Capturing Value in Pharmaceutical Distribution Strategies

by

Lauren Matz
Bachelor of Science in Industrial Engineering

and

Irene Ogbuefi
Bachelor of Pharmacy

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Signature of Author: _____
Department of Supply Chain Management
May 6, 2022

Signature of Author: _____
Department of Supply Chain Management
May 6, 2022

Certified by: _____
Dr. Jarrod Goentzel
Principal Research Scientist, Center for Transportation and Logistics
Capstone Advisor

Accepted by: _____
Prof. Yossi Sheffi
Director, Center for Transportation and Logistics
Elisha Gray II Professor of Engineering Systems
Professor, Civil and Environmental Engineering

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ABSTRACT

Market Share in the pharmaceutical industry has been dominated by manufacturers that develop the most effective Go-To-Market Strategy. New promises in Cell & Gene Therapy and Personalized Healthcare Products open a wealth of opportunities for new market share in the Asian Pacific region, if manufacturers that can position their supply chain and associated partners effectively from the start. While previous supply chain strategies for pharmaceutical distribution have relied on a single large distributor to manage affiliate level in-country logistics, administration, & payment management services, alternative distribution strategies and partnership schemes may provide greater value to the overall healthcare ecosystem for patient-centric products. To perform a proper evaluation of the potential value a novel distribution strategy could deliver to the manufacturer, patients, and healthcare system, a Multi Attribute Value Analysis (MAVA) Model was created for two use case countries. The alternatives under consideration were a traditional distributor strategy, a switch to a multiple-partner strategy to handle different components of the CGT/PHC supply chain flows, and a switch to an in-house management strategy with the manufacturer handling the majority of the distribution roles. The criteria chosen for the MAVA model evaluation included financial, logistics, and patient factors that aimed to capture a holistic view of the distributor's performance. Value functions mapping a criteria's rating to a normalized score were determined, and weight importance assignment was elicited from key stakeholders. Upon generating data for the initial MAVA model run, the total value a distributor could provide was determined by the model. For the new personalized healthcare product segment, it was found the multi-partnership strategy provided the best overall value in both use cases countries (with a final score of , primarily due to better performance in critical Inventory Management and Patient Engagement KPIs. From this study, it is evident that considering the market structure and pharmaceutical regulations of individual countries helps pharmaceutical companies tailor supply chain strategies to each country's context to maximize patient satisfaction, resource mobilization and cost optimization.

Capstone Advisor: Dr. Jarrod Goentzel
Title: Director, MIT Humanitarian Supply Chain Lab

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1 INTRODUCTION

1.1 Problem Background

One go-to-market strategy that positions companies for greater market share is service to customers. Attention to customer preferences and tailoring production and distribution strategies to these preferences fosters customer satisfaction. The fashion, automobile and electronics industries consistently update customer offerings according to trends. Recently, the pharmaceutical industry is considering its response to increasingly dynamic demand patterns. The era of high demand for public health care products that are usually mass-produced and serve the health care needs of majority of the populace is gradually changing to accommodate demand for individualized health care products. Efficient and effective distribution strategies are required to ensure accessibility and availability of an increasingly diverse product portfolio. This project focuses on Asian Pacific distribution channel strategy for Cell and Gene therapy and Personalized Health Care Product (CGT/PHCP).

1.1.1 Vertical SC Stability & Maturity of 3PL Services

Distribution to service delivery points is a vital segment in the supply chain of health care commodities. Traditional distributors have served as the intermediaries between manufacturing companies and health care service providers to guarantee commodity security. Traditional distributors profit from turnover of large volume goods on small margins. Fourth-party logistics service providers (4PLs) and third-party logistics service providers (3PLs) can also assume the role of traditional distributors. Manufacturing companies rely on distributors to perform several internally determined downstream supply chain roles that culminate in commodity delivery. In the 3PL model, the manufacturers control the majority of the supply chain roles and assign specific logistics and transportation activities to the 3PLs. On the other hand, in the 4PL model, the manufacturers outsource the bulk of the downstream supply chain roles (order fulfilment, payment and credit risk management, warehousing, tender and contracts

management, freight and logistics management, 3PL management) to the 4PLs. These services come with a “cost to serve" fee to the manufacturer.

In recent times, fueled by a desire to invest in untapped patient information at the individual community level, manufacturers seek more participation in downstream supply chain activities. In addition, with technological advances in medicine and Information and Communication Technology (ICT); the suitability of the traditional distributor model has been questioned for its inability to measure up with complementary value-added distributor services. The value-added services in high demand are services to improve patient and data management. Manufacturers therefore seek alternatives that address the shortfalls of the traditional distributor strategy. A potential decrease in patronage for the traditional distributor usually occurs, in the event that they are unable to provide distributor services that are fit for purpose for the changing portfolio of pharmaceutical companies; this leads to vertical integration of roles that were originally fragmented. Some of the vertical integration strategies used include direct distribution from the manufacturer to the service delivery point using designated 3PL service providers; the use of designated traditional distributors to serve the need of a market; and a distribution strategy completely managed by the manufacturing company (Kanavos et al., 2011).

1.1.2 Growth of Pharmaceutical APAC Markets

One key aspect this capstone project will address is what makes the Asian Pacific market distinct compared with other markets that F. Hoffmann-La Roche Ltd. serves. The Asian Pacific region offers an open learning ground due to its large size and population, wide income disparity, variations in health systems and pharmaceutical policies (disbursements and pricing), and variations intercountry in public/private expenditure on health (Banerji, 2013). The pharmaceutical market is experiencing significant growth in the Southeast Asian region. This sector has a projected increase in market share of 11% from 2020 to 2025 and estimated sales of forty billion dollars in 2020 alone. This region has been

described as having one of the fastest growing pharmaceutical markets globally (CHPI South East Asia Report, 2020). Factors favoring growing demand of pharmaceuticals in this region include an aging population, increasing health care expenditure, rising disease incidence and prevalence, the presence of supportive regulatory systems, and increasing efforts at attaining sustainable healthcare through deployment of new technologies. The South East Asian pacific region cannot boast of a well-established pharmaceutical manufacturing sector and are therefore heavily dependent on imports.

Thailand and Taiwan are regional countries of interest in this study. Thailand is densely populated and is notably one of the countries with the fastest aging population. A study has shown a strong correlation between older population welfare expenditure and numbers of Thais aged 60 and above (CHPI South East Asia Report, 2020). Thailand is also a hub for medical tourism and has a well-established Universal Health Insurance Scheme for citizens. These factors have nurtured the positive trend in Thai pharmaceutical market growth; it is estimated at $4.6 billion in 2016 with projected values of $6.3 billion in 2021 and $8.6 billion in 2026 (Sutduean et al., 2019).

Taiwan shares similar pharmaceutical market characteristics as Thailand. A quarter of the health care expenditure in Taiwan is spent on pharmaceuticals (Hsieh & Sloan, 2008); 99% of the Taiwanese population were reported to have health insurance coverage in 2007 (Banerji, 2013). The Taiwanese government is projecting the country to international investors as a base for Research and Development (Business Monitor International Ltd, 2016).

1.1.3 Rise of Personalized Healthcare

Research and development (R&D) in health care thrives on the need for breakthroughs in medicines to tackle new, emerging and existing diseases. The discovery of Personalized Health Care Products (PHCP) and Cell and Gene Therapies (CGT) are R&D successes with high potential. PHCPs are customized medications using molecular information for preventive, therapeutic and palliative purposes.

CGTs belong to the wider category of PHCPs but have a specific focus on modifying or correcting mutant/defective genes using nucleic acids (DNA or RNA). CGT/PHCPs offer value for patients with few or no other therapy interventions for either maintenance or cure within specific disease areas, many of which include rare and ultra-rare diseases. The personalized nature of CGT/PHCPs demands end-to-end traceability of viable cells; long-term follow-up, greater degree of transparency of manufacturing process to patients and treatment physicians, and several mandated regulatory requirements (Deloitte, 2021). CGT clinical trials have been primarily focused on treating oncological disease (65% of trials), with emerging interest in neurological disease (13% of trials), infectious disease (7% of trials), and cardiovascular disease (6% of trials) (Hanna & Toumi, 2020).

1.2 Motivation of Partner (Roche) – Market Growth & Capture

The growth of the Asian Pacific pharmaceutical market and increasing demand for personalized health care products holds promising potentials to gain market share. Having a formidable distribution channel strategy will help guarantee commodity availability, accessibility, customer satisfaction and financial sustainability for Roche.

The distribution model currently in use by Roche in Thailand and Taiwan is the traditional distributor model. Of the 80 – 90 SKUs in the distribution pipeline approximately 97.5% are routed through singular traditional distributor (4PL) per country and the remaining 2.5% are routed through the 3PL distributor model for Taiwan. The traditional distributors provide in country logistics, administration and payment management services. Roche's product portfolio is increasing to include CGT/PHCP. These products are specialty product and the patient is part of the supply chain since they the repository for the raw materials needed to initiate production. The key factors that guide manufacturers' choice of an appropriate distribution strategy for specialty drugs are: drug characteristics (dosage form, handling and temperature requirements); point of delivery (hospital, research institutes); distributor services required

(order fulfilment, patient support, risk evaluation and mitigation); referrals based on historic performance and prior business relationships (Xu, 2020). Roche has recognized that the conventional distribution strategy (pick, pack, ship, warehouse before delivery to the last mile) using the traditional distributors may not be the most appropriate strategy for personalized health care products and cell and gene therapies. Roche seeks supply chain solutions that will guarantee that all of its products are delivered in the right place, at the right time, cost and condition. The company is motivated to define CGT/PHCP product segments where the supply chain is synchronized with other products and segments to be handled in isolation.

1.3 Problem Statement

Roche would like to understand the patient factors that are leading to transitions in demand for health care products. Roche is also interested in understanding the intricacies of the Asian Pacific Pharmaceutical Market that make it unique compared to other markets that the company serves. This is because understanding the market structure and pharmaceutical regulations of individual countries helps pharmaceutical companies tailor supply chain strategies to each country's context to maximize patient satisfaction, resource mobilization and cost optimization. This will also aid the overall penetration and sustenance of market share. Roche seeks to evaluate the suitability of 4PL and 3PL traditional distributor models for PCHPs and CGTs. Roche would like to understand why, how and when to propose a change in distribution strategy. Taking into consideration financial, logistics and patient factors, the ultimate goal of this capstone project is to determine which distribution channel strategy will offer Roche the best value proposition for dynamic product portfolios and patient demands.

2 PROBLEM CONTEXT

To fully address the research question, a fundamental understanding of the demand changes in both personal healthcare and in Asia-Pacific was necessary. The first step explored the demand transitions that have occurred independently in personalized healthcare and in the Asia-Pacific healthcare experience to understand any disparate tendencies. The next step synthesized the trends from both areas into three primary themes, which guided the direction of the framework development. The final step developed an impact analysis of these themes on the distributor, which resulted in the identification of both improved services required and emerging services desired.

2.1 Exploration of Demand Transitions in Healthcare Products and Markets

In order to lay the foundation for the framework, an exploration of the current and ongoing demand transitions in the Healthcare Industry was pursued. Cell & Gene Therapy (CGT) products were discovered to impact segmentation strategies, instill new complexities, and redefine value-added services to an already complex environment. Asian Pacific Healthcare Transitions Demands had been identified as actively preventing counterfeit drug dispersion, providing higher quality care, and allowing greater product affordability and accessibility. From these two streams of literature, a synthesis of the individual trends across both areas was created.

2.1.1 Personalized Healthcare Demand Transitions for Healthcare Supply Chains

The rise of CGT products in the healthcare industry necessitated supply chain professionals to move from traditional unidirectional network designs and to novel circular designs. As the patient is both the start and the end of the supply chain, the network becomes a closed-loop system (Tarnowski et al., 2017). With a closed-loop supply chain, new complexities, services, and segmentations will be required for implementation.

2.1.1.1 New Supply Chain Complexities

In order to preserve the sensitive temperature conditions that CGT products require, stringent measures must be in place to ensure the quality of the product. Specifically, CGT products will require intensive Chain-of-Identity (COI) and Chain-of-Compliance (COC) measures (Sarkis et al., 2021). Chain-of-Identity refers to the fully permanent and completely transparent association of the unique patient to their cell/tissue sample throughout the entire care lifecycle, from manufacturing to post-treatment monitoring. Chain of Compliance refers to the permanent and unalterable data capture of every step and action that the cell/tissue sample undergoes, from collection to product administration.

While pharmaceutical supply chains have always been subject to strict standards of traceability, new COI and COC standards demand that every single actor and action partaking in the supply chain will be digitally recorded and retained. Crafting and maintaining the data systems and structures to enable full COI & COC traceability will be a transformative capability for the industry.

2.1.1.2 New Supply Chain Value Added Services

As every CGT product is unique to the patient whose cells/tissues they emanate from, there are new services that will be required to ensure the entire process occurs smoothly. Unlike traditional pharmaceutical products, the product characteristics of the CGT therapies drive price, point of care, and entire site networks (Srivastava, 2019).

With a product designed, produced, and delivered for a singular patient, a dramatic increase in the tailoring of care required is an inevitable consequence. As CGT therapy represents a holistic journey rather than an isolated outcome, closer ties to the patient to ensure their compliance, adherence, and comfort in the therapy process can either encourage or erode the overall success of the treatment plan.

A supply chain designed around the interactions with the patient will be a differentiator that will separate the best from the rest.

2.1.1.3 New Supply Chain Market Segmentations

While health and medicine continue to technologically progress in both precision and personalization, CGT products will introduce an entirely new segment of the pharmaceutical market. Unlike mass distributed oncological products currently on the market, CGT products will be provided for a specific target audience, with a very low volume of products with a very high cost value (Vicente et al., 2020). As a result, CGT products will inadvertently drive further segmentation of already specialized pharmaceutical product offerings.

With such high costs associated with serving a very small population, pharmaceutical companies will have to be increasingly strategic in what specific portion of the disease population they will be targeting. The capability to produce and deliver an incredibly valuable product to the critical few will be determined by how well both the supply chain and distribution networks are designed to accommodate the new market profile.

2.1.2 Asian Market Demand Transitions for Healthcare Supply Chains

From a pharmaceutical manufacturer's perspective, the rise of Asia over the last 20 years has heralded exciting prospects for large market shares. Southeast Asia's promising emerging pharmaceutical market represent a tantalizing opportunity to increase by 18% over the next 15 years (Tohme, 2013). Understanding the ongoing supply chain challenges, as well as opportunities, will provide any distributor with a significant competitive advantage.

2.1.2.1 Ongoing Distribution Challenges

Emerging Markets offer a very lucrative opportunity for expanded market share not only for established pharmaceutical companies, but also for illegitimate drug makers. In particular, the Thai government has faced significant challenges in their ability to track and suppress the offenders, as the legal penalties against offenders remain weak (Pumtong, 2020). Though exploiting immature regulatory structures in the region, a thriving illegitimate drug trade flourishes in the Asian Pacific.

While both the domestic and tourism medical markets in Asia continue to grow, putting solid regulatory practices in place will help curb counterfeit drug proliferation in the pharmaceutical supply chain. As the distributor's ability to counter these measures serve as pharma's greatest defense against imitations, the supply chain is uniquely positioned to be a force for good in the ecosystem.

2.1.2.2 Ongoing Quality of Care Divisions

Though the Asian Pacific healthcare marketplace is often seen as an aggregate, there are many stark divisions in the maturity and capabilities of the pharmaceutical supply chain across them. In an audit performed by the World Health Organization on 30 distributors within 5 Asian Pacific Countries, the average Cold Chain Management compliance to WHO Model Quality Assurance System (MQAS) was only 50%, with a range of 42% - 75% (Van Assche et al., 2018). As the countries utilized in the audit represent countries of various socioeconomic progress, such as Myanmar and the Philippines, the resulting disparities create imbalanced overall healthcare experiences.

While a pharmaceutical manufacturer may feel the desire to apply a blanket strategy across an entire region, country-specific intricacies, technological readiness, and adoption rates differ vastly across the continent. Treating the region as an aggregate is a clear distribution pitfall that will not fully satisfy any one particular country segment.

2.1.2.3 Ongoing Accessibility and Affordability Issues

Though the Asian Pacific region is quickly becoming a hotspot for pharmaceutical investment and activity, accessibility to basic drug products remains a far larger issue than the implementation of CGT products. In a comparative study of Indonesia, Malaysia, Singapore, & Thailand, it was noted that the majority of Asian Pacific healthcare systems must first address the fundamental issue of access to basic healthcare services prior to undergoing a larger and more complex CGT transformation (Chong et al., 2018). While the cost of CGT products will continue to rise, the economic impacts will also be felt by the individual countries.

When targeting such a small portion of the population with CGT products, pharmaceutical manufacturers must ensure that for every patient that can be reached, they can also access and afford treatment. While a distributor may be able to physically reach the target market, they must also ensure that final delivery can be achieved.

