Corporate-wide Digital Transformation Driven by Analytics

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Astellas Pharma Inc.
March 27, 2023

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Information about pharmaceutical products (including products currently in development) which is included in this material is not intended to constitute an advertisement or medical advice. Information about investigational compounds in development does not imply established safety or efficacy of the compounds; there is no guarantee investigational compounds will receive regulatory approval or become commercially available for the uses being investigated.

Agenda

3

I **What Astellas is Aiming for with Corporate-wide Digital Transformation**

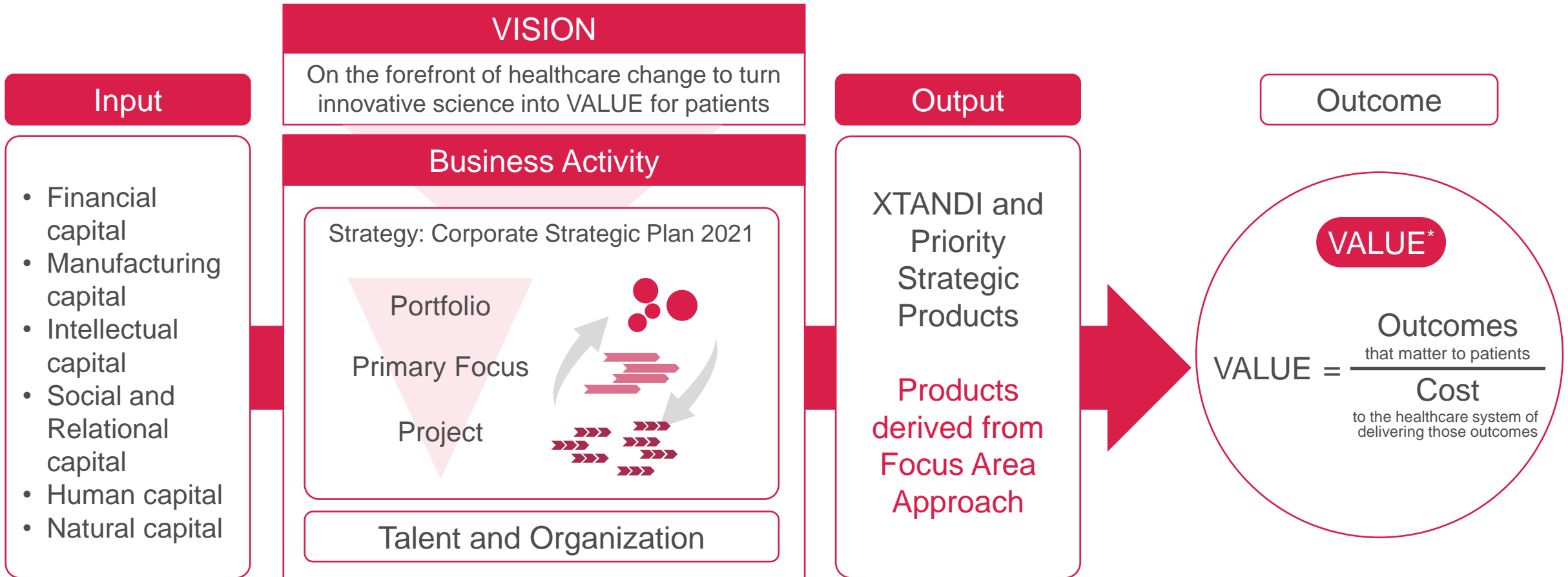**Naoki Okamura**, Chief Strategy Officer

II **Corporate-wide Digital Transformation Driven by Analytics**

Masanori Ito, Ph.D., MBA, Senior Director, Advanced Informatics & Analytics

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What Astellas is Aiming for with Corporate-wide Digital Transformation

Naoki Okamura, Chief Strategy Officer

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VALUE Creation

Input

- Financial capital
- Manufacturing capital
- Intellectual capital
- Social and Relational capital
- Human capital
- Natural capital

VISION

On the forefront of healthcare change to turn innovative science into VALUE for patients

Business Activity

Strategy: Corporate Strategic Plan 2021

Portfolio

Primary Focus

Project

Talent and Organization

Output

XTANDI and Priority Strategic Products

Products derived from Focus Area Approach

Outcome

VALUE*

$$VALUE = \frac{\text{Outcomes that matter to patients}}{\text{Cost to the healthcare system of delivering those outcomes}}$$
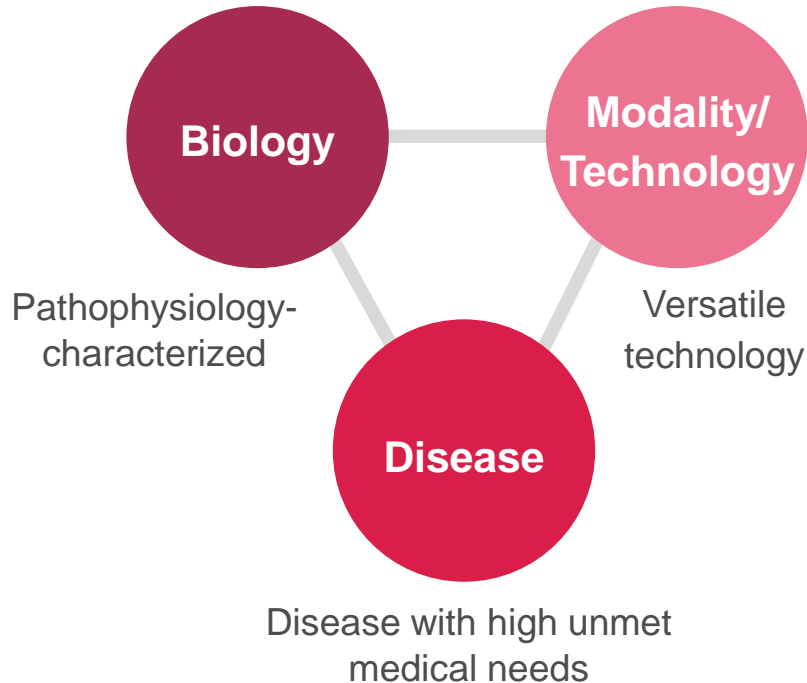
*Adapted from "What Is Value in HealthCare?" Porter, M.E. (2010). New England Journal of Medicine

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Astellas R&D Strategy
Analytics to turn innovative science into VALUE

Focus Area Approach

is designed to identify drug discovery opportunities flexibly and efficiently by combining innovative biologies and modalities/technologies to address diseases with high unmet medical needs

Biology — Pathophysiology-characterized

Modality/Technology — Versatile technology

Disease — Disease with high unmet medical needs

Primary Focus

Modality
- ● Small molecule
- ● Antibody
- ● Gene
- ● Cell
- ● Other

	Biology/Modality/Technology [1]	
Genetic Regulation	Gene replacement (AAV)	● (Gene)
Immuno-Oncology	Checkpoint	● (Small molecule)
	Artificial adjuvant vector cell (aAVC)	● (Other)
	Oncolytic virus (intratumoral)	● (Gene)
	Oncolytic virus (systemic)	● (Gene)
	Bispecific immune cell engager	● (Antibody)
	Cancer cell therapy (UDC)	● (Cell)
Blindness & Regeneration	Cell replacement	● (Cell)
	Cell replacement (UDC)	● (Cell)
	Gene regulation (AAV)	● (Gene)
Mitochondria	Gene regulation & mitochondrial biogenesis	● (Small molecule)
	Mitochondrial stress	● (Small molecule)
	Mitochondrial transfer	● (Cell)
Targeted Protein Degradation	Protein degradation	● (Small molecule)

**Coordinate a portfolio of various possibilities → Analytics and modeling support this decision making**

1. Not exhaustively listed.
AAV: Adeno-associated virus, UDC: Universal donor cell

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Database
of companies and products
in the industry