2.2 Synthesis of Demand Transitions for Healthcare Supply Chains

The need to support PHCP/CGT markets and emerging Asian markets resulted in the three following trends:

2.2.1 Demand for Greater Product Visibility

Both Manufacturers and Distributors must understand where the product is at all times when moving through the supply chain. Whether the Distributor is fulfilling serialization requirements for the local country or medicinal labeling requirements imposed by the manufacturer, the Distributor must have a considerable level of visibility available.

2.2.2 Demand for Enhanced Patient Support

With the ongoing pressures to simultaneous compensate for poor healthcare infrastructure in developing countries as well as meet high quality care standards required for PHCP/CGT therapies, ensuring the patient is supported through the entire process will be a new value for distributors to provide in the supply chain. While this capability currently does not exist, it may serve as a differentiator in the future.

2.2.3 Demand for Extended Care Accessibility

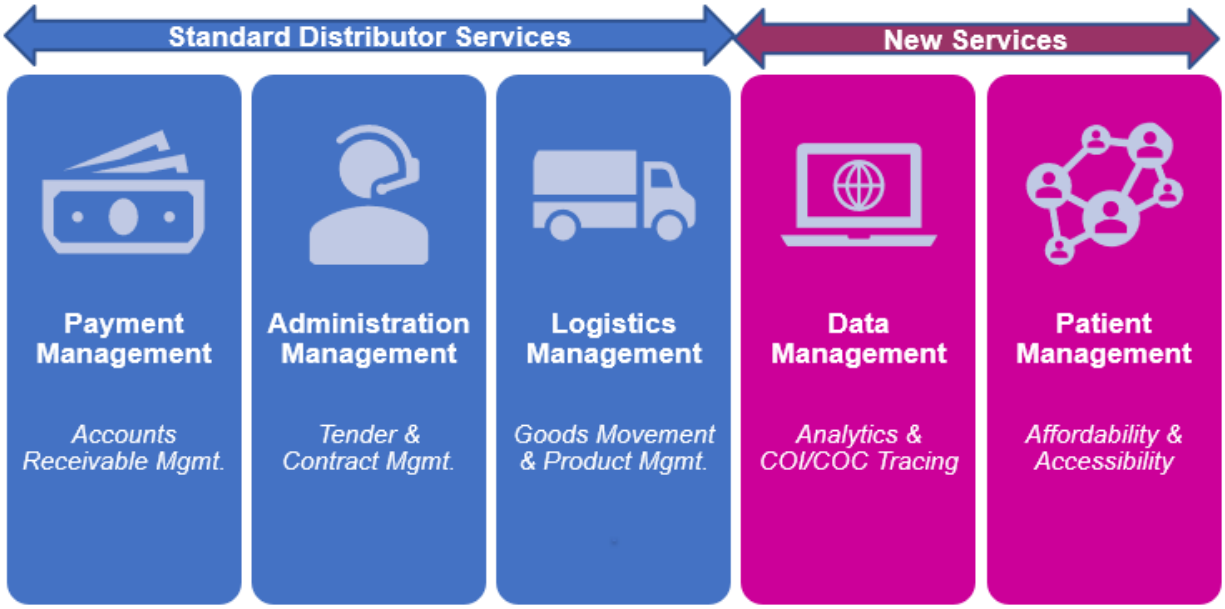
As PHCP/CGT products become extremely specialized, a whole new host of patients become a part of the target market for new drug development and delivery. The Distributor that can reach these novel patient groups, and overcome both social and geographical constraints, will be well suited to perform in this future space.

2.3 Impacts to Distribution Channel Service Strategies

From reviewing the trends outlined above, the future Distributor has a large opportunity to provide both improved traditional services as well as new services that will benefit the manufacturer, the local health network, and the patient concurrently. A description of the potential service improvements is outlined in Figure 1.

Figure 1

Standard & New Services of the Distributor



2.3.1 Improvements upon Traditional Distributor Services

2.3.1.1 Payment Management Services

The Distributor has the potential to augment payment management services, acting as an enabler for transactions to happen at a smoother and quicker pace than previously allowed. This should ease burdens on both the local healthcare system as well as the manufacturer.

2.3.1.2 Administration Management Services

The Distributor has the potential to help accelerate the Tender and Contract Management portion of the drug delivery. As each CGT product will represent its own SKU, each product will have to undergo its own tender process. The Distributor can help shape and standardize this process so it is as streamlined as possible, which may include faster reimbursement from the customer to the distributor.

2.3.1.3 Logistics Management Services

The Distributor will continue to play a dominant role in ensuring the product will physically leave the manufacturer and arrive at the point of care at the right time, at the right place. Leveraging core competencies and best practices for cold-chain delivery will continue to play a critical role in determining distribution capability.

2.3.2 Development of Emerging Distribution Channel Services

2.3.2.1 Data Management Services

Extended visibility to support Chain of Identity & Chain of Compliance Standards will be a critical factor to the successful implementation of CGT treatments. The manufacturing will demand not only descriptive analytics of where the product currently is, but also demand predictive analytics on whether the product will arrive on schedule. A Distributor that can provide such visibility will be well positioned in the value chain to enable overall success of the system itself.

2.3.2.2 Patient Management Services

Treating the patient as a critical node in the supply chain will be required for any Distributor that wishes to perform in the CGT space. Through prioritizing the patient, the Distributor can jointly address the emerging demands of enhanced support and care accessibility. Having a keen understanding of their pain points, their needs, and ways to improve their experience will be critical in capturing as much of the treatment market as possible.

3 LITERATURE REVIEW

This chapter explores the available wealth of knowledge in literature on the key subjects in this project - Distribution Channel Strategies, Cell and Gene Therapies and Personalized Health Care Products (CGT/PHCP); and the Asian Pacific Region. Particular areas of interest in this literature review are:

- Strategies for Pharmaceutical Distribution Channel Selection: This will focus on current pharmaceutical distribution channel strategies, factors that informed selection and how well they have served; the sustainability of traditional distributor strategies with the advent of CGT/PHCP; and Asian Pacific pharmaceutical distribution channel strategies to understand how to create a fit for purpose distribution strategy for unique market structures
- Review of Selection & Decision-Making Model: Strategy is key to attaining set organizational goals. Strategy selection ideally should be based on consensus of stakeholders in an organization. Decision-Making Models help inform strategy choices. This section will explore how previous studies have used Decision Making Analytics and Prescriptive Decision-Making Models to make decisions critical to a change in strategy.
- Multicriteria Decision Model (MCDM) Types: Various MCDMs have been used in various studies to help make informed decisions. Understanding the unique characteristics of each and identifying the model with the best potential to elicit the objectives of this project will be the crux of this section.

3.1 Strategies for Pharmaceutical Distribution Channel Selection

3.1.1 Pharmaceutical Distribution Channel

Several studies that explored pharmaceutical distribution channel strategies made similar discoveries (Zhang, Q. & Zhang, M, 2017; Hisey et al., 2019). It is common practice to outsource downstream supply chain operations (warehousing, order fulfillment, last mile delivery) to middlemen who are called wholesalers or distributors. Hisey et al. in their study on The Role of Distributors in the US health care industry showed that prescription medicines routed through distributors increased from 82% in 2007 to 92% in 2017 with the remaining 8% using direct delivery (Hisey et al., 2019). Zhang, Q. & Zhang, M. attributed the high patronage for distributors in the supply chain pipeline to the longstanding segregation of duties in the pharmaceutical industry and the prioritization of research and development over roles that involve interfacing with customers. Traditional distribution helps companies leverage economies of scale. Warehousing and delivery can be consolidated by distributors, for different companies, for regular public health care products requiring similar handling and storage requirements. Our research seeks to determine whether the same could be said for CGT/PHCP.

3.1.2 CGT/PHCP Specific Distribution Channel Strategy Requirements

Product characteristics inform requirements for suitable distribution strategy. This helps to optimize product viability throughout its value chain. A study carried out by Papathanasiou et al. (2020) highlighted the unique properties of CGT/PHCP. CGT/PHCP are not only temperature sensitive but also stress sensitive. They should be entrusted to personnel skilled in handling them while in transit. The shelf life of CGT is short, therefore time is a major constraint in their supply chain. Greater financial risk is associated with CGT/PHCP as they are high value products. Technologies to facilitate traceability of samples are inevitable with CGT/PHCP since each sample must have a patient identifier number and be monitored throughout its flow through the supply chain pipeline. Chain of custody documentation at

every point in transit detailing location, temperature and security is also required (Papathanasiou et al.,2020).

A distribution strategy for CGT/PHCP will need to factor in the capabilities required to handle each of complexities listed. In a study on Delivering Advanced Therapies: the Big Pharma Approach Tarnowski et al. (2017) advocated for lasting supply chain remedies to optimize cost and access for CGT patients. Supply chain networks in existence default to central warehousing and generally, lack automated systems at close proximity to clients to facilitate the patient's journey through CGT/PHCP therapy. Cryopreservation equipment, patient support, robust data management systems and human resource capacity boost are new capacities suiting a CGT/PHCP worthy distribution channel (Hisey, 2019).

Supply Chain distribution strategies employed during the COVID-19 pandemic are of relevance in this study. CGTs//PHC and COVID vaccines distribution can be compared because both commodities are molecular customized treatments that must be stored and shipped at extremely low temperatures ideally, at -70 C and below (Saha & Roy, 2021). For COVID-19 vaccine rollout, partnerships were established and in cases where they already existed, they were strengthened; contracts with distributors were not limited to just one distributor but excess capacity was accommodated for distribution, warehousing and handling and blockchain solutions for real time data capture and product visibility were established (U.S. Department of Health and Human Services, 2020).

3.1.3 **Asian Pacific Pharmaceutical Distribution Channel Strategies**

The popular get-to-customer means for health care commodities is the traditional distributor. Literature search revealed limited studies on quality management and innovations in last mile distribution solutions; few of such studies is the case for Southeast Asian countries (Sohail et al., 2004). Poor management interest in exploring innovative solutions, lack of pressure from companies on traditional distributors and non-availability of finances to invest in supply chain innovations have been identified as

some of the challenges plaguing improved quality of logistics management in the Southeast Asian countries. Key drivers for improved distribution channel strategies were identified as low customer satisfactions, management interest and number of competitors in the product market space (Sohail et al., 2004). The key drivers give credence to the fact that distributor strategy review is ignited by a desire to gain more market share and satisfy distribution needs with changing product portfolio.

3.2 Decision-Making Models

3.2.1 Decision Making Analytics

Decision-making involves choosing from a set of options. As basic as this sounds, there is a logical sequence of events that should precede settling on an option. The first step in providing a model to support an organization in decision-making is descriptive analytics. This step can be likened to the iterative process between the business-understanding and data-understanding steps in Cross-Industry Standard Process for Data Mining (CRISP-DM). It involves looking at the available data and interacting with the company stakeholders to understand present state, motivation for change (social, economic or psychological) and the projected state they intend to achieve.

If the decision-making is constrained by uncertainty, then the next step is predictive analytics. Using historical data from the descriptive analytic stage, it is possible to simulate feature scenarios while exploring various decision-making options.

The next step in the decision-making process is normative analytics. This involves mapping metrics to the criteria for each decision option in order to facilitate quantification of the decision outcomes. Normative analytics reflects the assumption that decision makers conform to rationalism, which implies that they will not deviate from the goals established in the earlier stages.

The final stage is prescriptive analytics. Utilizing input from all the earlier stages, this step identifies the alternatives that are likely to produce the best solutions for the problem a company is trying to solve. Scenario planning is also factored in to forecast possible future opportunities, anticipate risks, and consider mitigation strategies for each of the best alternatives under consideration (Bozorgi-Haddad et al., 2021).

3.2.2 Prescriptive Decision-Making Model Research

This research seeks to explore existing and potential distributor channel strategies with an aim of choosing a distribution strategy that will increase Roche's value proposition in the CGT/PHCP space. One method that we will use to unravel this puzzle is the Multi Criteria Decision Making (MCDM) models. According to Hanne et al. (1995), MCDM is a management science, which leverages on multiple criteria (objectives, goals and attributes) to make decisions using quantitative and qualitative methods. There are two major categories of MCDM models, Multi-Objective Decision Making (MODM) and Multi-Attribute Decision Making (MADM). These two categories also have subcategories. MCDM models can be used under situations of certainty or uncertainty. A situation of certainty requires availability of relevant information and clear understanding of the inputs in the model. For the decision under certainty, the assumptions are availability of all relevant information about the prevailing situation and the ability to establish connection between the outcome and the decision. Decision under uncertainty prevails when relevant information about the decision situation is lacking or vague, often referred to as fuzzy (Singh & Malik, 2014).

3.2.3 Multi Objective Decision Making (MODM)

Multi Objective Decision Making (MODM) involves creating and exploring options to determine which one optimizes the multiple objectives available to the decision maker. The choices are usually

continuous (i.e., infinite number of alternatives) and the selection is based on the option that best matches the decision maker's priorities while taking into consideration highlighted constraints. This method is appropriate for complex problems comprising many decision variables with potential constraints. Planning and designing are integral components of MODM (Singh & Malik, 2014). Some studies have shown the relevance of Multi-objective Optimization Decision Models for vendor selection in Pharmaceutical Supply Chains (Kumar et al, 2006; Amid et al., 2006; Sigh &Goh, 2019). This capstone project is more of an evaluation of predetermined distributor strategy and not an effort at designing distributor channel strategies for CGT/PHCP. The MODM is therefore not the suitable MCDM model for this study.

3.2.4 Multi Attribute Decision Making (MADM)

Multi Attribute Decision Making (MADM) model is used to solve ranking problems were we there is a finite number of predetermined options tied to various attributes. Unlike the Multi Objective Decision Models that are for an infinite number of alternatives, the MADM models are for decision making within a discrete decision space (Triantaphyllou et al., 1998). This approach is more of an evaluation of possible conflicting options than planning and designing new alternatives. Shyur and Shih (2016) in their study on a hybrid MCDM model for strategic vendor selection confirmed MADM model's effectiveness in vendor selection despite the prevalence of conflicting criteria.

Standard characteristics of MADMs are:

1. A set of alternatives that will eventually be ranked by the model
2. Multiple goals, whose building blocks are information nodes that will guide the evaluation of the alternatives
3. A decision tree that can be used to visualize all inputs in the analysis
4. Should accommodate incommensurable units

5. Standardized weight allocations to attributes
6. Can be visualized using a decision matrix that provides a snapshot of how each alternative fared given the weights assigned/decision criteria (Triantaphyllou et al., 1998)

An MADM analysis for three decision alternatives and five criteria will have a Decision matrix that looks like Table 1.

Table 1

Multiple Attribute Decision Making Matrix

Criteria	C_a	C_b	C_c	C_d	C_e
Weights	W_a	W_b	W_c	W_d	W_e
Alternatives					
A1	X_{a1}	X_{b1}	X_{c1}	X_{d1}	X_{e1}
A2	X_{a2}	X_{b2}	X_{c2}	X_{d2}	X_{e2}
A3	X_{a3}	X_{b3}	X_{c3}	X_{d3}	X_{e3}

Where C_i = Criteria name

W_i = Weight for relative performance of criteria *i*

A_j = Alternatives under consideration

X_{ij} = Elements with assigned values for assessment of each alternative *i* for criteria *j*

The aim of the analysis remains to identify the alternative whose sumproduct of W_i and X_{ij} shows the highest degree of preference with respect to all enlisted criteria.

3.2.4.1 MAUT – Multi-Attribute Utility Theory

Multi-Attribute Utility Theory (MAUT) is a subcategory of Multi Attribute Decision Models (MADM). MAUT is an organized methodology designed to tackle the tradeoffs among multiple objectives in decision-making (High School Operations Research, 2022). It is a structured approach that uses Weighted Sum Model for quantifying decision-makers preferences. Standardizing weighted values assigned to the predefined functions provides a platform for effective comparison of outcomes. MAUT is suitable for decision making with or without uncertainty. One limitation of the Multi-Attribute Utility Model is that the data that makes up the hierarchal decision tree should have similar units (Shanmuganathan et al., 2018). Cardinal utility functions are assigned to decision options in this model and they give an insight into the strength of preference among the available options (Ramanathan, 2004). MAUT model is the most thorough MCDM as it incorporates both the risk preferences of the decision makers and the uncertainties in real life scenarios (Velasquez & Hester, 2013).

3.2.4.2 MAVT – Multi-Attribute Value Theory

Unlike the MAUT model that is capable of handling decisions under circumstances of certainty and uncertainty, the MAVT can only be used in decision making when the proposed criteria and the anticipated outcomes are certain (Lindell, 2017). The MAVT model is a simplified version of the MAUT model; this is because the model is oblivious to the uncertainty in the decision environment or possible risks that may present in the event of implementing the decision. The logic behind the MAVT model is assigning a value function to a decision maker's preference. If a decision maker favors decision A against decision B then value assigned to A will be greater than the value assigned to B in the model. The value function assigned in the MAVT model is ordinal. Like all MADM models, the MAVT observes the standard prerequisites of establishing the right alternatives and criteria; assigning numerical weights according to

criteria contribution in selected alternatives and translating numerical weights to an effective ranking process for each of the alternatives.