Revealing strengths and opportunities to identify partners that lead to increased corporate value
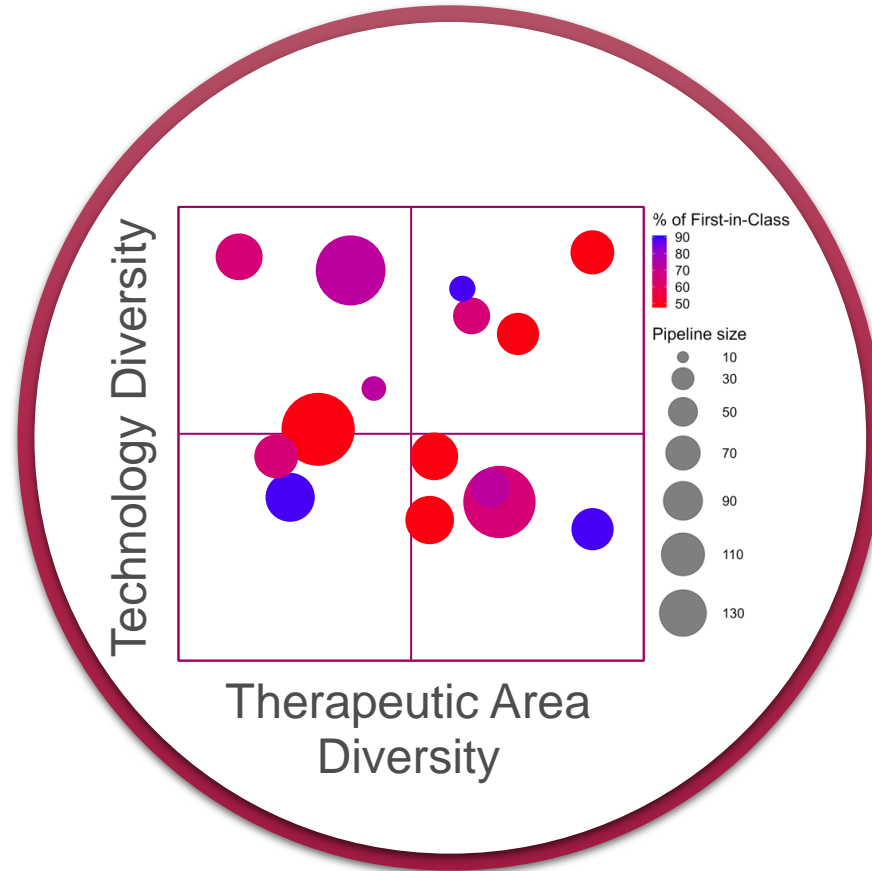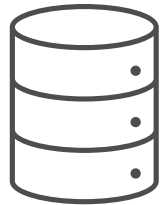
Insights on business models from portfolio profiling
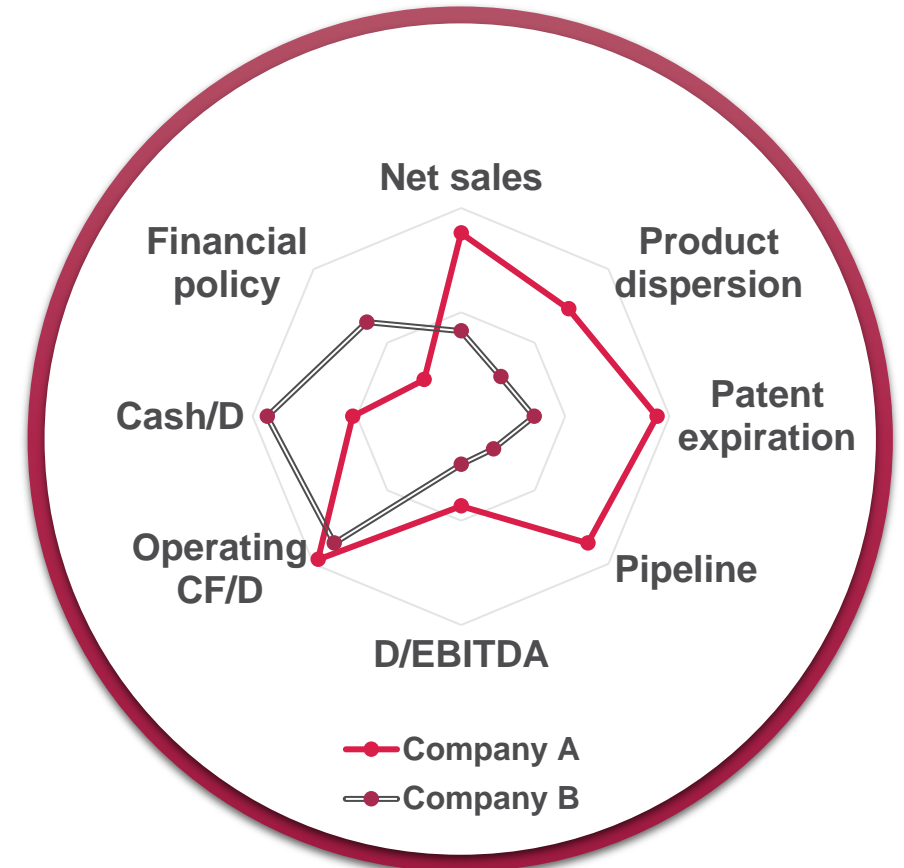
CF: Cash flow, D: Debt, EBITDA: Earnings Before Interest payments, Tax Depreciation, and Amortization

A state in which all data, from management decisions to individual projects, is organically connected to maximize VALUE
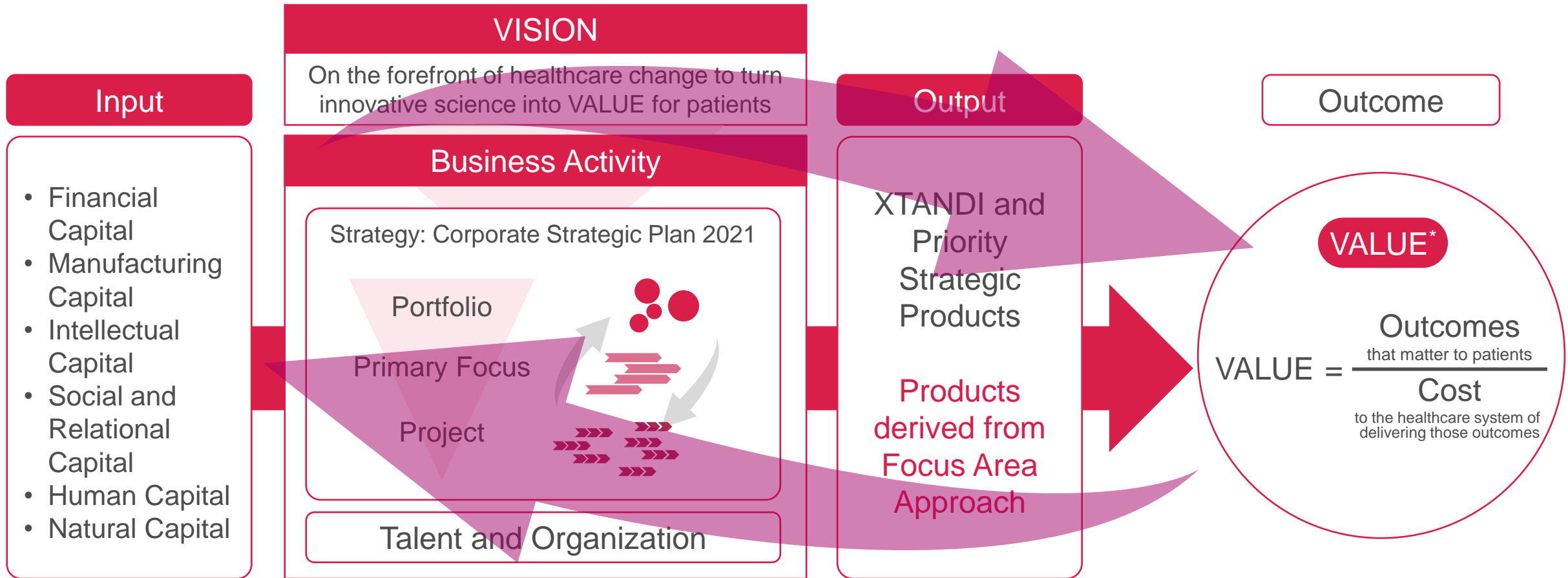
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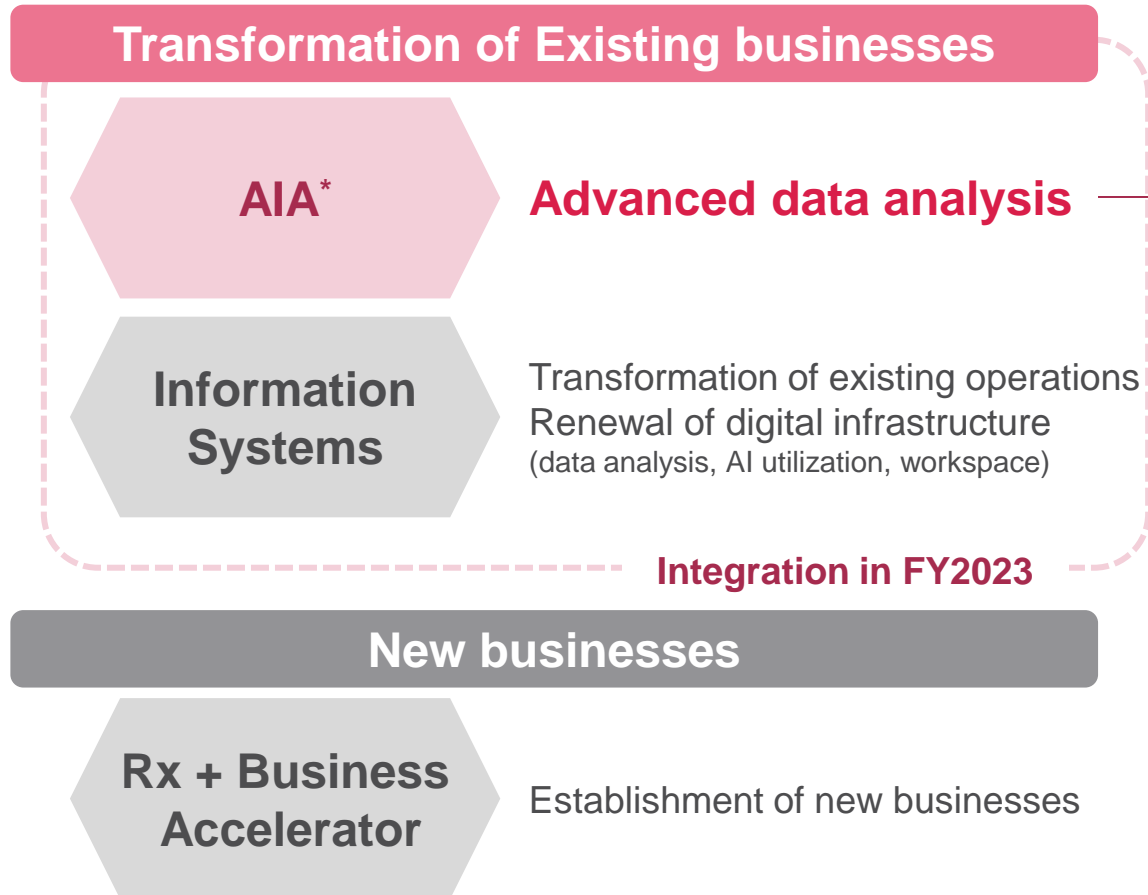# Corporate-wide Digital Transformation Driven by Analytics

Masanori Ito, Ph.D., MBA
Senior Director, Advanced Informatics & Analytics

Major divisions responsible for DX

Transformation of Existing businesses

AIA* → **Advanced data analysis**

Information Systems → Transformation of existing operations
Renewal of digital infrastructure
(data analysis, AI utilization, workspace)

Integration in FY2023

New businesses

Rx + Business Accelerator → Establishment of new businesses

Groups in AIA

Enterprise Insights and Digital Solutions
Supporting the division's strategic decision-making through advanced analytics and modeling solutions

Real World Data Innovations and Solutions
Enable data-driven decision-making through innovative solutions leveraging real-world data to generate robust insights at scale and at speed

Digital Research Solutions
Promotes and accelerates drug discovery R&D projects using the latest knowledge and technologies related to advanced medical big data, digital technologies, and advanced data analysis technologies

Technology, Governance and Informatics
Expands and supports advanced analytical capabilities with technology, governance, and data engineering
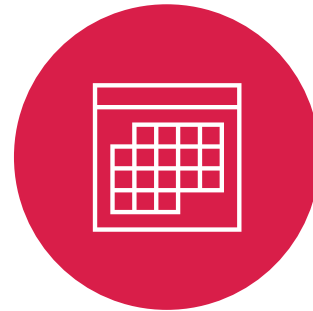
*AIA: Advanced Informatics & Analytics

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Characteristics of the Pharmaceutical Industry:
High levels of uncertainty while needing a lot of investment

Phase I to approval
Success rate[1]
7.9%

Development period[1]
10.5 years

R&D expenses[2]
$1B

Success rate[1] **is very low**

Assumptions change over long development period
- Hypotheses about biology
- Number of patients, competitive products, social conditions, etc.

Huge investments

Difficult decision on what to invest in and when

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Adopt analytical techniques appropriate to "Focus Area Approach"

Since the innovative drug development we are working on is highly uncertain,
it is necessary to support optimal management decisions based on simulation,
in addition to "prediction from past data", which has been remarkably developed by AI in recent years.

	Conventional	**Current** **Focus Area Approach**
Available data	• Much data accumulated in-house • Many public databases • Many bibliographic references	• Limited in-house data • Limited public databases • Limited bibliographic references • Rare diseases
Analysis method	Prediction from historical data (Data-driven)	Prediction from historical data (Data-driven) **+ Inference based on simulation**

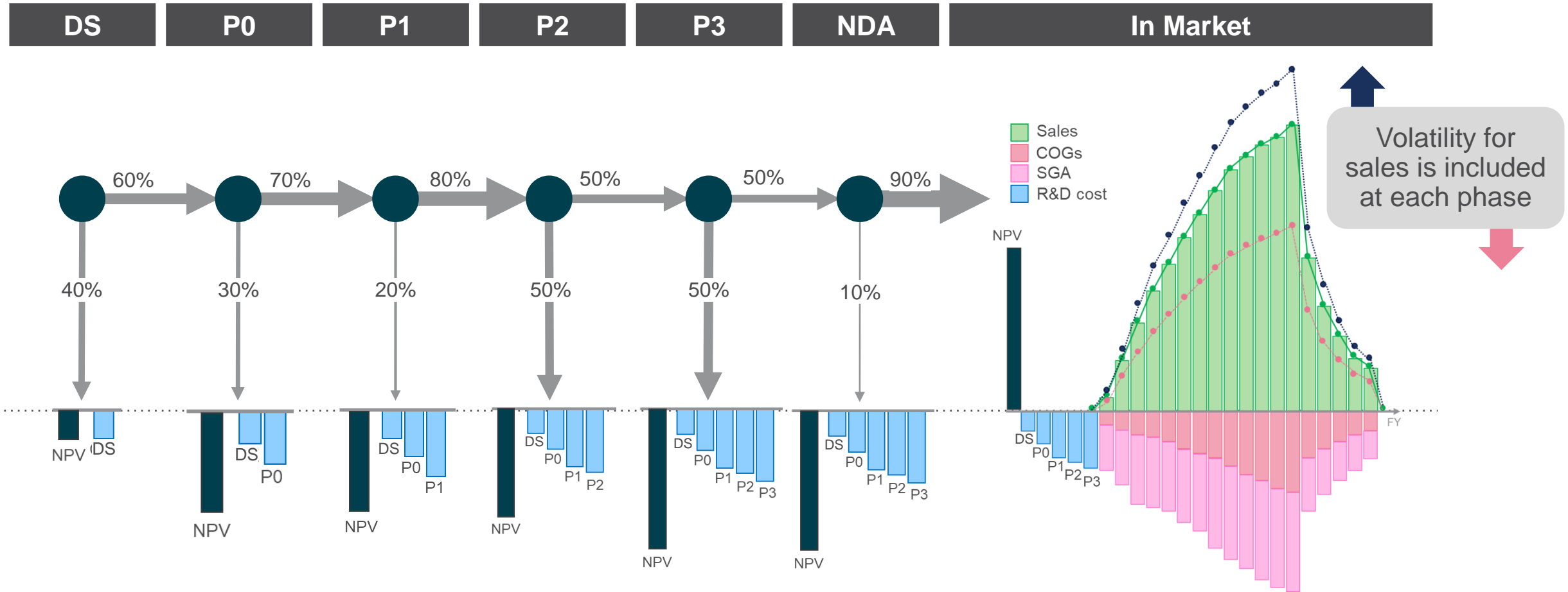astellas

Important Points for Simulation
- Forecasting by "range" rather than "single points"
- Identification of scenarios and countermeasures
- Accumulation of data to update assumptions and countermeasures
- Modeling to control uncertain situations

Benefits of Simulation
- Decision-making based on trade-offs
- Transparency and consistency in decision making
- Updating of actions in response to changes in the internal and external environment

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Simulation of Project Valuation in Drug Development

| DS | P0 | P1 | P2 | P3 | NDA | In Market |

Sales
COGs
SGA
R&D cost

60% 70% 80% 50% 50% 90%

40% 30% 20% 50% 50% 10%

NPV DS
NPV DS P0
NPV DS P0 P1
NPV DS P0 P1 P2
NPV DS P0 P1 P2 P3
NPV DS P0 P1 P2 P3
NPV

DS P0 P1 P2 P3

FY

Volatility for sales is included at each phase

*Numbers are examples

DS: Discovery stage, P0〜3: Phases of Clinical Trials, NDA: New **Drug** Application, NPV: Net Present Value

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Portfolio-level Simulation
Advantage of Focus Area Approach

○ Project Input

| 202x	202x+1	202x+2

Non-Focus Area Approach

POC success is **independent** on each other with limited linkage between projects.

Focus Area Approach

POC success is **dependent** on each other.
Success of lead program is likely to be followed by success of other programs based on the same platform.

Linkages between programs having Biology/Modality/Disease connection
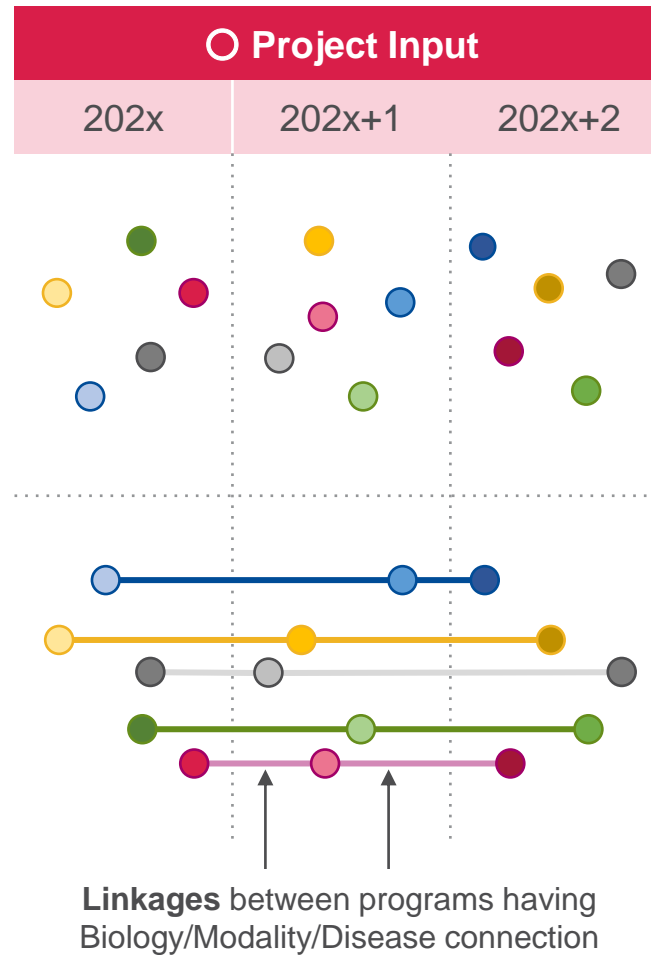
Probability of occurrence in 1 million simulations