3.2.4.3 The Weighted Sum Model (WSM)

The weighted Sum Model offers a simple evaluation approach in Multi Criteria Decision Making models. It is most suitable for linear problems. Its principle is to select the alternative that gives the highest numeric value for the sum product of weight and actual value per element for all the criteria under consideration.

$A_{prime} = \max \sum X_{ij} * weight_j$ for i = 1,2,3 …. Number of criteria

Where A_{prime} is preferred alternative from the analysis

X_{ij} = values assigned for each element under each criterion

$Weight_j$ = weight assigned each criterion

3.2.4.4 Analytic Hierarchy Process -AHP/ Analytic Network Process ANP

Analytic Hierarchy Process (AHP) is one of the classification techniques used in MCDM. AHP breaks complex problems into a multilevel hierarchical structure of objective, criteria and alternatives (Sharma et al., 2008). AHP allocates criteria weighting through pairwise comparison that serve as pointers to preferred alternatives. It has proved effective in decision making where the criteria can be structured using a hierarchical tree showing sub-criteria as the building blocks of desired goal (Tuzmen and Sipahi, 2011). AHP does not accommodate expansion of the model to include more alternatives after the model has been built. This is because the model is sensitive to post model development changes and is susceptible to rank reversal (Velasquez & Hester, 2013). AHP is also faulted for lacking transparency and difficulty of pairwise comparisons as the scope of problem element increases.

Analytical Network Process (ANP) serves a similar purpose as the Analytical Hierarchy Process but the hierarchical approach is deemphasized using ANP. This is because some problems are a complex web of multiple elements interacting in varied ways among decision levels and attributes. The ANP allows for multidirectional interaction of decision levels and attributes (Yüksel & Dağdeviren, 2007). It is referred to as a generalizable form of AHP since it gives room for dependence and interdependence among elements of the decision process and better mimics the real-life considerations that go into decision-making. It has received recommendation for project selection, green supply chain management, product planning, and optimal scheduling problems (Velasquez & Hester, 2013).

3.2.4.5 Technique for Order Preference by Similarity to Ideal Solution - TOPSIS

TOPSIS is rated as one of the best MDCM techniques for ranking alternatives in decision making It is relatively easy to use, serves well for both qualitative and quantitative data and has a transparent logic (Mousavi-Nasab, S. H. & Sotoudeh-Anvari, A, 2017). It works by finding the alternative of closest proximity to the positive ideal solution and of farthest proximity from the negative ideal solution (Qin et al., 2008).

3.3 Capstone Methodology Choice

This study seeks to explore the best distribution strategy that will support Roche, empower patients and be acceptable/satisfying to the physicians/health care system. The alternatives in this decision-making process are:

1. Maintain the status quo – continue to use the traditional distributor managed model
2. Switch to incorporate multiple partners that will handle different components of the distribution value chain for CGT and PHC

3. Switch to in-house management with majority of distributor roles handled by Roche and outsource few roles (logistics and patient management).

A limited set of predetermined finite alternatives will be analyzed in this study, which eliminates suitability of Multi Objective Decision Model. The Multi Attribute Value Theory (MAVT) is our model of choice for this study.

This capstone project has data in different measures – labor hours, cost inputs; unit counts of orders, shipments, deliveries; key performance tracking using percentage measures, etc. To accommodate varied units of measure, the approach will be to standardize relative values assigned to decision criteria elements. The Weighted Sum Model was selected as our ranking technique. The intention is to develop a simple model for decision making based on both expert judgment and available information. The weight assignments are subjective while the value assignments are objective. Montibeller and Francoin (2007) in the book titled Decision and Risk Analysis for the evaluation of Strategic Options gave credit to the Weighted Sum Model as a simple and effective model for calculating overall potential strategic alternatives. Since human judgment is involved at different levels of MCDM value tree, an analysis completely free of bias is unlikely (Montibeller, 2018). Weight allocation using swing weights is one of the approaches used to manage the technical lapses that accompany subjective judgment. Swing weights is a scaling approach that hinges expert opinions on worst and best levels of the attribute. Swing weights also help check for consistency in judgment by comparing difference in value between paired options.

4 METHODOLOGY

In order to provide Roche a comprehensive model for evaluating a distribution channel strategy, a Multi Attribute Value Analysis (MAVA) Model was developed. The MAVA Model functions as a practical application of MAVT in a realistic scenario for evaluating distinct alternatives (Ferretti, 2016). Through developing the MAVA Model, three different objectives were identified, and six different criteria were utilized for performance evaluation of the objectives, with twelve different sub-criteria measurements were used to support the criteria.

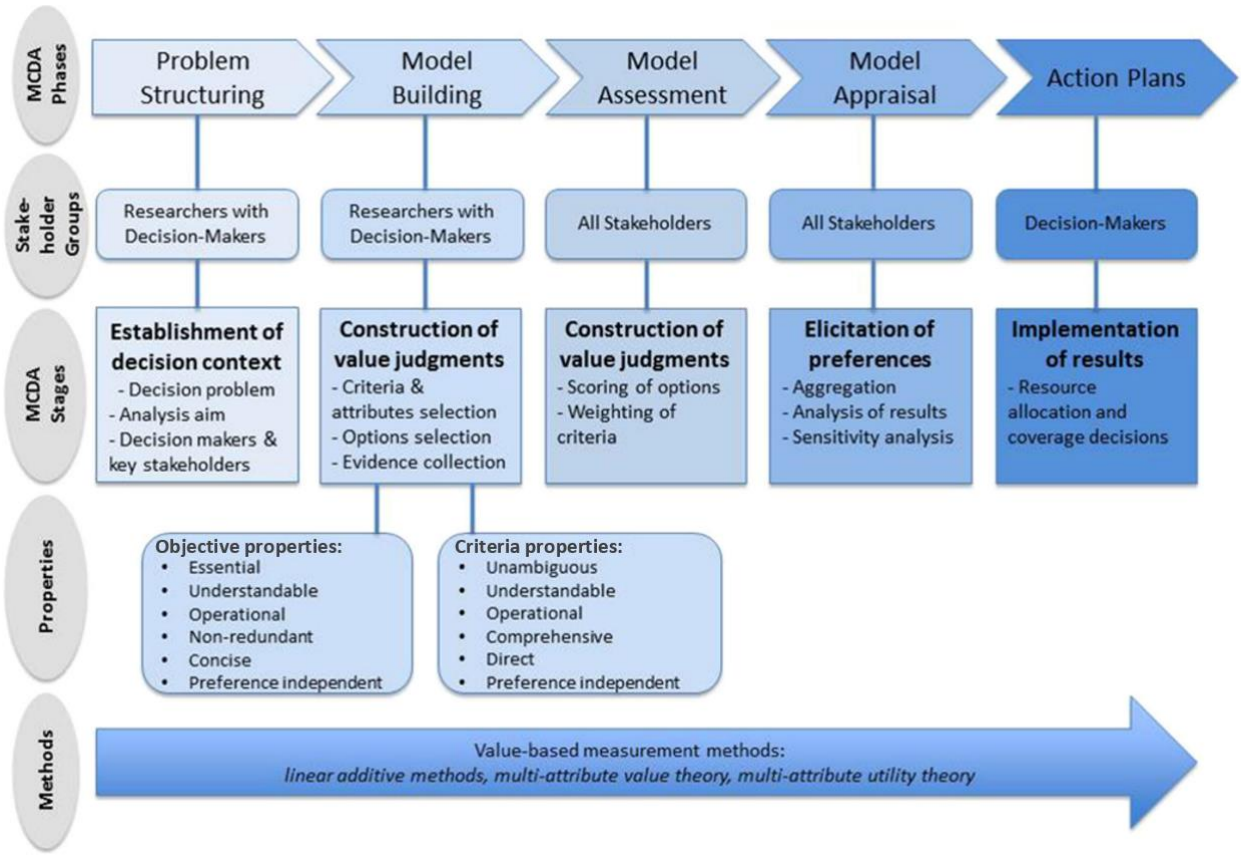
Our Methodology is segmented into the following sections:

4.1 Objective & Criteria Definition
4.2 Alternatives Description
4.3 Value Function Determination
4.4 Weights Assignment
4.5 Attribute Valuation
4.6 Total Value Assessment

Through applying the MAVT methodology, a Multi-Attribute Value Analysis (MAVA) Model was constructed for both the developed Asian markets PHCP/CGT Space as well as the emerging Asian markets PHCP/CGT Space. For the developed Asian Markets, Taiwan was used as a representative country, and for the emerging Asian Markets, Thailand was used as a representative country. The comprehensive methodology for creating the MAVA Model follows a schema similar to that seen in Figure 2.

Figure 2

MCDM Formulation Methodology for MAVA Model

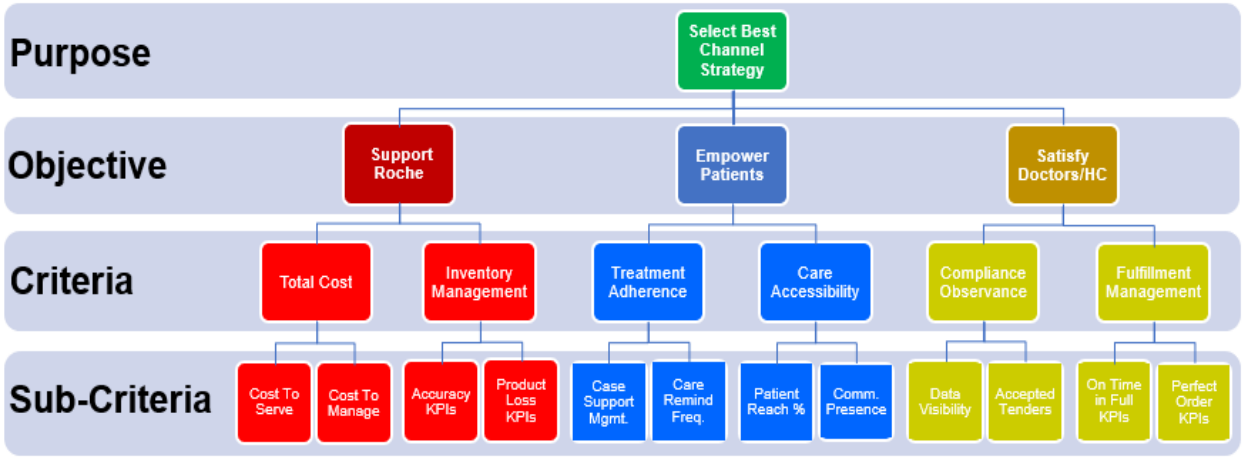


4.1 **Objective & Criteria Definition**

All objectives, criteria, and sub-criteria were developed with key Roche personnel and were reviewed for their completeness to capture the quintessential measures required for a comprehensive distribution channel strategy evaluation. Categorization was organized by the Value Function Hierarchy, in which all criteria are classified by the objective they serve (Parnell, 2013). A definitive overview of the Value Function Hierarchy can be seen in Figure 3.

Figure 3

Overall Functional Value Hierarchy for MAVA Model



4.1.1 **Definitizing the Objectives**

The initial step of creating a MAVA Model is to determine the overall goal of the outcomes of the model. For the distributor strategy MAVA Models, the primary goal of the model was to determine the "most valuable" distribution strategy, which would be the strategy that provided the most overall benefit to the primary stakeholders. Following the identification of the goal, the next task was to specify appropriate objectives that underlie the overarching goal of the MAVA model, and also set the foundation for a robust model. Further, objectives should be relevant, understandable, operational, non-redundant, & have preferential independence (O'Brien, & Dyson, 2007). Upon discussion with Roche Decision Makers, the three objectives chosen for the model aligned with the three key stakeholders that the future distribution channel would serve. The three key objectives identified were supporting Roche's internal business operations, empowering patients to complete their treatment, and satisfying the local healthcare system's regulations, as seen in the objective row of Figure 3.

4.1.2 Definitizing the Criteria

For criteria that were under consideration, a thorough review was required to ensure that they followed MAVA protocol. Further, criteria must be unambiguous, understandable, operational, comprehensive, direct, preferentially independent (criteria are not dependent on each other) and have weak-difference independence (criteria order preference is not influenced by the presence of a single other criterion) (Dyer & Sarin, 1979). Finally, the criteria must have upper and lower limits well specified, as this creates the bounds in which the model will assess the possible criteria (Montibeller, 2018). There were six different criteria that were identified with the Roche decision makers, as well as twelve different sub-criteria, as seen in the criteria and sub-criteria rows of Figure 3.

4.1.2.1 Criteria supporting Roche Objectives

The two primary criteria that were identified for Roche support were the following: 1) Total Cost Roche would incur for the specific distribution strategy, & 2) Inventory Management practices that the potential distributor had demonstrated. This resulted in four different sub-criteria, which aimed to measure Total Costs to both Serve & Manage the new distribution channel strategy, as well as aimed to capture both Inventory Accuracy & Product Loss Key Performance Indicators for the distributor's internal warehouse operations. The sub-criteria that directly supports Roche's business operations are described further in depth below:

4.1.2.1.1 Total Cost-To-Serve (supports Total Cost criteria)

The Total Cost-To-Serve is defined as the activities tied to the distributor's ability to manage the supply chain network. These activities include, but are not limited to, product management (demand management), order processing, warehousing, transportation, other services (recalling product).

The Total Cost-To-Serve was chosen as a metric because of the financial insight into the distributor that can be uncovered. Capturing Total Cost-To-Serve has been effective at uncovering how costs accumulate though the supply chain, based on the combinations of products and customers, and how choices made by the distributor drive the costs (Braithwaite, 1998). Within the pharmaceutical industry, The Total Cost-To-Serve allows Roche to determine how much of a fee is attached to a biological product, as well as to provide a yardstick for comparison with other options.

4.1.2.1.2 Total Cost-To-Manage (Supports Total Cost criteria)

The Total Cost-To-Manage is defined as the cost that Roche has incurred internally to manage the distributors and the respective distribution channel. These activities include, but are not limited to, service contract fees, property rentals, business administration costs (SG&A), as well as staff strength for distributor management services.

Utilizing the Total Cost-To-Manage metric is a beneficial measure for the pharmaceutical industry to understand the extent of personnel and resources required to effectively utilize the distribution network (Zhang, 2017). Total Cost-To-Manage can be seen as an interesting juxtaposition to Total Cost-To-Serve, as it is a supplementary expense beyond what Roche is already incurring.

4.1.2.1.3 Inventory Accuracy KPIs (Supports Inventory Management Criteria)

The Inventory Accuracy KPI is defined as a measure of how accurately the distributor is tracking both the quantity and availability of products in inventory, and involves tracking the end of year stock balance against annual physical count. Inventory Accuracy KPIs are valuable to pharma organizations, as monitoring and evaluation strategy helps align with organizational goals and ensure continuous availability of product.

Ensuring accurate inventory levels further encourages the distributor to actively control their warehouse practices, and also serves as a way to ensure the inventory level is required to be high enough to maintain a mutually agreed upon service level to the downstream customers and low enough to control investment buying (Zhao et. al, 2011). If inventory levels are not accurate at the level of the distributor, serious ramifications can manifest downstream during final product delivery.

4.1.2.1.4 Product Loss KPIs (Supports Inventory Management Criteria)

The Product Loss KPI is defined by the quantity of product leaving the pipeline for reasons other than administering to a patient. There is a high level of scrutiny and interest in improving visibility and accountability for products from arrival in-country-through distributor-to last mile.

The use of Product Loss KPIs as a metric provides a way for a pharmaceutical company to evaluate possible risk a distributor may introduce to the supply chain. Depending on the facilities and operational practices used, there can be a dramatic variance in the distributor's ability to appropriately and accurately handle product (Grujic et. al, 2020). While this metric could be expounded into an entire host of risk factors, Product Loss KPIs are intended to collectively capture the impacts of poor distributor inventory practices.

4.1.2.2 Criteria supporting Patient Objectives

The two primary criteria that were identified for patient empowerment were the following: 1) Treatment Adherence to the prescribed therapy plan, & 2) Care Accessibility for all potential vulnerable populations. This resulted in four different sub-criteria, which aimed to measure the effectiveness of the distributor's Case Support & Care Reminder Management Services, as well as aimed to capture both the Patient Reach and Community Presence of the distributor's footprint. The sub-criteria that directly supports empowering the patients are described further in depth below:

4.1.2.2.1 Case Support Management (supports Treatment Adherence criteria)

Case Support Management is defined as the ability of a distributor to resolve CGT patient issues in a quick, effective, and efficient manner. Having a care network that is responsive and present to patient concerns has been proven to be an essential engagement measurement (Dukhanin et. al, 2018).

CGT represents a continuously moving supply chain, with critical actions required by the manufacturer, physician, and patient. If there is an issue during the patient journey that is not resolved in a timely manner, the drug may expire or the patient may miss their scheduled treatment.