— Focus Area Approach
— Non-Focus Area Approach

NPV
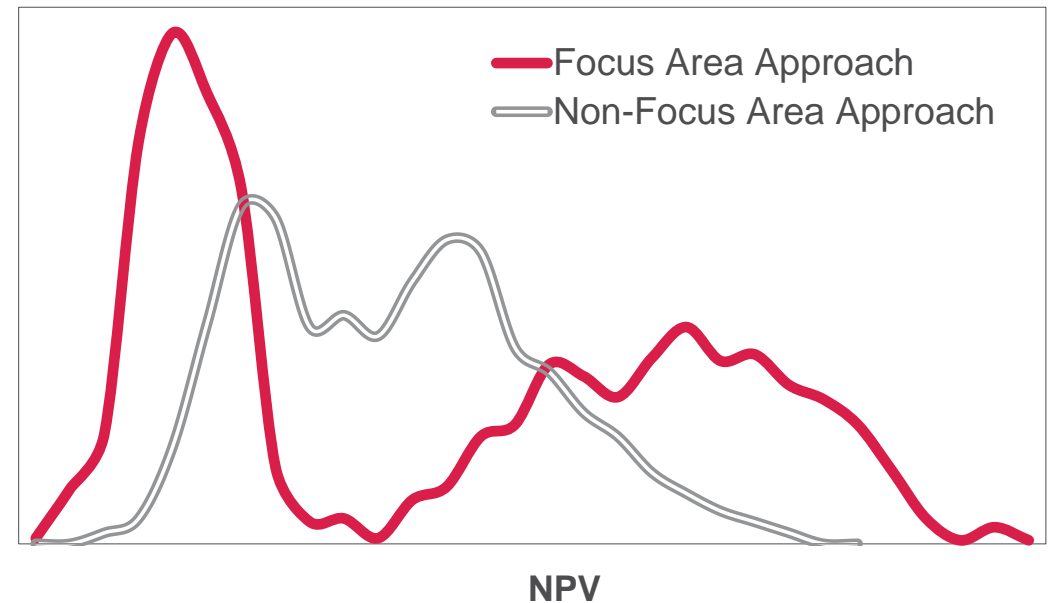
Focus Area Approach dramatically increases the probability of a highly profitable event.

POC: Proof of Concept, NPV: Net Present Value

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Simulation-based forecasting and decision-making

Utilizing a model based on Monte Carlo simulations[*], factors such as development success/failure and sales ups and downs are taken into account.

→Obtain possible scenarios and their probabilities of realization for pipeline outcomes

1 **Generate 10,000 random observations**   **2** **Calculated cashflows for each project**   **3** **Output NPV Distribution**

Observation 1 | Baseline

Platform A	●	○	○	○	●
Platform B	○	○	●	○	○
Platform C	○	●	○	●	●

Strategy A | **Two failures allowed**

Platform A	●	○	○	⊗	⊗
Platform B	○	○	⊗	⊗	⊗
Platform C	○	●	○	⊗	⊗

Strategy B | **Three failures allowed**

Platform A	●	○	○	○	⊗
Platform B	○	○	●	○	⊗
Platform C	○	●	○	●	●

● Launch   ○ Fail   ⊗ Not Done
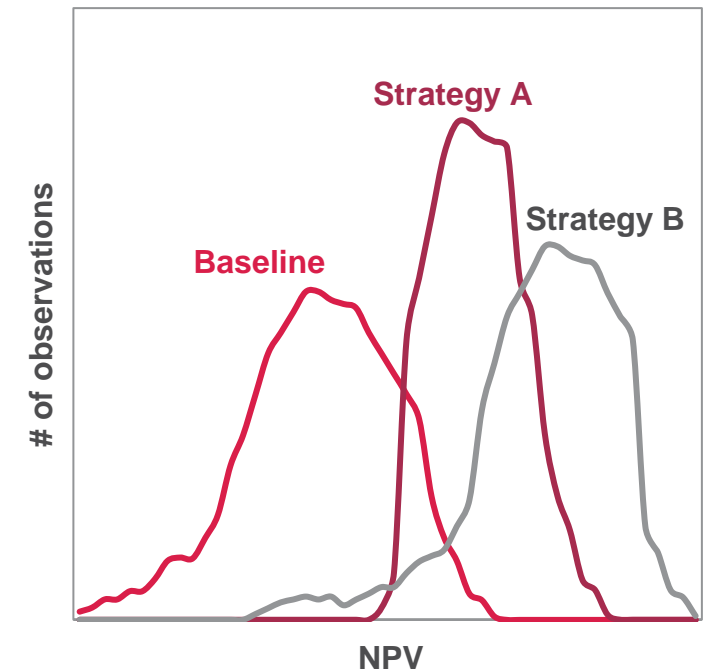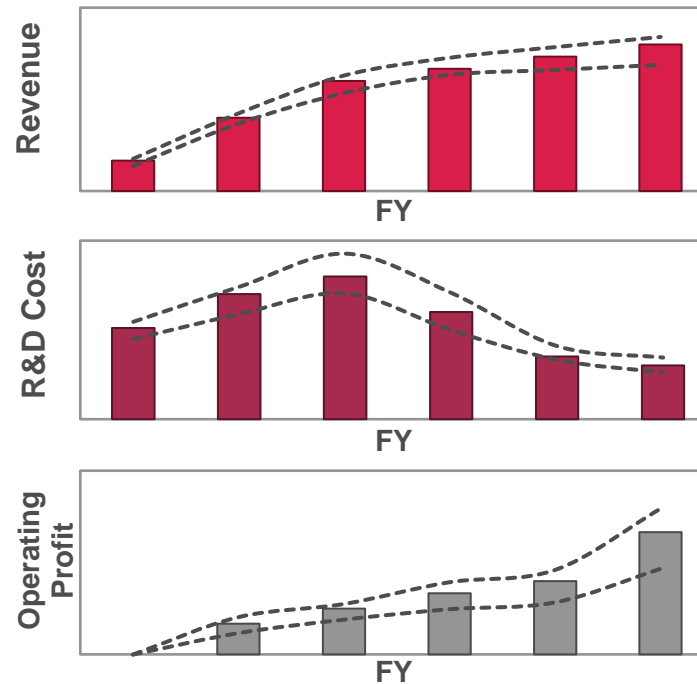
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Input

- Financial Capital
- Manufacturing Capital
- Intellectual Capital
- Social and Relational Capital
- Human Capital
- Natural Capital

VISION

On the forefront of healthcare change to turn innovative science into VALUE for patients

Business Activity

Strategy: Corporate Strategic Plan 2021

Portfolio

Focus Area

Project

Talent and Organization

Output

XTANDI and Priority Strategic Products

Products derived from Focus Area Approach

Outcome

VALUE*

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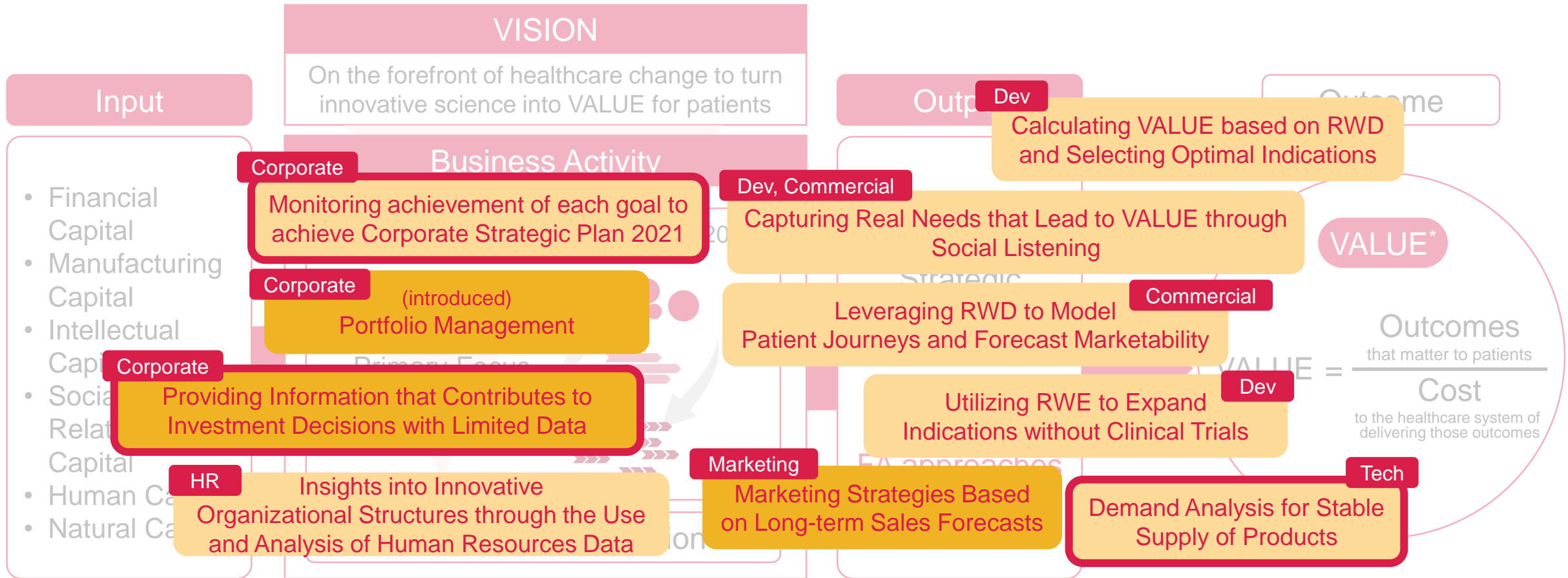
*Adapted from "What Is Value in HealthCare?" Porter, M.E. (2010). New England Journal of Medicine

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Analytics is Utilized in All Areas of Enterprise to Maximize VALUE

Data-driven + Simulation

Initiatives not introduced during the presentation are also listed in the Appendix.