4.1.2.2.2 Care Reminder Frequency (supports Treatment Adherence criteria)

Care Reminder Frequency is defined as the number of times a distributor will contact the patient to ensure that they are adhering to their treatment schedule. Engaging the patient, through multiple points in the treatment journey, encourages continued patient involvement and promotes shared decision making (Daack-Hirsch & Campbell, 2014).

Every single step of a patient's CGT journey impacts the timing and delivery of the drug product. The distributor is in a unique position to ensure that not only the product is delivered to the treatment center on time, but the patient is as well. Ensuring the patient is engaged, attending their treatments, and scheduling their follow up monitoring visits will drive successful CGT treatments.

4.1.2.2.3 Patient Reach Percentage (supports Care Accessibility criteria)

Patient Reach Percentage is defined as the total percentage of patients that the distributor can serve, given the country's CGT treatment center footprint and infrastructure. If the infrastructure exists, but the supporting network cannot support it, then a critical portion of the population may not be served.

Pharmaceutical access indicators have been previous assessed as a major driving factor to equitable medicine across socioeconomic lines (Davari et. al, 2015). While further developed countries within the Asian markets may not consider access to be as critical factor, it holds considerably more influence for the developing countries. As new CGT Techniques allow Roche to tap into an unexplored part of the pharmaceutical market, having accessibility to patients in need will allow for long term growth and capture.

4.1.2.2.4 Community Presence (supports Care Accessibility criteria)

Community Presence is defined as the longevity of the distributor's presence in the affiliate nation and relationship with the local Hospitals/Doctor Network (ex. New Arrival vs. Established). In Levesque's Conceptual Framework for Healthcare Access, the joint Availability and Accommodation factor is one of the critical features that the Healthcare Network can provide to patients (Cu et. al, 2016).

Having a distributor that not only ensures that the pharmaceutical product can reach the market, but also understands the local sociodemographics will be well suited for unforeseen exogenous circumstances. A distributor with a strong country presence will have a greater capacity to create local contingency measures when resiliency is required. Further, there are inherent levels of trust that arise from a distributor that is established in the region.

4.1.2.3 Criteria supporting Local Healthcare Systems Objectives

The working definition of the Local Healthcare System in the MAVA Model is the network of National Hospitals, Physicians, and Private Clinics. The two primary criteria that were identified for local healthcare system satisfaction were the following: 1) Compliance Observance to local government pharmaceutical distribution requirements, & 2) Fulfillment Management performed at an acceptable service level. This resulted in four different sub-criteria, which aimed to measure the distributor's Data

Management & Tender Bidding Compliancy, as well as capture both On Time in Full & Perfect Order Key Performance Indicators for drug delivery. The sub-criteria that directly satisfy the local healthcare system are described further in depth below:

4.1.2.3.1 Data Report Visibility (supports Compliance Observance criteria)

Data Report Visibility is defined by the timeliness and completeness of the data reports that are received from the distributor. The inclusion of a metric that evaluates the data report availability and usability is critical for understanding how well the distributor communicates. From a pharmaceutical manufacturer's perspective, exceptional care must be taken to track of the quantity and quality of the information they receive from each distributor, or else risk priority misalignment (Frazier et. al, 2009).

There remains a high level of interest into examining the data from the distributor, who will need to provide Roche and the manufacturing team full visibility into every step of the supply chain, for every individual product SKU. This activity will generate a substantial amount of data, and will require quick decision chains between these actors.

4.1.2.3.2 Tender Acceptance Rate (supports Compliance Observance criteria)

Tender Acceptance Rate is defined as the ability of the distributor to secure logistics contracts and successfully complete orders in a timely fashion. In Southeast Asia, infectious diseases treatment and management is handled through public programs and government tenders, which are generally awarded on an ad hoc basis, which greatly disrupt a pharmaceutical manufacturer's ability to forecast drug market entrances and finances (Deloitte et. al, 2021).

Tender Acceptance Rate is valuable to the CGT ecosystem as there will be a substantial amount of paperwork and administration that will be required to distribute CGT products. This criterion attempts

to evaluate whether the distributor has a track record of successfully processing logistics tenders and orders.

4.1.2.3.3 On Time in Full KPIs (supports Fulfillment Management criteria)

The On Time in Full KPI is defined by the tracking precision of deliverables leading to order fulfillment, usually by means of validating the invoice accuracy rate. In the pharmaceutical industry, this metric is one of the leading indicators of reliability of distributor performance, as it captures not only the distributor's ability to manage stock, but also manage orders in a timely manner (Huang & Kesker, 2007).

While the use of On Time in Full KPI is coveted by the manufacturers, it is also critical for the end use doctors and pharmacies. These KPIs track pertinent arrivals, which serve as a not only a measure of customer satisfaction with service delivery, but also the ability to fulfil critical need.

4.1.2.3.4 Perfect Order KPIs (supports Fulfillment Management criteria)

The Perfect Order KPI are defined by the tracking precision of deliverables leading to order fulfillment. Establishing strong credibility with achieving perfect orders has demonstrably become not only a critical service metric, but an expectation for CGT products and treatments.

One of the necessities for creating a comprehensive CGT supply chain network will be implementing a Real-Time Value Network (RTVN), that enables optimized execution through delivery of the right amount of product at the right time (Behera, 2020). These KPIs are considered valuable as they track perfect order can serve as a measure of patient satisfaction with service delivery.

4.2 Alternatives Description

When developing the distribution channel strategy alternatives, the primary aim is to overcome the Pharmaceutical Industry's 'cognitive inertia' concerning the growth of the CCT & PHCP space in both developed and emerging Markets. Most mental models that the pharmaceutical industry holds are rigid views of the current high volume, low value driven portfolios. With the rise of CGT/PHCP treatments, pharmaceutical portfolios will transform into low volume, high value product focuses, which will drastically change the expectations and responsibilities of both the distributor and distribution channel.

Due to the extremely sensitive and personal product nature of the CGT treatments, the beginning and end nodes of the CGT distribution channel will remain the same across all three scenarios. The point-of-manufacturing will represent Roche's future manufacturing capacity centers, which would have been previously determined by other strategic research. The point-of-care will represent the dedicated facilities in which the CGT treatments will be administered, which would have been selected by the local nation's own healthcare network. Design choices considering point-of-manufacturing and point-of-care location and selection are therefore considered out of scope for both versions of the CGT Asia Markets MAVA Models, but could be explored in further research.

Though limited in the physical design choices available for CGT Distribution, there represents a great opportunity to shape the partnership design choices instead. As noted previously in Section 2.3, the great differentiator between distributors will be the level and quality of services they provide to Roche, to the local healthcare system, and to the patients.

For each distribution channel alternative, the services provided by the distributor and the corresponding supply chain network flows are defined. The services provided in each alternative are a combination of standard distributor services (payment, administrative, & logistics management) and new

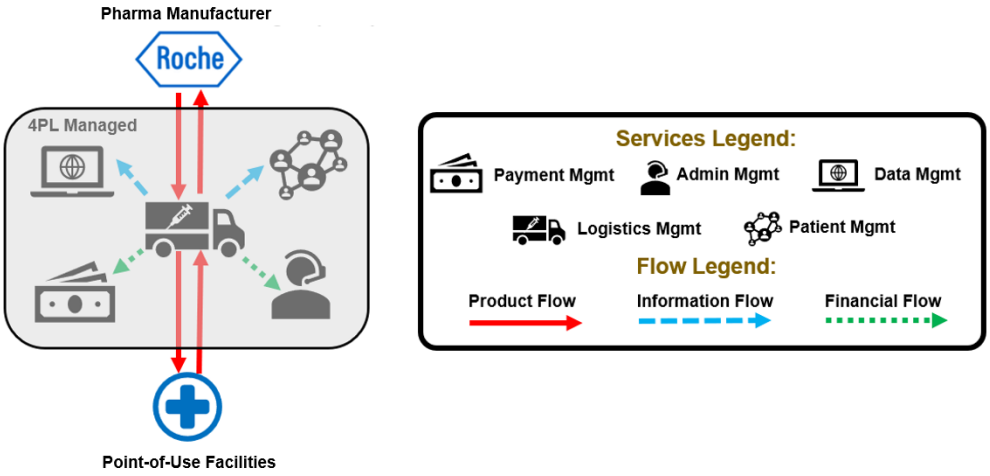
distributor services (data & patient management). We characterize these services in the context of three foundational supply chain flows: product (material), financial, and information.

4.2.1 First Alternative – The Traditional Model

The Traditional Model is a reflection of the current distribution channel that Roche currently relies on with the 4PL Model. This also reflects the use of consignment incentives to determine how much the distributor will charge Roche to distribute the designated portfolio of products. The overall flow of the Traditional Model is reflected Figure 4.

Figure 4

Overview of Traditional Model Scenario



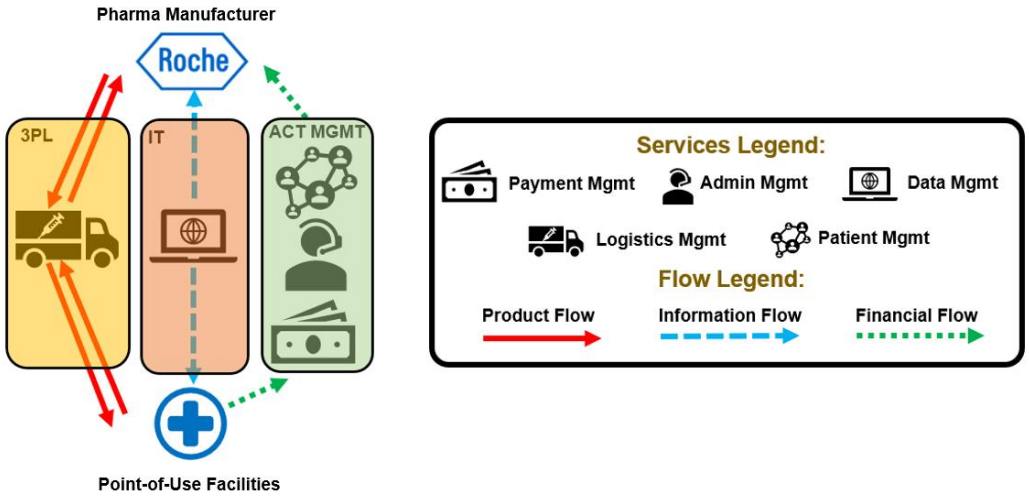
In the Traditional Model, the distributor is responsible for all five primary services required for CGT/PHCP distribution. This includes the standard distributor services (payment, administration, & logistics), as well as new distributor services (data & patient management). The distributor is also responsible for managing all three supply chain flows, as the product travels from manufacturing to point of care the associated product financial and information trail travels as well.

4.2.2 **Second Alternative - Multi-Partnership Model**

The Multi-Partnership Model is a reflection of choosing several key partners to manage the distribution network. In this alternative, Roche would divide ownership of services into the major partnerships, which are divided by their core competencies. The overall flow of the Multi-Partnership Model is reflected Figure 5.

Figure 5

Overview of Multiple Partnership Scenario



The first partnership would be with a 3PL to handle the goods movement component of the supply chain. The 3PL partner would provide the ability to physically move product, as well as satisfy any cold chain requirements.

The second partnership would be with an IT firm, which would be responsible for handling the data management services required to fulfill Chain of Identify/Chain of Custody Requirements necessary for handling CGT/PHCP products.

The third partnership would be with an account management firm, which would be responsible for handling both the care network and patient interface. In this role, the payment management,

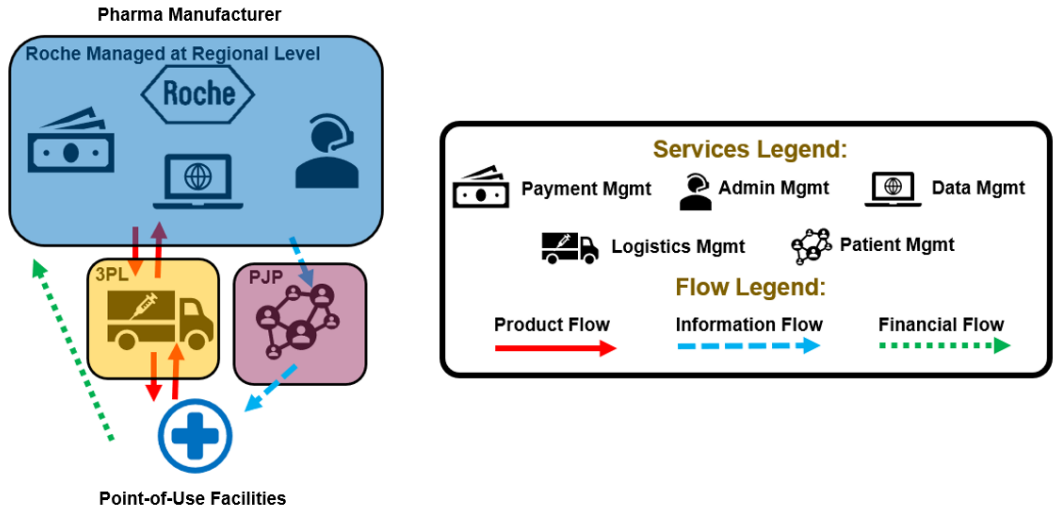
administrative management, and patient management would all be handled by a third party, as to ensure the patient information is sanitized before being handed off to Roche.

4.2.3 Third Alternative - In-House Services Model

The final alternative represents Roche handling the majority of the distribution service measures at the affiliate level. Instead of relying on external partners, Roche can enable regional strengths and rely on their own internal competencies, and thus ensure that the distribution system is aligned to their own company goals and vision. The overall flow of the In-House Model is reflected in Figure 6.

Figure 6

Overview of In-House Services Model



In this alternative, Roche would have ownership of the administration management, data management, and payment management. As logistics is not a core competency of Roche, the 3PL physical distribution services would be managed by an outside service. To ensure the sanitization of the patient data, the patient management services would belong to an external partner as well. The supply chain financial flows travel directly from the healthcare network to the Roche regional affiliate, whereas the product flows through the 3PL, and the information flow travels through the Patient Journey Partner (PJP).

4.3 Value Function Determinations

Upon defining the criteria and alternatives that would be used for the MAVA Models, the level of importance that decision makers seek for each criterion must be defined by a value function (Carland et al, 2018). For each of the sub-criteria, the definition was discussed and the measurements defined with the Roche affiliates, as seen in Table 2.

Table 2

Sub-Criteria List with Units of Measure (UoM)

Criteria	Sub-Criteria	UoM
Total Cost	Cost To Serve	Percentage (%)
	Cost To Manage	Percentage (%)
Inventory Management	Accuracy KPIs	Percentage (%)
	Product Loss KPIs	Percentage (%)
Treatment Adherence	Case Support Management	Rating (#)
	Care Reminder Frequency	Rating (#)
Care Accessibility	Patient Reach %	Percentage (%)
	Community Presence	Rating (#)
Compliance Observance	Data Visibility	Percentage (%)
	Accepted Tenders	Percentage (%)
Fulfillment Management	On Time in Full KPIs	Percentage (%)
	Perfect Order KPIs	Percentage (%)

After establishing the sub-criteria and the unit of measure associated with it, the sub-criteria's value function was determined. Following this, initial datasets for all three alternatives were collected and aggregated, which enabled the criteria weight elicitation process.

4.3.1 Acceptable Criteria Bounding Definition

Prior to collecting any formal data, the value function for each sub-criterion must be defined. This is completed by first determining the range of acceptable values for each criterion, thus establishing the upper and lower bounds of each (O'Brien & Dyson, 2007). For this case, acceptable bounds were

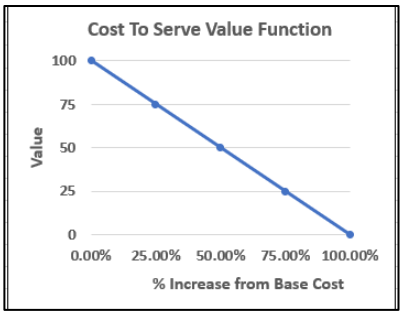
determined through the literature, and were verified with the Decision Makers. The establishment of the upper and lower acceptable bounds is captured in Appendix A**.**

4.3.2 Value Function Creation

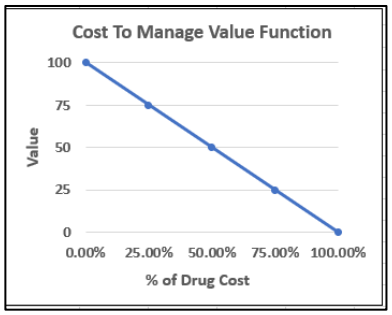
After establishing the range of acceptability for each sub-criterion, the value function supporting each sub-criterion can be created. Dyson & O'Brien (2007) note that the value function is essential for the stakeholders to be able to perceive and visualize the impact of their preferences on the MAVA model. With the range previously established, each sub-criterion value function was developed through a comprehensive review of the literature, and then was validated by the decision makers for value acceptability. The corresponding Value Functions for all twelve sub-criteria are shown in Figure 7, and are described further in depth in Appendix B.