VISION

On the forefront of healthcare change to turn innovative science into VALUE for patients

Input

- Financial Capital
- Manufacturing Capital
- Intellectual Capital
- Social Relationship Capital
- Human Capital
- Natural Capital

Business Activity

Dev
Calculating VALUE based on RWD and Selecting Optimal Indications

Corporate
Monitoring achievement of each goal to achieve Corporate Strategic Plan 2021

Dev, Commercial
Capturing Real Needs that Lead to VALUE through Social Listening

Corporate
(introduced)
Portfolio Management

Commercial
Leveraging RWD to Model Patient Journeys and Forecast Marketability

Corporate
Providing Information that Contributes to Investment Decisions with Limited Data

Dev
Utilizing RWE to Expand Indications without Clinical Trials

HR
Insights into Innovative Organizational Structures through the Use and Analysis of Human Resources Data

Marketing
Marketing Strategies Based on Long-term Sales Forecasts

Tech
Demand Analysis for Stable Supply of Products

VALUE*

$$VALUE = \frac{Outcomes}{Cost}$$

Outcomes that matter to patients

to the healthcare system of delivering those outcomes

*Adapted from "What Is Value in HealthCare?" Porter, M.E. (2010). New England Journal of Medicine

HR: Human Resource, Dev: Development, RWD: Real World Data, RWE: Real World Evidence

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Monitoring Achievement of Each Goal to Achieve Corporate Strategic Plan 2021
Data Visualization

Problem
- To transform into an innovative organization, cross-divisional and ambitious goals (Shared Objectives) are set. Data on initiatives related to goals and their progress are centrally managed, but the volume of information is increasing.
- As the amount of information to be aggregated and checked increases, the time available for sense-making is reduced.

Solution
- Developed a dashboard to support management decision-making by automating the analysis and processing of large amounts of data
- Visualization of initiatives and progress, enabling prioritization of critical information and extraction of trends

Value
- Time from data entry to visualization reduced from 3 days to 15 minutes.
- Report creation is focused on meaning-making over production.

Verified in FY2021, currently being utilized
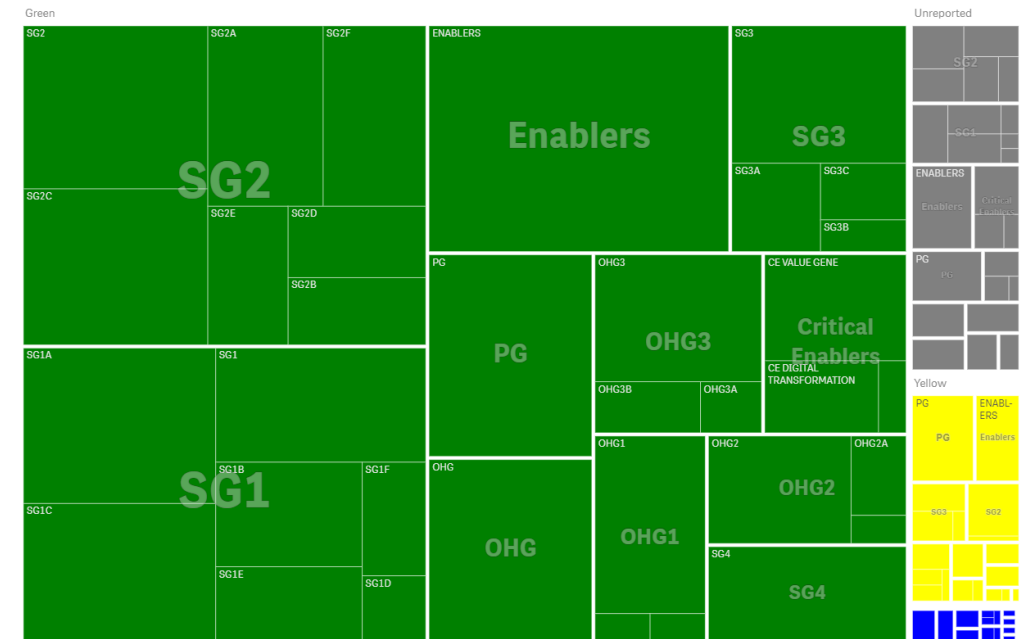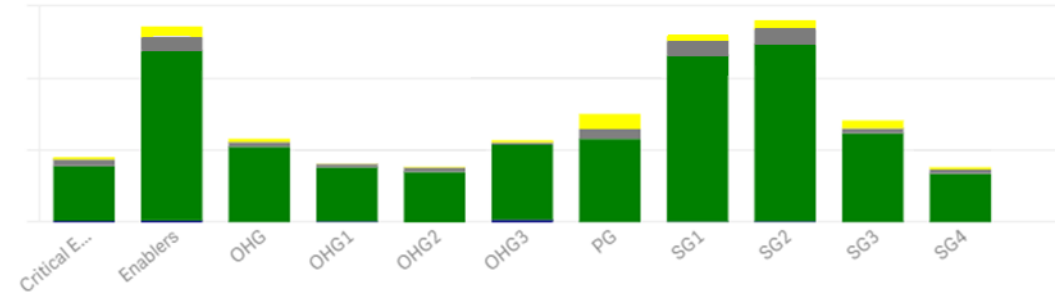
Demand Analysis for Stable Supply of Products
Supply Chain Management

Problem

- Demand forecasting is critical to avoid inventory shortages and surpluses
- Accurate forecasting requires customization to account for seasonality, calendar, and market-specific patterns
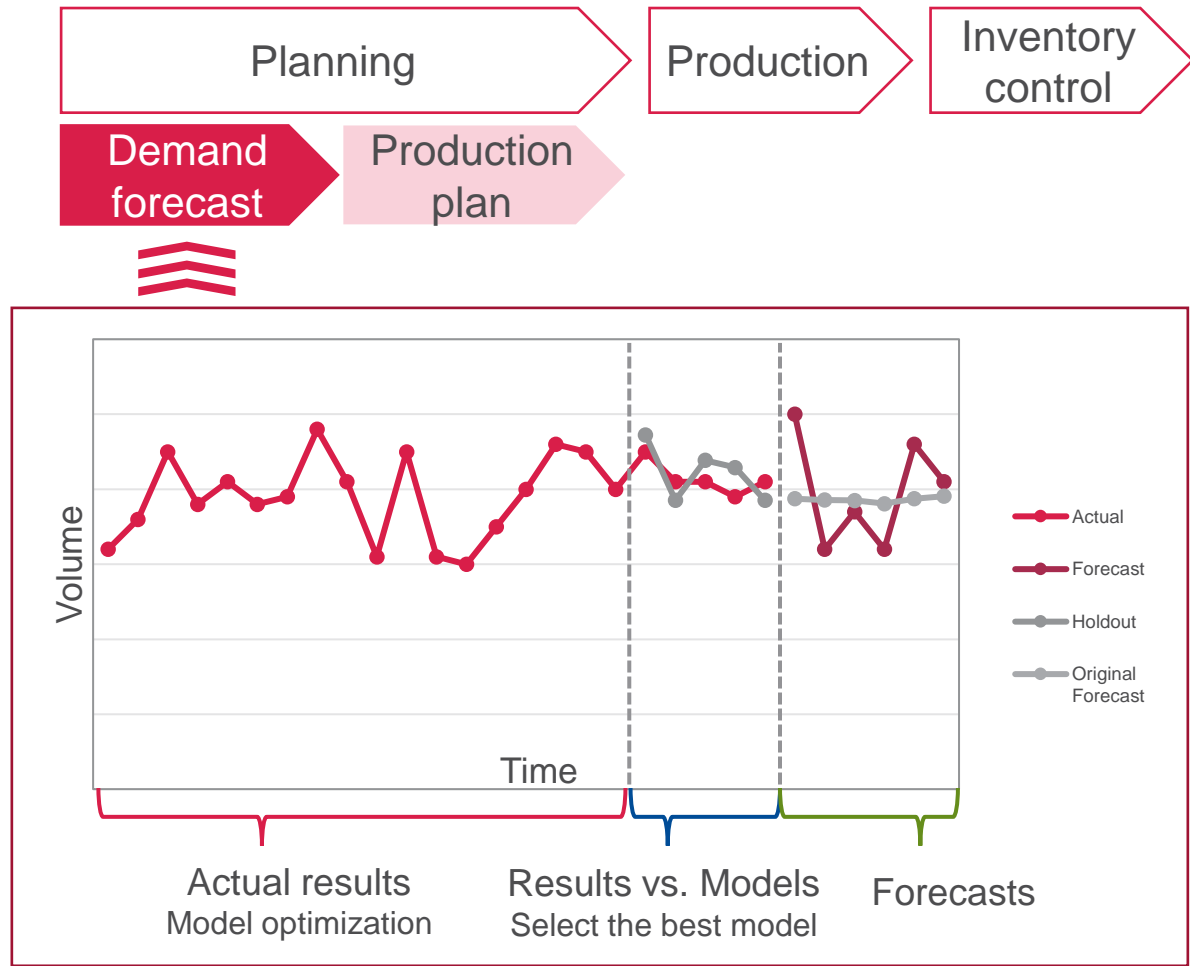
Solution

- New supply chain forecasting platform with eight freely selectable time-series algorithms
- Improved forecasting accuracy by allowing selection of the best algorithm for each product

Value

- Improved forecasting accuracy for stable product supply and cost optimization
- Reduction of external vendor dependence/costs

Verified in FY2022, currently being utilized in several projects

Planning → Production → Inventory control

Demand forecast → Production plan

Volume

Time

Actual — Forecast — Holdout — Original Forecast

Actual results
Model optimization

Results vs. Models
Select the best model

Forecasts

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Providing Information that Contributes to Investment Decisions with Limited Data
Real-Option Valuation

Problem

- Speed is important in asset evaluation, but human evaluation is time-consuming and expensive
- Especially in the early stage, there are many cases where data is insufficient, and the results will differ if different people perform the estimation.
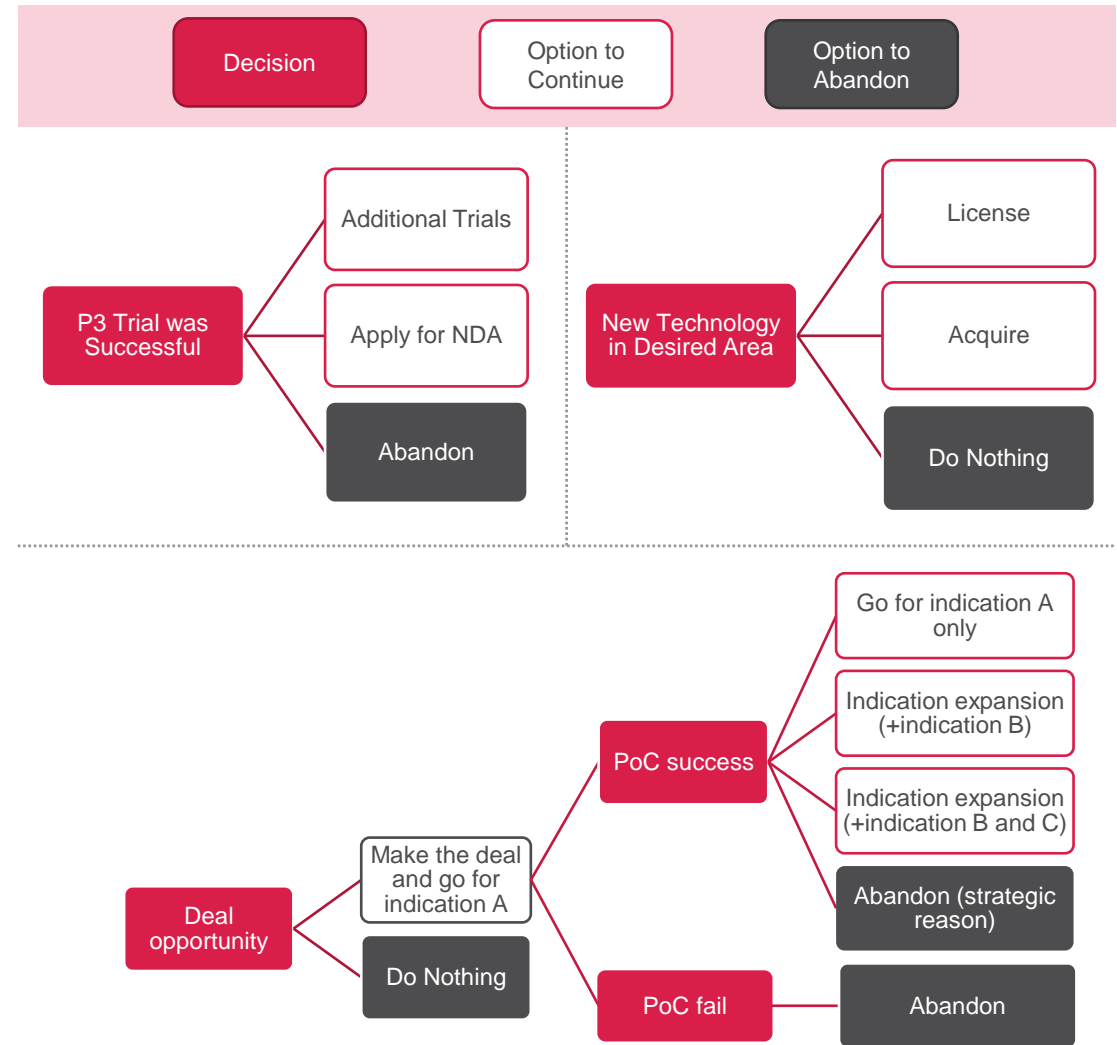
Solution

- Developed a Python-based methodology based on an external dataset of tens of thousands of compounds that can be evaluated even in the presence of missing data (e.g., how long and how much does it cost to target a certain indication with a certain compound, how much sales, etc.)

Value

- Quick valuation of early-stage assets
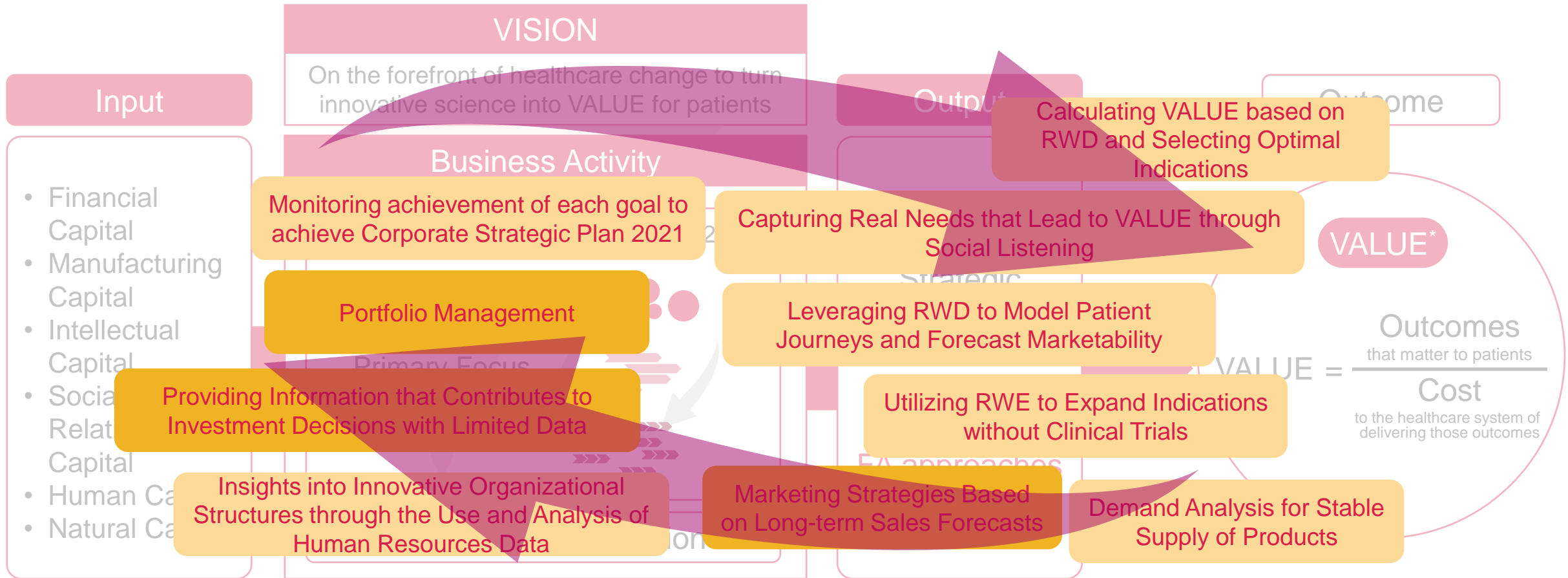- Increased information for early-stage investment decisions

Currently under verification

POC: Proof of Concept, NPV: Net Present Value, P3: Phase 3 clinical trial

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What Astellas is Aiming for with Corporate-wide Digital Transformation
From point solutions to end-to-end

A state in which all data, from management decisions to individual projects, are organically connected to maximize VALUE

VISION
On the forefront of healthcare change to turn innovative science into VALUE for patients

Input
- Financial Capital
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- Human Ca...
- Natural Ca...

Business Activity

Output

Outcome

VALUE*

$$VALUE = \frac{Outcomes \text{ that matter to patients}}{Cost \text{ to the healthcare system of delivering those outcomes}}$$

Monitoring achievement of each goal to achieve Corporate Strategic Plan 2021

Calculating VALUE based on RWD and Selecting Optimal Indications

Capturing Real Needs that Lead to VALUE through Social Listening

Portfolio Management

Leveraging RWD to Model Patient Journeys and Forecast Marketability

Providing Information that Contributes to Investment Decisions with Limited Data

Utilizing RWE to Expand Indications without Clinical Trials

Insights into Innovative Organizational Structures through the Use and Analysis of Human Resources Data

Marketing Strategies Based on Long-term Sales Forecasts

Demand Analysis for Stable Supply of Products

*Adapted from "What Is Value in HealthCare?" Porter, M.E. (2010). New England Journal of Medicine

HR: Human Resource, Dev: Development, RWD: Real World Data, RWE: Real World Evidence

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Calculating VALUE based on RWD and Selecting Optimal Indications
RWD Data Hub