Figure 7

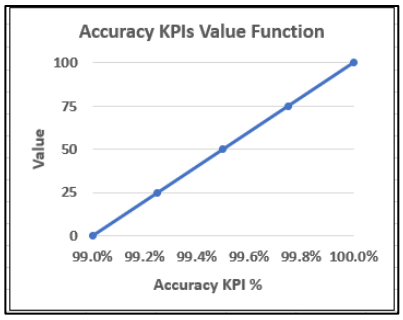
Sub-Criteria with Value Functions



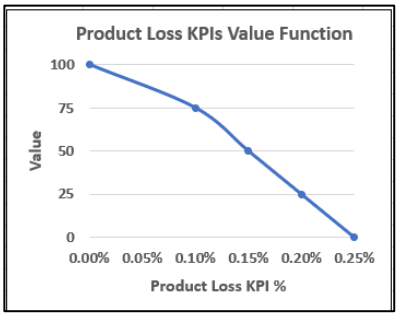
Cost To Serve



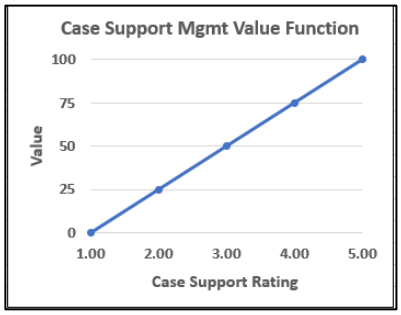
Cost To Manage



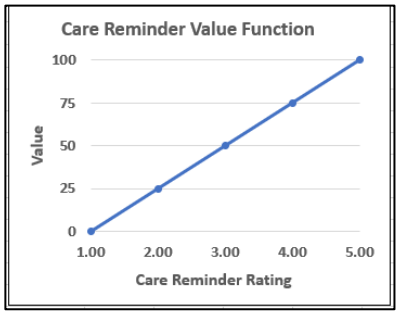
Accuracy KPIs



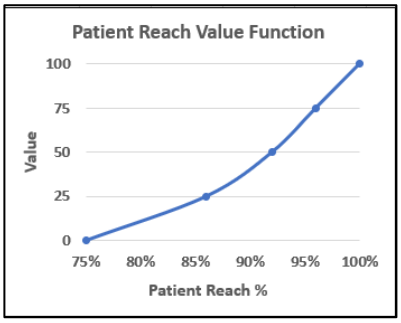
Product Loss KPIs



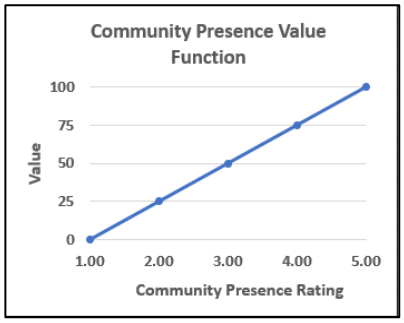
Case Support Management



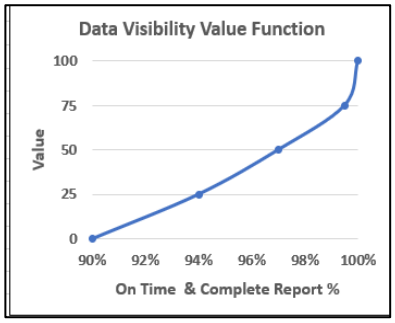
Care Reminder Frequency



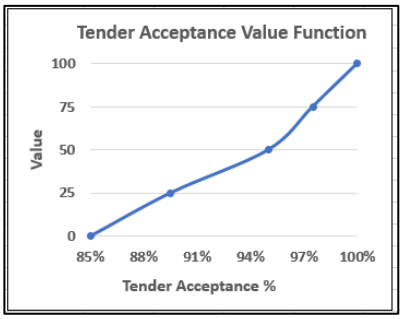
Patient Reach %



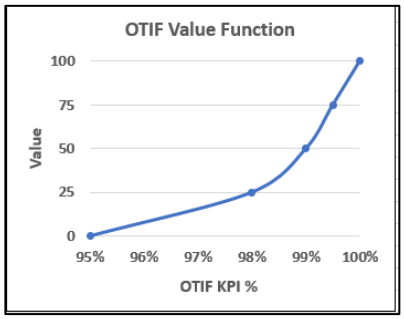
Community Presence



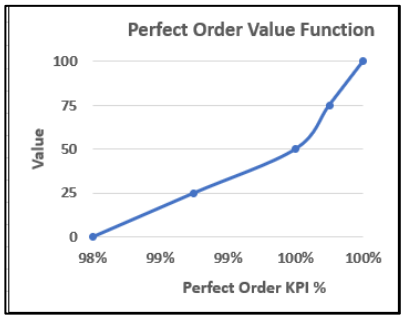
Data Visibility



Accepted Tenders



On Time In Full KPIs



Perfect Order KPIs

There are two primary methods for eliciting Value Functions, which are through the Bisectional Method and the Direct Rating Method. The Bisectional Method was the preferred method of choice, as one determines the sub-criterion's mid-range values by comparing it to the previously established upper and lower range values. As the Bisectional Method is used primarily for quantitative measures, it allows the Decision Makers to score items on a continuous distribution and was used as extensively as possible (Carland et al, 2018). For the newer qualitative measures that do not have fully established KPIs or popularized metrics, the Direct Rating Method allows the stakeholders to determine sub-ranges to organize the data, and then provide the sub-ranges an overall score (O'Brien & Dyson, 2007). This method was utilized for the case Support Management, the care reminder frequency, & the community presence criterion. Once establishing all of the sub-criterion value functions, the data gathering could begin without bringing stakeholder bias into the mix.

4.4 Weight Assignment

The overall goal of the MAVA model was to select the best distribution channel strategy for Roche, which required an understanding of the comparative importance of criteria against each other (Carland, 2018). The three objectives that informed this decision were the distributor's ability to support Roche, empower patients, and satisfy the requirements of the health care system. These objectives are connected to various criteria that give an insight the strength of different distribution strategies under consideration. Weights for these objectives were set by seeking the opinion of Roche's stakeholders on the order of preference for improving the objectives to accommodate the distribution specifications for CGT/PHCP. For each criteria, focused group discussions with the stakeholders elicited maximum feasible values and minimum acceptable values. KPI Values from 2021 for all sub-criteria data was then used to identify current performance for each of the objectives.

4.4.1 Key Stakeholder Engagement Process

For the weight elicitation process, key stakeholders were identified for both the Taiwan and Thailand use cases. For Taiwan, key supply chain management personnel were present, along with a representative from the Rare Disease Community of Practice. For Thailand, key supply chain management personnel were present, along with a representative from the newly developing Cell & Gene Therapy Community of Practice. With representation from both supply chain functions and key medicinal functions, a wider perspective on perceived stakeholder value could be elicitated.

After identifying the stakeholders that would be involved in the weight elicitation process, a management engagement session was scheduled to review both objectives and criteria importance. During the management engagement session, the stakeholders were given a base scenario in which they asked to first review the objectives. The stakeholders were asked to evaluate the importance of supporting Roche, empowering patients, and satisfying the local healthcare network by using the swing weights method (Montbellier, 2018). The stakeholders were asked which objective would be most important to raise from low performance to high performance, and then were asked to give a valuation of the importance of that performance change on a scale of 1 to 10. After reviewing the first objective, the next most important objective to raise performance in was identified, and given an importance valuation than had to be lower than the valuation given to the first objective identified previously. Once the swing weight process was repeated for all objectives, the same process was repeated for the criteria measures, with only direct comparisons being made directly between criteria that fall under the same objective.

4.4.2 Weight Normalization

During the swing weight process, a valuation factor was assigned to each objective on a scale on 1-100. The objective that had the highest preference for improvement received 100 points. The second most favored objective received a value less than 100 depending on the preference strength agreed on by Roche stakeholders (assume 80 points) and the last objective received the least points still based on rating by Roche stakeholders (assume 60 points). The outcome of normalizing the weights gave the following weights for each of the objectives can be seen in Table 3.

Table 3

Normalized Weights for Objectives

Objectives	Weights	Normalize	Standardized weights
Support Roche	100	=100/240	0.42
Empower Patients	80	=80/240	0.33
Satisfy Health Care System	60	=60/240	0.25
Sum	240		1

After applying the same weight normalization process to each of the criteria, a full matrix of weighted objectives and criteria was created. For the sub-criteria, it was determined that the sub-criteria feeding into the criteria would be complementary measures, rather than competing measures, and thus would be weighed equally. As an example, under the Fulfillment Management criteria, On Time In Full KPIs and Perfect Order KPIs are KPIs that act in concert to capture high quality fulfillment practices, rather than act as tradeoff measures. An example of the weight evaluation outputs can be seen in Table 4, and the full weight normalization outputs for all scenarios can be found in Appendix C.

Table 4

Weight Evaluation Output

Weight Adjustment					
Objective Weight Inputs					
Objective	Support Roche	Empower Patients	Satisfy HC System	Weight Sum	Required Sum
Weight	0.37	0.34	0.29	1.00	1.00
Criteria Weight Inputs					
Criteria	Total Cost	Treatment Adherence	Compliance		
Weight	0.53	0.36	0.44		
Criteria	Inventory Mgmt.	Care Accessibility	Fulfillment Mgmt.		
Weight	0.47	0.64	0.56		
Weight Su	1.00	1.00	1.00		
Required	1.00	1.00	1.00		

Sub-Criteria Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.09805
Cost-To-Manage	0.09805
Inventory Accuracy KPIs	0.08695
Product Loss KPIs	0.08695
Case Support Management	0.0612
Care Reminder Frequency	0.0612
Patient Reach %	0.1088
Community Presence	0.1088
Data Visibility	0.0638
Tender Processing	0.0638
OTIF KPIs	0.0812
Perfect Order KPIs	0.0812
Sum	1

4.5 Data Valuation

To effectively initialize the first pass of the MAVA models, primary and secondary data points were collected to represent the attribute values. The data gathering process required a combination of receiving primary data directly from Roche, and determining acceptable values from secondary data. As the second and third alternatives for the distribution channel strategy partnerships are hypothetical at this point of time, logical and clear assumptions were required for their valuation. The data gathering methods for each alternative were captured in Table 5 and are described further in depth in Appendix B.

Table 5

Data Gathering Techniques used for All Alternatives

Criteria	Sub-Criteria	Alt. 1 Data	Alt. 2 Data	Alt. 3 Data
Total Cost	Cost To Serve	Primary	Secondary	Secondary
	Cost To Manage	Primary	Secondary	Secondary
Inventory Management	Accuracy KPIs	Primary	Secondary	Secondary
	Product Loss KPIs	Primary	Secondary	Secondary
Treatment Adherence	Case Support Management	Secondary	Secondary	Secondary
	Care Reminder Frequency	Secondary	Secondary	Secondary
Care Accessibility	Patient Reach %	Secondary	Secondary	Secondary
	Community Presence	Primary	Secondary	Secondary
Compliance Observance	Data Visibility	Primary	Secondary	Secondary
	Accepted Tenders	Primary	Secondary	Secondary
Fulfillment Management	On Time in Full KPIs	Primary	Secondary	Secondary
	Perfect Order KPIs	Primary	Secondary	Secondary

4.5.1 Primary Data Collected from Roche

The data collected directly from the Roche affiliate exclusively covered the information for the first alternative, which reflects the current 4PL business operations. This data primarily fell under the traditional criteria measures, such as the Total Cost, Inventory Management, & Fulfillment Management. As these are measures the affiliate is already collecting, the range of these values is fairly stable and well known.

4.5.2 Secondary Data Drawn from Market Proxies & Applied Literature

The data drawn from market proxies & applied literature represents the measures that Roche does not currently collect, but can be gathered from market research. Though the Roche affiliates do not directly interact with other logistic providers or IT firms, the information concerning their performance can be gathered through annual reports, marketing pitches, and consumer indexes. As the 2nd and 3rd alternatives (representing the new Multi-Partner distributor strategy and the In-House strategy) are not currently employed but are actively practiced elsewhere, the sub-criteria captured through Market

Proxies are the newly developing sub-criteria measures, such as the Treatment Adherence, Care Accessibility, & Compliance Observance.

4.6 Total Value Assessment

Once the Attributes have been defined, the Total Value of each alternative distribution strategy can be calculated. For the Distribution Strategy MAVA Model, a simple Weighted Sum Aggregation method calculated the final score for each alternative, as a simpler aggregation method is preferred for both academic and industrial MCDM & MAVT applications (Carland, 2018).

Prior to utilizing the simple Weighted Sum Aggregation, the criteria had to be checked for preferential and weak-difference independence conditions (Dyer & Sarin, 1979). Each criteria & sub-criteria were checked by verifying that the value difference between the lowest and highest available scores would remain the same if another criteria was also at its extreme scores (Montbellier, 2018). As an example, the Inventory Accuracy sub-criteria value score was not affected by increasing or decreasing the Patient Reach % sub-criteria value score.

The sum product of these weights and the values for each criterion was collected for all three of the alternatives. The alternative with the highest result from this analysis emerged the preferred distributor channel strategy.

5 RESULTS & DISCUSSION

After following the methodology outlined in the section above, the MAVA models representing both the Taiwan and Thailand pharmaceutical marketplaces were created. Through establishing an initial scenario for the model, feedback elicitation from key Roche regional and local affiliate stakeholders was gathered. Upon their commentary and further analysis of the model generated, we synthesized our results to lead to meaningful and creative discussion with Roche for implementation of the model in an actual business environment.

Through the analysis, the intent of the research is to deliverable an innovative model that captures and quantifies distributor value in the pharmaceutical industry.

5.1 Interpretation of Initial Results

5.1.1 Results of CGT/PHCP Scenario

5.1.1.1 Taiwan CGT/PHCP Scenario

Table 6 shows an aggregate of the sub-criteria values that make up the score for each of the 3 distributor channel alternatives in Taiwan's CGT/PHCP scenario, while Figure 8 shows a diagrammatic buildup of the scores. The three alternatives considered were the traditional distributor strategy (base scenario), the multiple partners for service strategy and the in-house managed strategy. These 3 alternatives are ranked on a scale of 0 – 1. All results are captured in further depth in Appendix D.

Table 6

Weighted Value Computation for Taiwan CGP/PHCP

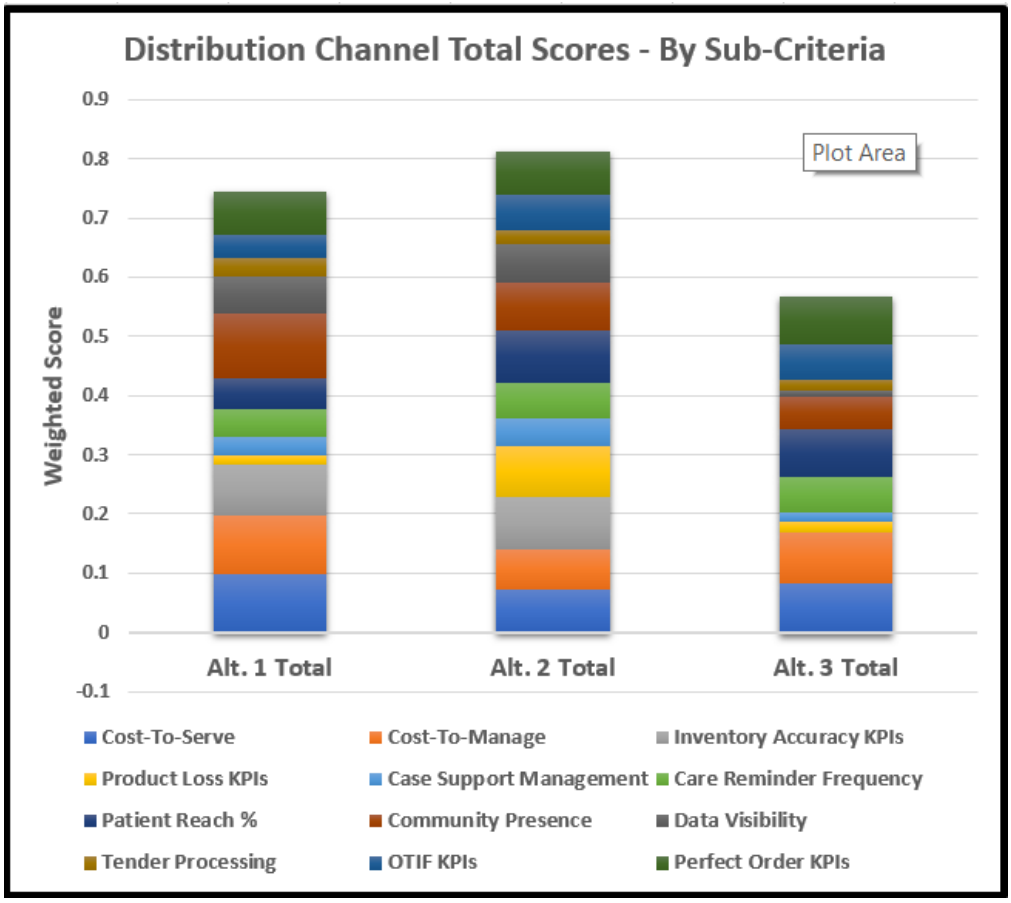
Sub-criteria Name	**Alternative 1** Base scenario	**Alternative 2** Multi-partner	**Alternative 3** In-house managed
Cost to serve	0.098	0.073	0.083
Cost to manage	0.098	0.068	0.086
Inventory accuracy KPI	0.087	0.087	-0.002
Product loss KPI	0.017	0.087	0.017
Care support management	0.031	0.046	0.015
Care Reminder frequency	0.046	0.061	0.061
Patient reach	0.053	0.088	0.081
Community presence	0.109	0.082	0.054
Data visibility	0.064	0.064	0.011
Tender processing	0.031	0.023	0.017
OTIF	0.038	0.060	0.060
Perfect order KPI	0.073	0.075	0.081
Total	**0.744**	**0.813**	**0.566**

Note: The highest weighted criterion for the sponsoring company was patient care accessibility (0.109). The ultimate goal of all the activities in the logistics management cycle is service to customer and to achieve this, companies must guarantee commodity security. Commodity security increases patient satisfaction and drives demand. The next most valuable criterion was the total cost structure (0.098) of the distributor service. As expected, the high value nature of CGT/PHCP calls for financial sustainability to guarantee profitability as well as scale research and development of more of the products. Competitive

cost to serve and cost to manage fees are therefore a major consideration in deciding the distributor channel strategy to adopt for CGT/PHCP.