Problem

- VALUE of a drug is not only its therapeutic effect, but also its cost of care, quality of life, burden on caregivers, etc.
- Optimizing VALUE through clinical trials alone is time-consuming and expensive.
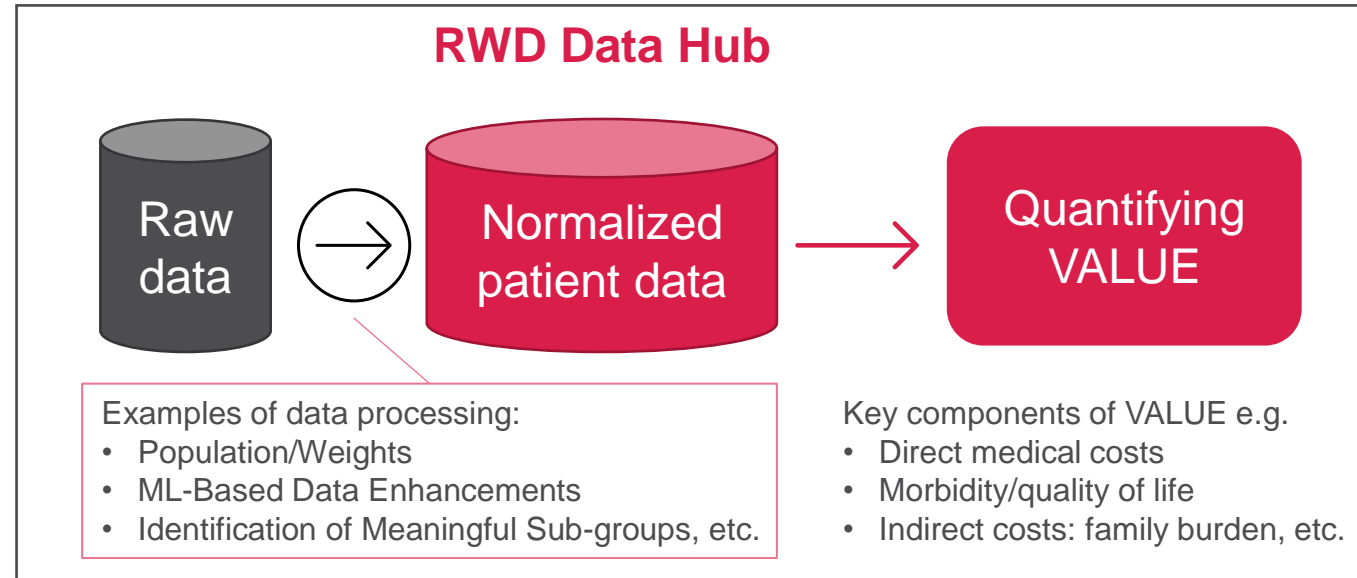
Solution

Build a uniquely processed data hub based on RWD
- Capable of quantifying VALUE (within 1 day)
- Can perform clinical analysis and evaluation at various stages of the drug development cycle

Value

- Faster time-to-market
- Reduction of study costs

Verified in FY2021 and currently being utilized in multiple projects

RWD Data Hub

Raw data → Normalized patient data → Quantifying VALUE

Examples of data processing:
- Population/Weights
- ML-Based Data Enhancements
- Identification of Meaningful Sub-groups, etc.

Key components of VALUE e.g.
- Direct medical costs
- Morbidity/quality of life
- Indirect costs: family burden, etc.

- National / Global Projections
- Patient Segmentation, Volumes
- Incidence / Prevalence
- Treatment Patterns
- Burden of Disease
- Trial Endpoints
- Health care resource utilization / Cost
- Comorbidities

Selecting the best indications for maximizing VALUE

RWD: Real World Data

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Capturing Real Needs that Lead to VALUE through Social Listening
Patient Insights from Social Media

Problem

- Learning about the patient experience is critical to understanding the outcomes that truly matter to patients
- On the other hand, it is difficult to filter out the noise and gain insight from social media posts

Solution

- Using natural language processing technology to filter data on relevant content and identify, for example, key themes in posts by patients and caregivers

Value

- Understanding the needs of patients (more efficient market research)
- Insight into the patient environment, not only the patient, but also potential patients before diagnosis, untreated patients after diagnosis, and care givers

Being utilized in multiple projects in FY2022

Social Media Listening

Gain insight into which symptoms patients are struggling and/or coping with, how they relate to other diseases, etc.

- Perception/Sentiment
- Trends
- Needs/Opportunities
- Competitor Analysis
- Reader Analysis
- Share of Voice
- Conversation Analysis

Person A's Voice

Person B's Voice

Experiences / Art & Exhibition

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Marketing Strategies Based on Long-term Sales Forecasts
Long-Range Forecasting

Problem

- Long-term sales forecasting is uncertain and difficult because of the impact of multiple uncontrollable factors, such as government price controls and increasing market share of competing products. On the other hand, using only a single point estimate based on a variety of assumptions
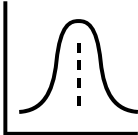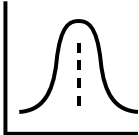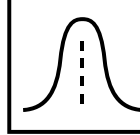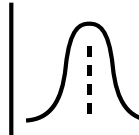
Solution

1. Assumptions are made about the impact and probability of occurrence of each of the factors affecting sales. Monte Carlo simulations generate a "range" of numerous possibilities and outcomes
2. Predicts future trends based on time-series data, using models that leverage statistics, machine learning, and deep learning

Value

- Marketing strategies with appropriate estimates of risk
- Improved understanding of possible scenarios
- Ability to pre-test the impact mitigation strategies

Verified in FY2021, currently being used in multiple projects

NPV: Net Present Value

1. Monte-Carlo Simulation

Input Data Sets (e.g.)	A (# of patients)	B (competing product)	C (insurance reimbursement)
Assumed distribution			
Take random sample and model outputs			
Repeat 1000s of time to generate a distribution of model outputs			

$$NPV = f_{NPV}(X_A, X_B, X_C)$$

2. Time Series Forecasting

—— Sales (Predicted)   —— Sales (Actual)
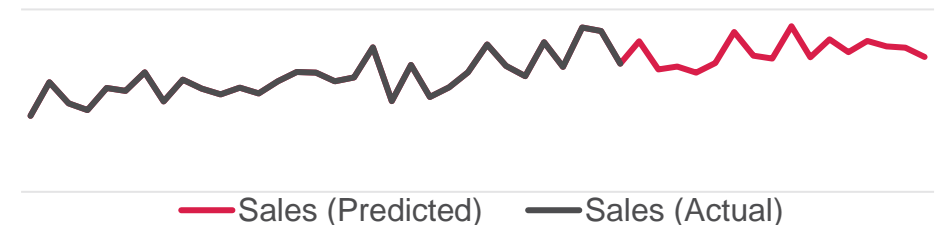
Leveraging RWD to Model Patient Journeys and Forecast Marketability
Dynamic Patient Flow Model

Problem

- To predict marketability, it is necessary to predict how a candidate compound will be incorporated into actual therapy.
- This is especially challenging for diseases with complex or evolving therapeutic pathways.
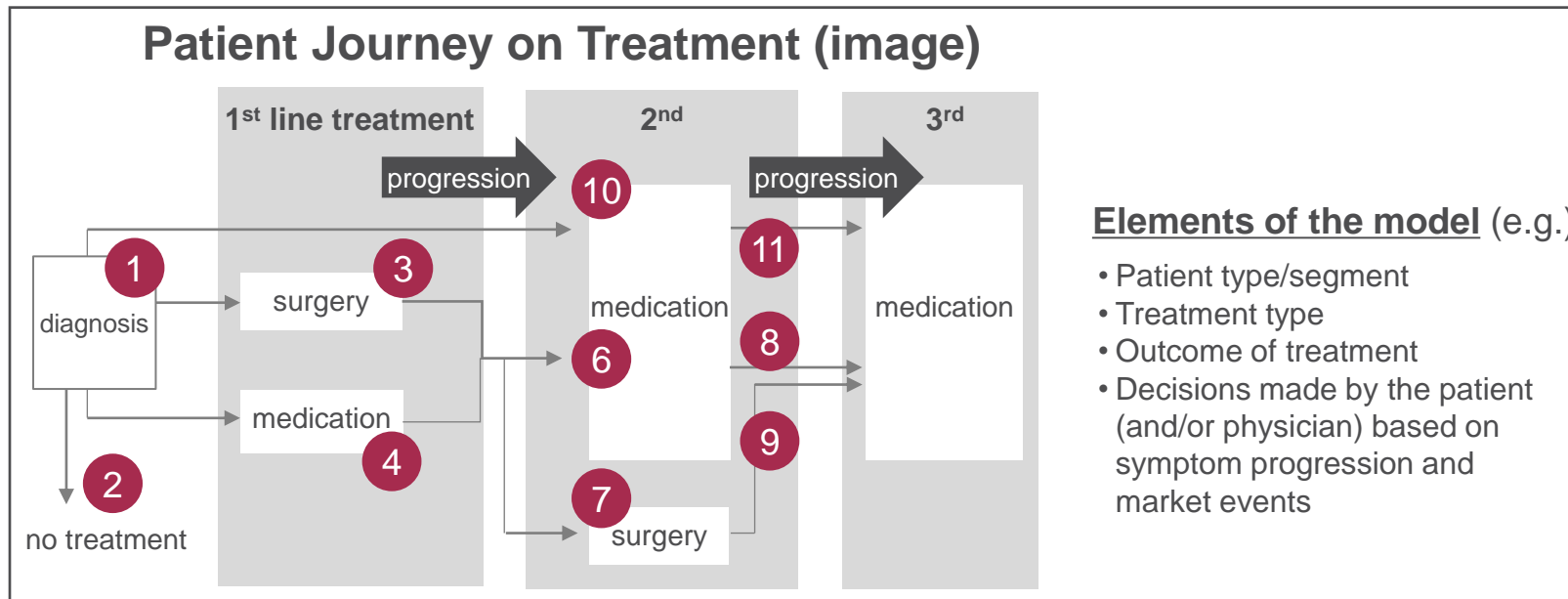
Solution