Figure 8

Graphical Representation of CGT/PHCP Distribution Channel Scores - Taiwan



For CGT/PHCP the key performance indicators are benchmarked at higher values than for regular high volume pharmaceutical products. This is because of its low volume, high value and patient-centric nature. The preference strength for the three alternatives is 0.77 (Alternative 2-multiple partners for service), 0.744 (Alternative 1 - traditional distributor) and 0.536 (Alternative 3 – In-house managed service). The input data showed that the traditional distributor had competitive scores for majority of the KPIs tracked. This made the traditional distributor still a strong contender for CGT/PHCP distribution. However, despite the close margin between the base scenario (Alternative 1) and the multiple partners

for service (Alternative 2), the model suggests Alternative 2 for CGT/PHCP. The highest contributors to Alternative's 2 rank are KPI results for Inventory accuracy and product loss. However, the traditional distributor still stands out for having the highest community presence than any of the three distributors. Zuellig Pharma, the traditional distributor in Taiwan, has being in business in Taiwan for 34 years. Community presence infers better understanding of the in-country pharmaceutical regulation, acceptance by the health care system and ease of business transaction with customers.

5.1.1.2 Thailand CGT/PHCP Scenario

Table 7 shows an aggregate of the sub-criteria values that make up the score for each of the 3 distributor channel alternatives in Thailand's CGT/PHCP scenario, while Figure 9 shows a diagrammatic buildup of the scores.

Table 7

Weighted Value Computation for Thailand CGT/PHCP

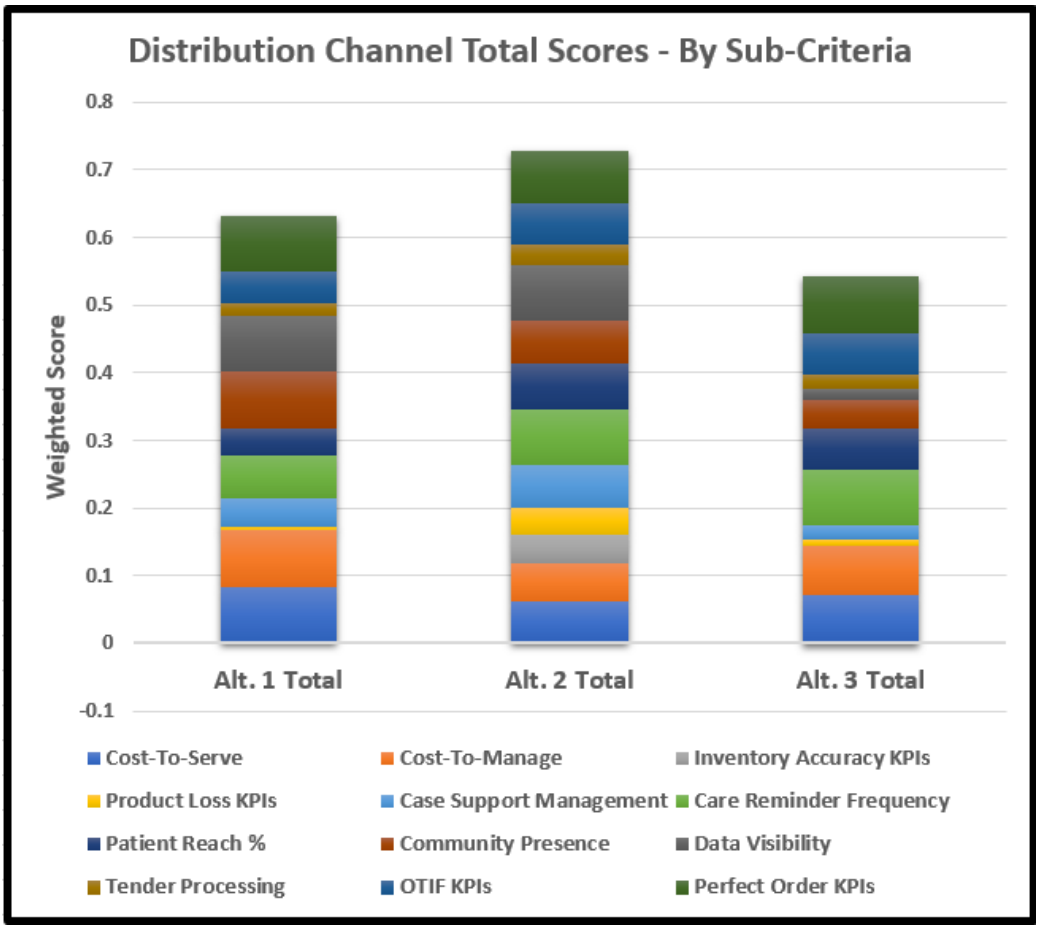
Criteria Name	**Alternative 1** Base scenario	**Alternative 2** Multi-partner	**Alternative 3** In-house managed
Cost to serve	0.083	0.062	0.071
Cost to manage	0.083	0.058	0.073
Inventory accuracy KPI	0.000	0.041	-0.002
Product loss KPI	0.007	0.041	0.009
Care support management	0.042	0.062	0.021
Care Reminder frequency	0.062	0.083	0.083
Patient reach	0.041	0.068	0.062
Community presence	0.083	0.062	0.042
Data visibility	0.083	0.083	0.015
Tender processing	0.019	0.030	0.023

OTIF	0.046	0.062	0.062
Perfect order KPI	0.082	0.077	0.083
Total	**0.631**	**0.728**	**0.541**

Note. The weight elicitation process for Thailand yielded equal weights for all 12 sub-criteria. This was because the expert judgement pool regarded all decision objectives and criteria as equally important to them in accessing distributor value proposition. Although this is not the ideal for a model that proffers results based on weighted average, the model was still able to scale the 3 alternatives in increasing order of preference.

Figure 9

Graphical Representation of CGT/PHCP Distribution Channel Scores - Thailand



Note: The preference strength for the three distribution channel strategy alternatives are 0.728 (Alternative 2 - multiple partners for service), 0.631 (Alternative 1 - traditional distributor) and 0.541 (Alternative 3 – In-house managed service). The multiple partners for service strategy outperformed the two other alternatives. This result is similar for both Thailand and Taiwan. The highest contributors to Alternative's 2 rank in Thailand are KPI results for data visibility, care reminder frequency and perfect order (Invoice accuracy). This reestablishes the fact that identifying specialty distributors with the potential to perform various roles in the supply chain management of CGT/PHCP is key for effective last mile solutions of these products.

5.1.2 Results of High-Volume Scenario

The analysis was conducted on high volume products to contrast the results from those obtained for CGT/PHCP. In building the model to suit this scenario, the acceptable inventory management KPI range was relaxed. This is because with high volume products, inventory discrepancies during receipts, storage, pick and pack are often inevitable. The margin for cost to serve and cost to manage for the various distributor alternatives was reduced since we envisaged that it will be higher for CGT/PHCP. The distributor value added functions required to provide support to the patient through the CGT/PCHP care path were also deemphasized for high volume products.

5.1.2.1 Taiwan High-Volume Scenario

Table 8 shows an aggregate of the sub-criteria values that make up the score for each of the 3 distributor channel alternatives in Taiwan's high volume product scenario, while Figure 10 shows a diagrammatic buildup of the scores.

Table 8

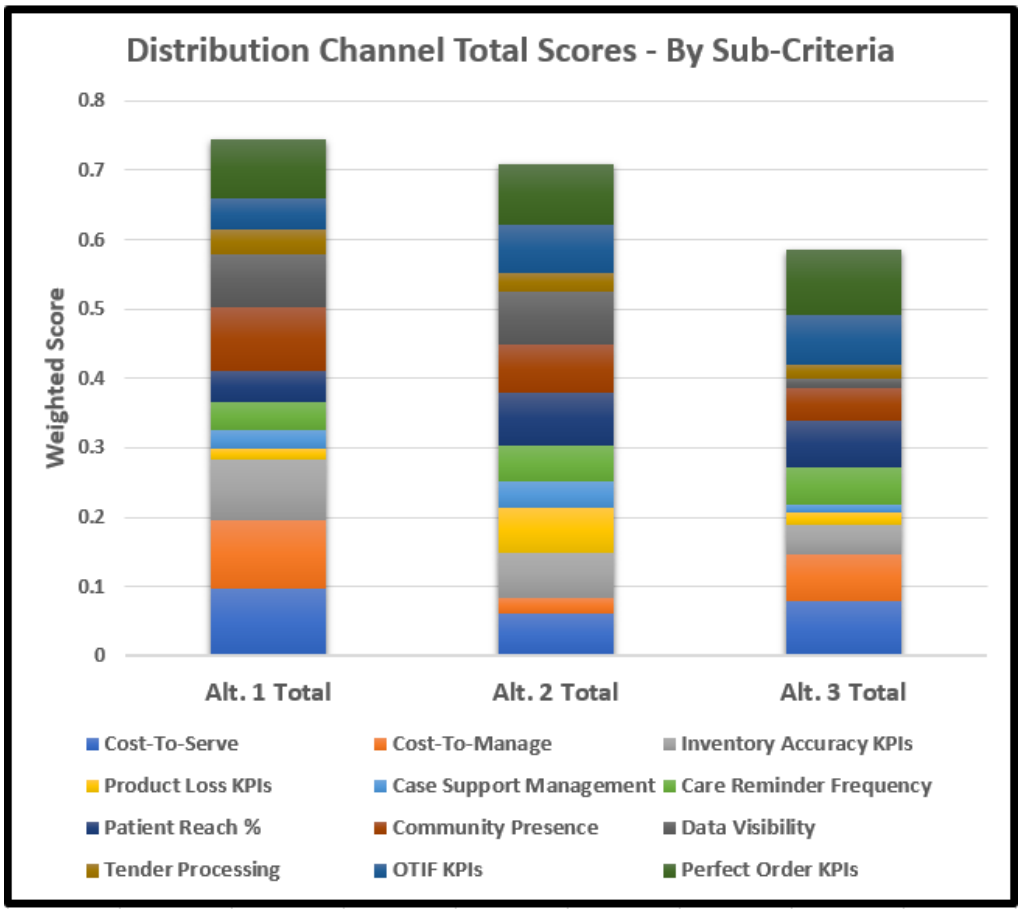
Weighted Value Computation for Taiwan High Volume Products

Sub-criteria Name	**Alternative 1** Base scenario	**Alternative 2** Multi-partner	**Alternative 3** In-house managed
Cost to serve	0.098	0.061	0.080
Cost to manage	0.098	0.024	0.068
Inventory accuracy KPI	0.087	0.064	0.042
Product loss KPI	0.017	0.064	0.017
Care support management	0.026	0.039	0.013
Care Reminder frequency	0.039	0.052	0.052
Patient reach	0.045	0.075	0.069
Community presence	0.093	0.070	0.046
Data visibility	0.075	0.074	0.013
Tender processing	0.037	0.027	0.020
OTIF	0.044	0.070	0.070
Perfect order KPI	0.086	0.088	0.095
Total	**0.745**	**0.709**	**0.586**

Note: Values generated in Table 8 shows that the model is sensitive to changes in weights as well as the value functions assigned to the KPIs based on performance. The aggregated scores therefore varied from those obtained for CGT/PHCP scenario with the traditional distributor having the highest score (0.745).

Figure 10

Graphical Representation of High-Volume Products Distribution Channel Scores - Taiwan



Note: The preference strength for the three distribution channel strategy alternatives is 0.745 (Alternative 1 - traditional distributor), 0.709 (Alternative 2-multiple partners for service) and 0.586 (Alternative 3 – In-house managed service). Total cost structure and community presence for the traditional distributor model have been age-long strengths of this strategy. The traditional distributor also showed good scores (>90%) on inventory and fulfilment management KPIs. This analysis shows that the traditional distributor is still the favored option for high volume products in Taiwan.

5.1.2.2 **Thailand High-Volume Scenario**

Table 9 shows an aggregate of the sub-criteria values that make up the score for each of the 3 distributor channel alternatives in Thailand's high volume product scenario, while Figure 11 shows a diagrammatic buildup of the scores.

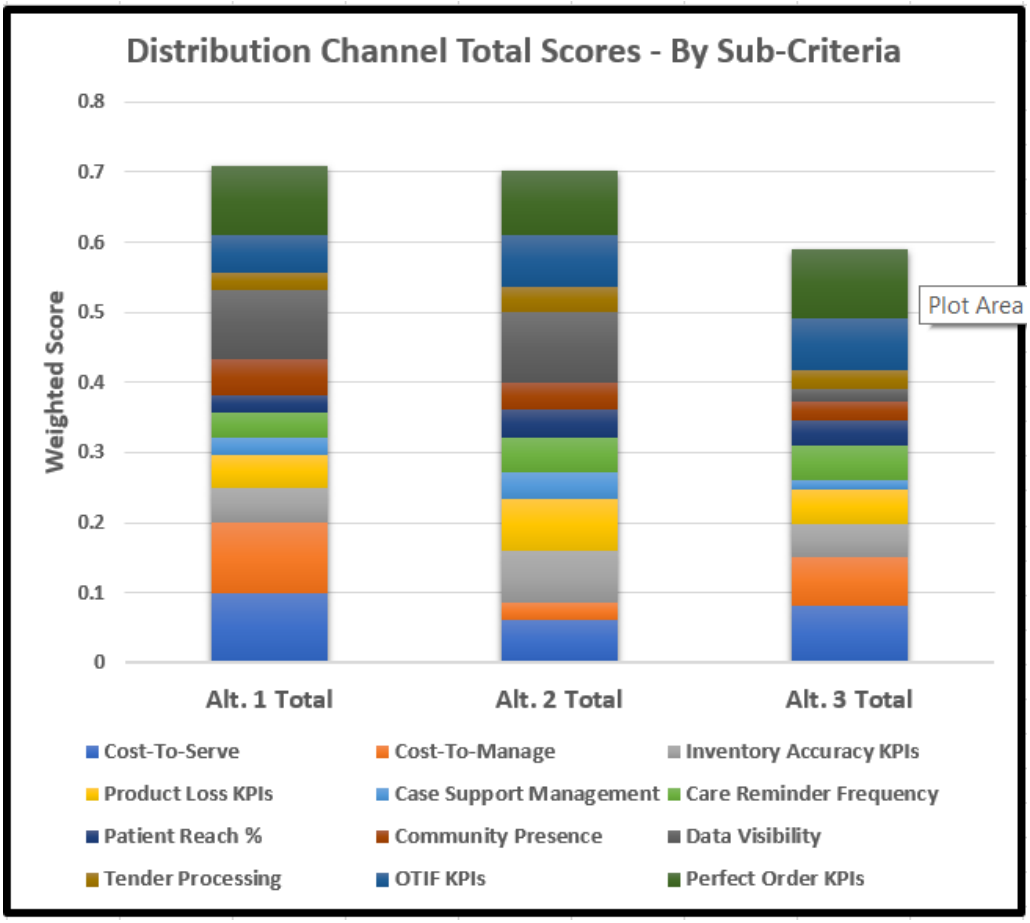
Table 9

Weighted Value Computation for Thailand High Volume Products

Criteria Name	**Alternative 1** Base scenario	**Alternative 2** Multi-partner	**Alternative 3** In-house managed
Cost to serve	0.1	0.062	0.081
Cost to manage	0.1	0.024	0.069
Inventory accuracy KPI	0.049	0.074	0.048
Product loss KPI	0.047	0.074	0.049
Care support management	0.025	0.038	0.013
Care Reminder frequency	0.038	0.05	0.05
Patient reach	0.025	0.041	0.037
Community presence	0.05	0.038	0.025
Data visibility	0.1	0.1	0.018
Tender processing	0.023	0.036	0.027
OTIF	0.055	0.074	0.074
Perfect order KPI	0.098	0.092	0.1
Total	**0.708**	**0.702**	**0.591**

Note: Thailand's high-volume scenario gave similar results as Taiwan's high-volume scenario. The traditional distributor outperformed other alternatives (0.708).

Figure 11: Graphical Representation of High-Volume Product Distribution Channel Scores - Thailand



Note: Alternative 1 showed the highest preference strength (0.708) followed by Alternative 2 (0.702) and then Alternative 3 in 3rd place (0.591).

It is worthy to note that these findings are based on the data provided by the sponsoring company, the weights assigned and the value functions generated. At any point in the future, if any of the input data change, the preference ranking may also change. Monitoring and evaluation of KPIs used as input data for the analysis and adjusting benchmark KPI ranges as well as weight assignments will be relevant in determining the tipping point for changing distributor strategy. Conducting sensitivity analysis, which is part of the process mentioned in Figure 2, is also important in determining values where a decision might

change. This will require more advanced analysis that could be considered when Roche has more robust data.

5.2 Managerial Implications

Upon reviewing the initial results of the MAVA distribution strategy model, there were several managerial implications to be considered, specifically concerning the interpretation and implementation of the model. Both of these measures must be fully understood by leadership prior to incorporation in any further simulation or situation.

5.2.1 Interpretation of Model Outputs

While the MAVA model is intended to be a tool to help provide a quantitative perspective for potential distribution strategy selection, it is not intended to be the definitive answer for switching distributors. Though the tool utilizes prescriptive analytics to provide an overall value score for each distribution strategy alternative, it is intended to be a decision support tool that enables the manager to make the ultimate decision. When switching distribution strategies in an actual business setting, strategy cohesion, buy-in across all business functions, and other factors may also be required.

It is also of importance to note that while the MAVA model was applied directly to Distribution Strategy Evaluation, the theory and frameworks behind MCDM and MAVT can be applied to other business decisions as well. While the model was initially created to support the selection of new distributor strategies, it can also be used to monitor ongoing distributor performance. Specifically, when there is a known change to business conditions, such contract expirations or product portfolio changes. Through applying the methodology outlined in Section 4, new models evaluating other business functions can also be generated, as well as analyze different parameters, such as overall volume of SKUs.

5.2.2 Implementation to other Geographies

As the Decision Makers will seek to implement the MAVA model to other countries throughout the Asian Pacific Region, there are several steps required to adapt the MAVA model to the respective local healthcare environment. The steps are as follows:

1. *Define business case, objectives, and criteria with all stakeholders* – Ensure that all Decision Makers understand the intent and meaning of the goal of the MAVA Model, and the supporting objective and criteria measures. This provides the foundation and context for the model, and ensures all Decision Makers are in agreement on the intent and usage of the model itself.
2. *Review Value Functions with local Decision Makers* – Review the upper and lower bounds of each sub-criteria to ensure relevancy to the country's unique pharmaceutical needs. Ranges may vary, depending on the level of service and cost structures that distributors within that country can provide. If different values arise, elicit the new upper and lower bounds, as well as the function itself, with the local affiliate Decision Makers.
3. *Evaluate Weights based on Local Decision Maker preferences* – Perform the weight elicitation process outlined in Section 4.4. As each local affiliate will have their own preferences in the relative importance of each measure, updates to the weights will reflect the unique local perspective of each affiliate.
4. *Gather Attribute Values and Complete Value Analysis* – After finalizing the country-specific value functions and weights, data can be collected concerning the attribute values. Once collected, the newly recalibrated MAVA model can be utilized to determine the Overall Value Scores for each Alternative Distributor. In future uses of the model, further exploration into improving the rigor of some of the new criteria measures can add further context to the model. As an example,

the Community Presence sub-criteria can be tied to Voice of the Customer (VOC) metrics directly. Translating more of the sub-criteria under the Empower Patients and Satisfy Local Healthcare Systems from Likert scale measures to established KPI measures will not only make the model more robust, but also easier to disseminate across regions and business units.

5.3 Model Limitations & Improvements

While a viable MAVA Model was developed to evaluate distribution strategies for the pharmaceutical industry, there are several important limitations that must be addressed along with implementation. The modeling of distribution strategies for a hypothetical pharmaceutical portfolio is a prospective study, and not as comprehensive as a traditional approach.

5.3.1 Non-Rigorous Approach to MAVA Model Creation

As noted in the literature, the most common approach to the creation of MAVA Models is to develop the model based off of well-defined case studies and usually are created retroactively (Carland, 2018). As this approach leverages the knowledge that the decision makers have gained through their intimate experience with the criteria that the MAVA Model is evaluating, the decision makers are both comfortable and conscious of the attributes they are evaluating.

Due to the personalized nature of PHCP/CGT products and the resulting transformation of the supply chain into a circular network, an extensive amount of the project is prospective and is not actively practiced at scale in any portion of the pharmaceutical industry. To properly evaluate the potential value that new distribution strategies could provide, novel criteria had to be introduced to evaluate these new services. Consequently, the decision makers are not as well equipped to provide expert judgement to the novel criteria, as their experience and exposure to such measures are limited.

With such limited exposure to new criteria, a deviation from a fully rigorous MAVA approach was required. While a traditional approach would elicit both the weights and the value functions solely from the preferences of the decision makers, only the weights were elicited directly from the decision makers. For the value functions, exemplary values were generated independently and then vetted and validated by decision makers.

Though the independent generation of the value functions represents a departure from a fully rigorous approach, providing an initial value function analysis will help introduce and mature the conversation surrounding the importance of these new criteria measures. As many of these new criteria directly fall under the Patient Empowerment objective, they represent information that is not being collected now, but will be of utmost priority in the future.

Through future conversations and further model iterations, there would be a long-term goal to improve the understanding and familiarity of the new criteria with the decision makers. Through further exposure and first-hand experience on the value-added benefit the new criteria can provide, the decision makers can gain a level of familiarity and comfort with evaluating these new measures directly. Further studies and implementations of the model could recalibrate the value functions so that the functions are elicited directly from the decision makers.

5.3.2 Limitations with Model Implementations

When reviewing the implementation of the distribution strategy MAVA Model, several limitations of the model should be kept in mind. Though the model was developed to be versatile, there are and considerations on the robustness, sensitivity, & assumptions that should be recognized.

Though the model can be utilized on various pharmaceutical types beyond CGT/PHCP, there exists a tradeoff between adaptability and robustness. While the model was developed to primarily capture the

PHCP/CGT portfolio (representing the high value, low volume mix of pharmaceutical products), the collective use of all twelve sub-criteria measures is aimed at capturing the total value that can be gathered from that scenario. However, when capturing the Small Molecule portfolio (representing the low value, high volume mix of pharmaceutical products), all twelve sub-criteria may not be fully applicable, and may result in a nullification of some sub-criteria and loss of fidelity in the model. While this condition is expected to persist in the near term, further exposure and experience with the novel criteria will increase the applicability of these measures that can be considered more critically in future evaluation efforts (in a similar manner as noted with the MAVA rigor).

Further, due to the prospective nature of the MAVA model, not all of the sub-criteria are not fully defined. The case support management, care reminder frequency, and patient reach percentage sub-criteria value functions were based on direct Likert Ratings, i.e. discrete values between one and five, that are not continuous variables like the other sub-criteria. This makes the model quite sensitive to value changes for these sub-criteria, and has the ability to change the overall selection of the most valuable distribution strategy. To overcome this, further definition of these three sub-criteria as continuous variables would improve model quality. A potential method for reaching such improvements would be changing the measurement case support management from a one to five rating system to a measure driven by Voice-of-the-Customer (VOC) surveys.

In addition to further defining the sub-criteria, further refinement in the upper and lower boundaries of the sub-criteria values will also provide model validation. As the Decision Makers become more familiar with the CGT/PHCP ecosystem, the ranges of each sub-criteria will become more reflective of best practices and industry standards. Due to the sensitive nature of MAVA models to the upper and lower boundaries, refinement and consensus of the ranges will ensure greater model effectiveness.

Finally, it is worth remarking that while the secondary data utilized for the initial model generation is grounded in both academic and market research, it still remains speculative in nature. As the CGT and PHCP markets continue to grow and mature, assumptions concerning the cost increases and service levels required could be validated or reevaluated. Further, as the distributors themselves become more comfortable with the new space, emergent criteria may be discovered.

6 Conclusion

In order to address how demand transitions in Asian Pacific markets for CGT/PHCP product portfolios are affecting Roche's distribution strategy, a new evaluation framework for understanding the role of the future pharmaceutical distributor was developed. First, an in-depth study of the supply chain challenges for Cell and Gene Therapies and Personalized Health Care Products (CGT/PHCP), the major challenges of pharmaceutical distribution in Asia-Pacific markets, and common themes between them was completed. From these common themes, several ways that future distributors could provide services that address the expected challenges were determined. Further definition of the services led to the creation of a quantifiable Multiple Attribute Value Analysis Model to evaluate a future distributor's ability to provide the required services for CGT/PHCP in Asia-Pacific. An initial valuation of the model highlighted potential distribution strategies to support local affiliate decisions that would increase the overall value of the pharmaceutical product delivery.

Future research could focus in on refining criteria definition and range functions, which would lead to a more robust MAVA Model. Through this process, we hope that we have expanded the perspective of the sponsor to consider novel criteria when determining and planning not only their future distribution strategy, but their supply chain network as a whole.

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8 Appendix A – Upper and Lower Bounds for Sub-Criteria

Criteria	Sub-Criteria	Lower Bound	Upper Bound
Total Cost	Cost To Serve	0.00%	100.0%
	Cost To Manage	0.00%	100.0%
Inventory Management	Accuracy KPIs	99.00%	100.00%
	Product Loss KPIs	0.00%	0.25%
Treatment Adherence	Case Support Management	1	5
	Care Reminder Frequency	1	5
Care Accessibility	Patient Reach %	75%	100%
	Community Presence	1	5
Compliance Observance	Data Visibility	90%	100%
	Accepted Tenders	85%	100%
Fulfillment Management	On Time in Full KPIs	95%	100%
	Perfect Order KPIs	98%	100%

9 Appendix B – Sub-Criteria Value Functions & Valuations

Sub-Criteria #1: Cost-To-Serve

Definition: The Total Cost To Serve is defined as the activities tied to the Distributor's ability to manage the distribution network. These activities include, but are not limited to, product management (demand management), order processing, warehousing, transportation, & other services (recalling product). For the model, Cost-To-Serve is captured as a % increase from the current % that the distributor charges to the proposed % increase.

Units: % increase, using the following Formula:

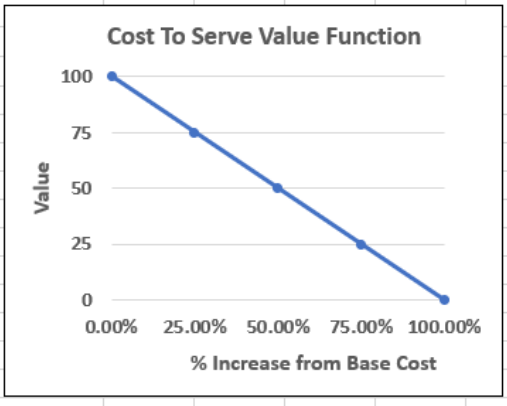
$$\text{Percentage Increase} = \frac{\text{Final Value} - \text{Starting Value}}{|\text{Starting Value}|} \times 100$$

Function Creation: We utilized a FFS Profit Maximization Function to determine appropriate values for the multi-partner strategy. The function follows that the profit that can be derived from the FFS Model that evaluates the impact of increasing service level has on distributor prices (Zhao et al, 2012).

Value Function Elictation - Bisection		
Vf	**Rank**	**Level - Represents what % of the Drug Cost**
0	Worst	100.00%
25		75.00%
50	Mid	50.00%
75		25.00%
100	Best	0.00%

Graphical Input					
% of Drug Cost	0.00%	25.00%	50.00%	75.00%	100.00%
Value	100	75	50	25	0

OUTPUT



Alt 1. Valuation:

Data Source: Primary - Collected from Roche

Limitations & Assumptions: A high earn biologic Polivy was used as a substitute for CGT/PHCPs. This may not be fully representative. Assumed no change in cost for first model run.

Alt 2 & 3 Valuation:

Data Source: Secondary Data Generation

Limitations & Assumptions: For Alternative 2, a multi-partnership model would drive higher service levels adherence across the board, which would drive cost for greater coordination efforts. This drove an overall higher value for the second alternative. For Alternative 3, the use of a single 3PL service who already has their own standardized metrics in place should yield the lowest value required for managing the distribution channel.

Sub-Criteria #2: Cost-To-Manage

Definition: The Total Cost To Manage is defined as the cost that Roche has incurred internally to manage the distributors and the respective distribution channel. These activities include, but are not limited to, service contract fees, property rentals, Business Administration costs (SG&A), as well as staff strength for distributor management services. For the model, Cost-To-Serve is captured as a % increase from the current % that the distributor charges to the proposed % increase.

Units: % increase, using the following Formulas:

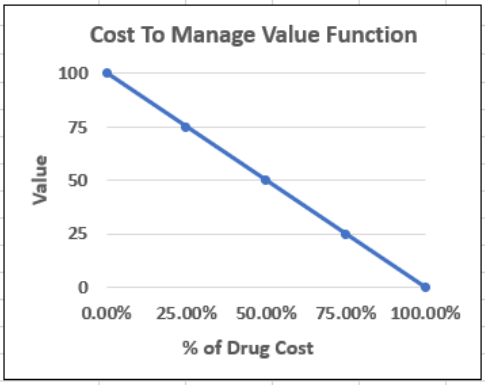
$$annual\ salary \times \#\ of\ employees\ involved \times \%\ of\ workload$$

$$\text{Percentage Increase} = \frac{\text{Final Value} - \text{Starting Value}}{|\text{Starting Value}|} \times 100$$

Function Creation: The Cost To Manage Function captures the Product Management Costs that are charged by management internally. The # of employees involved is a function of both volume increases and employee training required. The Product Management Module of the Cost To Serve Activity Framework captures this cost as a stepwise function (Zhang et al, 2017).

Graphical Input					
% of Drug Cost	0.00%	25.00%	50.00%	75.00%	100.00%
Value	100	75	50	25	0

OUTPUT



Value Function Elictation - Bisection		
Vf	Rank	
0	Worst	100.00%
25		75.00%
50	Mid	50.00%
75		25.00%
100	Best	0.00%

Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Value representative of cost equivalent of man hours allocated to manage distributors. Assumed no change in cost for first model run.

Alt 2 & 3 Valuation:

Data Source: Secondary Data

Limitations & Assumptions: For Alternative 2, a multi-partnership model would drive higher service levels adherence across the board, which would drive cost for greater coordination efforts. This drove an overall higher value for the second alternative. For Alternative 3, the use of a single 3PL service who already has their own standardized metrics in place should yield the lowest value required for managing the distribution channel. For Alternative #3, it represents the option where the affiliate has the most responsibility to manage the distribution network. While the actual functions would be handled at the Regional or Affiliate Level, internal coordination would be required.

Sub-Criteria #3: Inventory Accuracy KPIs

Definition: The Inventory Accuracy KPIs is defined as a measure of how accurately the Distributor is tracking both the quantity and availability of products in inventory, and involves tracking the end of year stock balance against annual physical count. Inventory Accuracy KPIs are valuable to pharma organizations, as monitoring and evaluation strategy helps align with organizational goals and ensure continuous availability of product.

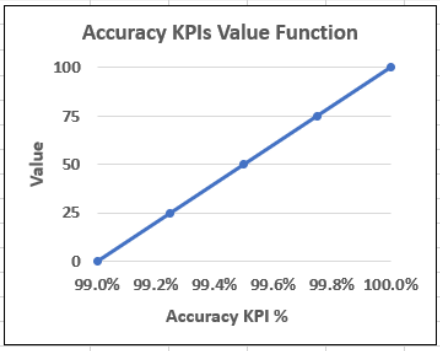
Units: %, using the following Formulas:

(Inventory # at physical stock count) / (Inventory # on inventory management tool)

Function Creation: Selected best performer inventory accuracy value in study (99.5%). Value is representation of accuracy of physical stock count when compared with stock in automated warehouse inventory management system. Company managed inventory accuracy findings given as a combination of shrinkage error (1%), misplacement error(0.008%) and wrong scanning error(0.008%). This gave an inventory error of 1.016%

Graphical Input					
KPI %	100.00%	99.75%	99.50%	99.25%	99.00%
Value	100	75	50	25	0

OUTPUT



Value Function Elictation - Bisection		
Vf	Rank	Level - Fuzzy Logic
0	Worst	99.00%
25		99.25%
50	Mid	99.50%
75		99.75%
100	Best	100.00%

Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Inventory accuracy value is for all SKUs

Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: 3PL will be expected to measure up to this level of inventory accuracy for CGT/PHCPs (Hila et al, 2015). Study emphasizes the value of inventory accuracy for a company managed inventory (Prasad et al, 2019). The case study was however not from a pharma industry.