Modeling the Patient Journey with RWD
- What paths patients follow
- How the patient journey itself changes
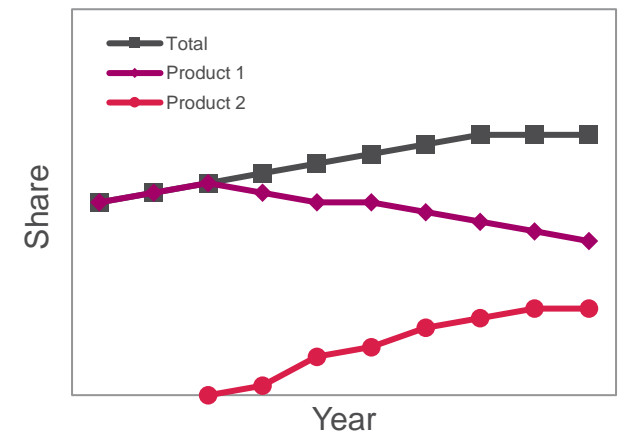- Reflects individual patient characteristics and treatment history

Value

- Improving the robustness of pipeline product forecasting
- Insights into marketing strategies

Verification has been conducted for 1 project in FY2022

Patient Journey on Treatment (image)

1st line treatment

2nd

3rd

progression

progression

10

diagnosis

1

surgery

3

medication

11

medication

medication

6

8

2

no treatment

medication

4

7

surgery

9

Elements of the model (e.g.)

- Patient type/segment
- Treatment type
- Outcome of treatment
- Decisions made by the patient (and/or physician) based on symptom progression and market events

Forecasting Share Trends

- Total
- Product 1
- Product 2

Share

Year

RWD: Real World Data

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Utilizing RWE to Expand Indications without Clinical Trials
Expansion of Prograf (tacrolimus) Indications

Problem

- No immunosuppressant drug approved for lung transplantation in US, and access issues were reported
- Tacrolimus is a drug that prevents organ rejection and was only indicated for liver, kidney, and heart transplant patients in 2018
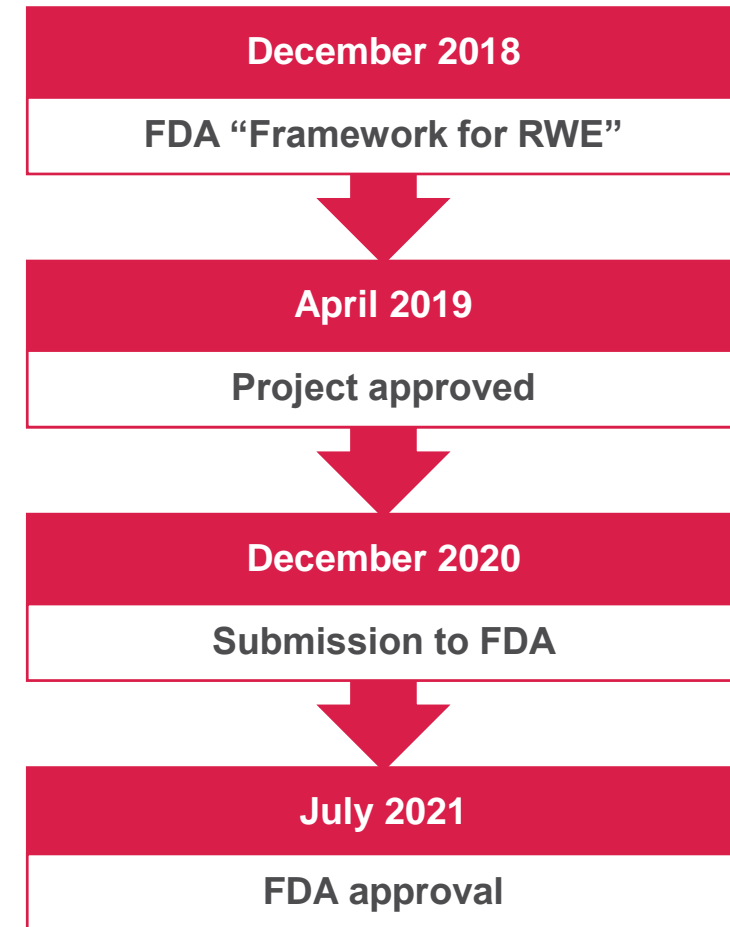
Solution

Application to expand the indication to adult and pediatric lung transplant patients utilizing the FDA's new RWE framework
- Leveraged data from more than 25,000 patients over 20 years
- Approved less than 3 years after the framework was presented

Value

- Expanding indications without clinical trials to help address unmet medical needs

FDA approves expansion of indication to include lung transplantation in July 2021

December 2018

FDA "Framework for RWE"

April 2019

Project approved

December 2020

Submission to FDA

July 2021

FDA approval

FDA：Food and Drug Administration, RWE: Real World Evidence

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Insights into Innovative Organizational Structures through the Use and Analysis of Human Resources Data
DX in People Analytics

Problem

- The large number of hierarchical positions (up to 10) has been an impediment to innovation, causing delays in decision-making and making it difficult for ideas from the field to be raised.
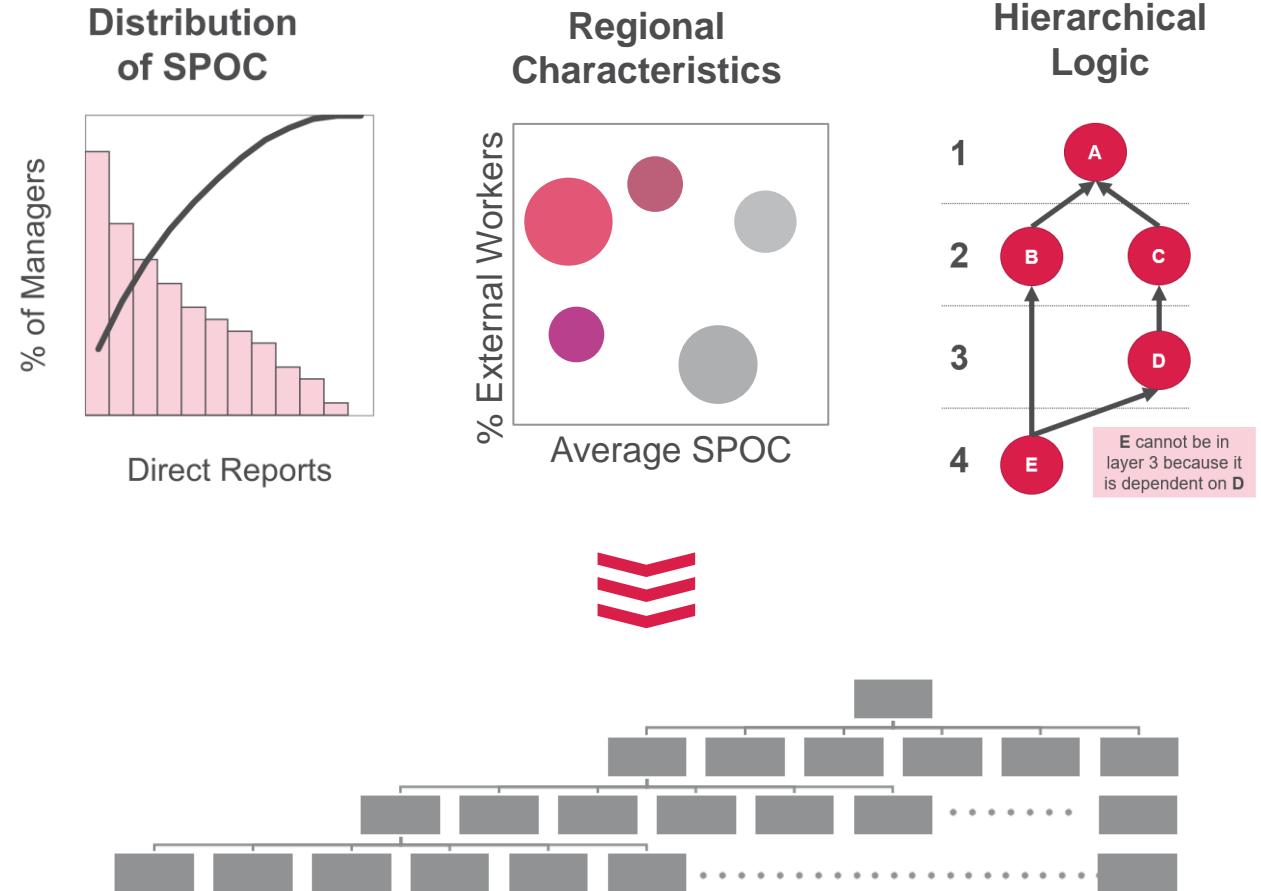
Solution

- Multidimensional quantitative analysis of the percentage of managers with subordinates, divisional and country differences, hierarchical structure, etc., using the HR database.

Value

- Insights into optimal organizational structure
- → Transformation underway to innovative organizational structure

Verification conducted for 1 project in FY2022

Distribution of SPOC

% of Managers

Direct Reports

Regional Characteristics

% External Workers

Average SPOC

Hierarchical Logic

1
2
3
4

A
B   C
D
E

E cannot be in layer 3 because it is dependent on D

SPOC: Span of Control (Number of members that one people manager manages)

astellas