Sub-Criteria #4: Product Loss KPIs

Definition: Product Loss KPIs are defined by the quantity of product leaving the pipeline for reasons other than administering to a patient. There is a high level of scrutiny and interest in improving visibility and accountability for products from arrival in-country-through distributor-to last mile

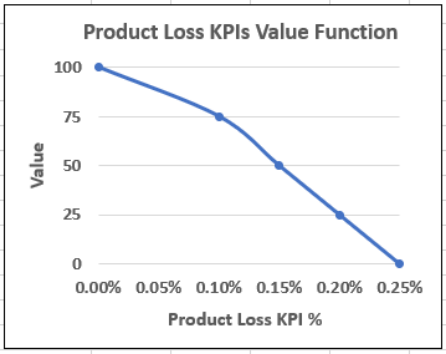
Units: %, using the following Formulas:

(# of Products Lost or Damaged) / (Total Amount of Product in Flow) = Product Loss

Function Creation: Study provided range of accuracy for organizations with inventory counting programs (89%-99.5%) (Prasad et al, 2019).

Graphical Input					
KPI %	0.00%	0.10%	0.15%	0.20%	0.25%
Value	100	75	50	25	0

OUTPUT



Value Function Elictation		
Vf	**Rank**	**Level - Represents KPI %**
0	Worst	0.25%
25		0.20%
50	Mid	0.15%
75		0.10%
100	Best	0.00%

Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Used upper bond of value given by Roche

Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: For Alternative 2, Using the upper limit of inventory accuracy expectations, permissible product loss value was assumed to be 100% less the upper accuracy bound i.e 100%-99.5% = 0.5%. For Alternative 3, Shrinkage error from study was given as 1% (Hila et al, 2015). Study source is not a pharmaceutical company but a company striving to optimize its inhouse inventory managed supply chain KPIs

Sub-Criteria #5: Case Support Management

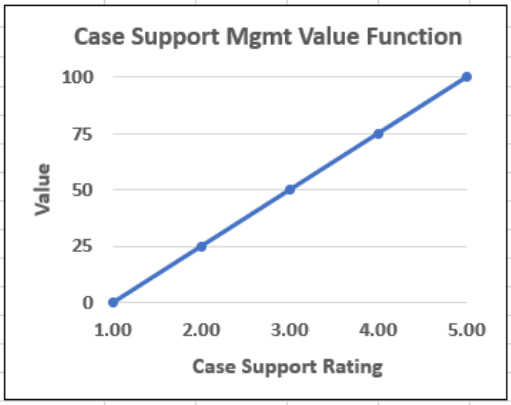
Definition: Case Support Management is defined as the ability of a Service Provider to resolve CGT Patient issues in a quick, effective, and efficient manner. Having a care network that is responsive and present to patient concerns has been proven to be an essential engagement measurement.

Units: numerical rating, using the following Value Function.

Function Creation: Adapting Case Response Metrics from Comparable Study on Patient Engagement Measures. Metric adapted from Case Support Management metrics for other specialty pharma products (Vat et al, 2021).

Graphical Input					
Range	5.00	4.00	3.00	2.00	1.00
Value	100	75	50	25	0

OUTPUT



Value Function Elictation - Direct Rating		
Vf	**Rank**	**Level**
0	Worst - Response > 24 hrs	1.00
25	Bad Mid - Response 12 < X < 24	2.00
50	Mid - Response 6 < X < 12	3.00
75	Good Mid - Response 2 < X < 6	4.00
100	Best - Response < 2 hrs	5.00

Alt 1, Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

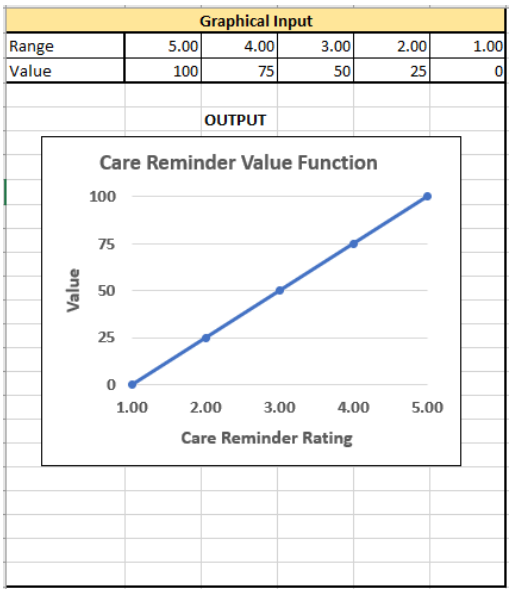
Limitations & Assumptions: Data is not directly representative of Cell & Gene Therapy products, but rather comparable medicines. Response times are expected to be tightened under these circumstances. Alternative 1 and Alternative 2 rely on external partners for Administration Management, and are expected to have a higher performance value for these services. Alternative 3 has Administration Management as an in-house service, and will not have the same level of core competency as an outside firm.

Sub-Criteria #6: Care Reminder Frequency

Definition: Care Reminder Frequency is defined as the number of times a Service Provider will contact the patient to ensure that they are adhering to their treatment schedule. Engaging the patient, through multiple points in the treatment journey, encourages continued patient involvement and promotes shared decision making.

Units: numerical rating, using the following Value Function:

Function Creation: Adapting Care Reminder Frequency Survey Data from Comparable Study on Patient Engagement Measures. Metric adapted from a Likert Scale of how the P2PC Network was contacted (Dukhanin, 2018).



Value Function Elictation - Direct Rating		
Vf	**Rank**	**Level**
0	Worst - Reminder for less than 75%	1.00
25	Bad Mid - Reminder for 75% of events	2.00
50	Mid - Reminder for 85%	3.00
75	Good Mid - Reminder for 95% of events	4.00
100	Best - Reminder for every event	5.00

Alt 1, Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Data is not directly representative of Cell & Gene Therapy products, but rather for oncological products. Treatment timing and administration will vary accordingly. Alternative 1, Alternative 2, and Alternative 3 rely on external partners for Patient Management, and are expected to have a higher performance value for these services. Alternatives 2 and Alternatives 3 rely on a dedicated specialty service partner, which is expected to perform better than the umbrella service under Alternative 1.

Sub-Criteria #7: Patient Reach %

Definition: Patient Reach Percentage is defined as the total percentage of patients that the service distributor can serve, given the country's CGT treatment center footprint and infrastructure. If the infrastructure exists, but the supporting network cannot support it, then a critical portion of the population may not be served.

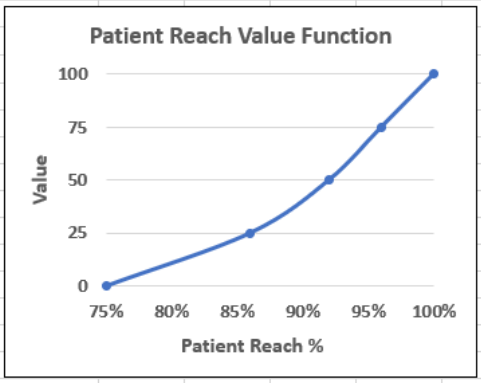
Units: %, based on range given on Equity Access Study

Total # of People with Medicine Access / Total Affected Population

Function Creation: Comparable Metric used in the Equity Measurements, aimed at understanding the portion of the population that is served by the distributor network. Patient Reach is an equity measurement. Patient Reach measures will be dependent on the location chosen for CGT Treatment centers (Davari, 2015). In the time being, Patient Reach % assumes that a distributor can reach the footprint of all available patients.

Graphical Input					
Reach %	100.00%	96.00%	92.00%	86.00%	75.00%
Value	100	75	50	25	0

OUTPUT



Value Function Elictation - Bisection		
Vf	Rank	Level - Fuzzy Logic
0	Worst	75.00%
25		84.00%
50	Mid	88.00%
75		92.00%
100	Best	100.00%

Alt 1, Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Alternative 1 data extrapolated from the overview metrics provided by the distributor. Alternative 2 and Alternative 3 data utilizes an estimate from other 3PL service in Taiwan and the footprint they can cover, with approximate cold chain capabilities.

Sub-Criteria #8: Community Presence

Definition: Community Presence is defined as the longevity of the Distributor's presence in the affiliate nation and relationship with the local Hospitals/Doctor Network (ex. New Arrival vs. Established). In Levesque's Conceptual Framework for Healthcare Access, Availability and Accommodation is one of the critical features that the Healthcare Network can provide to patients

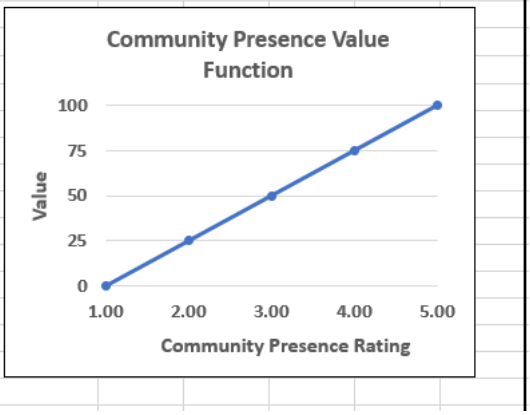
Units: numerical rating, using the following Value Function:

Function Creation: Adapting Care Reminder Frequency Survey Data from Comparable Study on Patient Engagement Measures and Community Health Network (Shortell et al, 2002). Metric adapted from a Likert Scale of how the Network had been perceived by the local community.

Value Function Elictation - Direct Rating		
Vf	**Rank**	**Level**
0	Worst - Low Trust with Local Health Network	1.00
25	Bad Mid	2.00
50	Mid - Local Health Network is Neutral	3.00
75	Good Mid	4.00
100	Best - High Trust with Local Health Network	5.00

Graphical Input					
Range	5.00	4.00	3.00	2.00	1.00
Value	100	75	50	25	0

OUTPUT



Alt 1, Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Data is not directly representative of Cell & Gene Therapy products, but rather comparable medicines. This measure is heavily dependent on the affiliate level having an understanding of their local ecosystem and congruent support network. Survey data requires elicitation from a community group that may be difficult to gather. Alternative 1 assumes the distributor has a strong presence in the local country and has been performing satisfactory to this point, thus developing a level of trust with the local network. Alternative 2 and Alternative 3 assumes the distributor is taking over a new portion of the market, with trust not fully established yet within the surrounding networks, with Alternative 3 having the least established network. In future runs, this may best be captured by using a VOC (Voice of the Customer) Score.

Sub-Criteria #9: Data Visibility

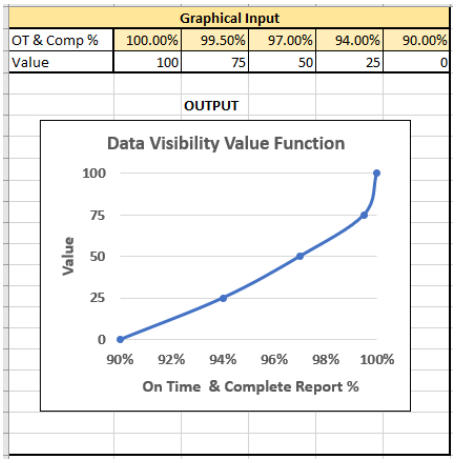
Definition: Data Report Visibility is defined by the timeliness and completeness of the data reports that are received from the Distributor. The inclusion of a metric that evaluates the data report availability and usability is critical for understanding how well the distributor communicates. From a pharmaceutical manufacturer's perspective, exceptional care must be taken to track of the quantity and quality of the information they receive from each distributor, or else risk priority misalignment

Units: % of Reports on Time & Complete, given by the following function:

# of Reports Completed On Time & Complete / # of Reports Requested

Function Creation: Comparable Metric used for Supplier Collaboration Metrics, which is aimed at capturing the number of on time and complete reports exchanged from the Distributor to the Manufacturer (Ramanathan et al., 2011). The comparable metric is a general supply chain metric, and not one specific to pharmaceuticals or even cell and gene therapies. May not be as robust as other methods.

Value Function Elictation - Bisection		
Vf	**Rank**	**Level - Fuzzy Logic**
0	Worst	90.00%
25		94.00%
50	Mid	97.00%
75		99.50%
100	Best	100.00%



Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Used value currently captured for Distributor by Roche

Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Data is not directly representative of Cell & Gene Therapy products, but rather of general supply chain data visibility trends. This measure is heavily dependent on the System Infrastructure each distributor maintains to house and hold their data management software. For further study, it may be interesting to include a review of the distributor's SW packages for each of information storage and sharing. Alternative 1 assumes that data management at the scale required is a new skill for the Traditional Distributor, and learning will need to occur. Alternative 2 assumes the best firm has been chosen to handle this data, and will be prompt, timely, and efficient with their information. Alternative 1 assumes that data management at the scale required is a new skill for Roche at the Regional Level, and learning will need to occur.

Sub-Criteria #10: Processed Tenders

Definition: Tender Process Rate is defined as the ability of the Service Provider to ensure that the paperwork associated with a tender award is successfully completed in a timely fashion. In Southeast Asia, infectious diseases treatment and management is handled through public programs and government tenders, which are generally awarded on an ad hoc basis, which greatly disrupt a pharmaceutical manufacturer's ability to forecast drug market entrances and finances.

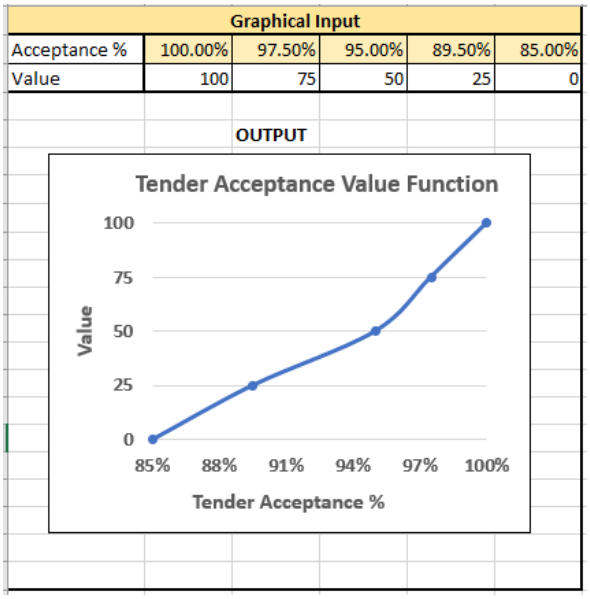
Units: % of Tenders, given by the following function:

# of Tenders Successfully Managed by the Distributor / # of Tenders Handled

Function Creation: Tender acceptance rate not a representation of Tender award rate. KPI used to show that distributors manage the submission and validate submissions to filter those meeting SOP prior to consideration for award (Suraratdecha, 2011).

Value Function Elictation - Bisection		
Vf	Rank	Level - Fuzzy Logic
0	Worst	85.00%
25		89.50%
50	Mid	95.00%
75		97.50%
100	Best	100.00%

Graphical Input					
Acceptance %	100.00%	97.50%	95.00%	89.50%	85.00%
Value	100	75	50	25	0



Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Acceptance Rate given by Roche Pharama

Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Limited Data in existence for Alternative Distributors for their Tender Processing Rate. Assumption made that Alternative 2 would have greater expertise than Alternative 3. Recommended to conduct more scrutinized research of this with sponsor company in future.

Sub-Criteria #11: On Time In Full KPIs

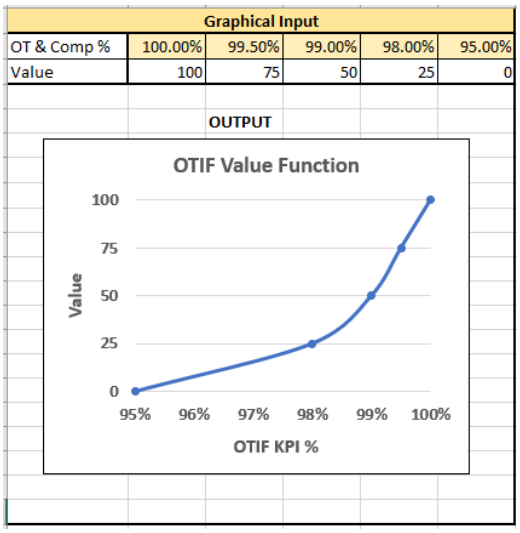
Definition: On Time in Full KPIs are defined by the tracking precision of deliverables leading to order fulfillment, usually by means of validating the invoice accuracy rate. In the pharmaceutical industry, this metric is one of the leading indicators of reliability of Distributor performance, as it captures both the Distributor's ability to manage stock, but also manage orders in a timely manner

Units: % of Orders on Time in Full, as given by the function here:

# of Orders Delivered on TIme & in Full / Total # of Orders handled

Function Creation: Representative of best practice for reputable pharma companies in developed market (Alicke et al., 2014)

Value Function Elictation - Bisection		
Vf	**Rank**	**Level - Fuzzy Logic**
0	Worst	95.00%
25		98.00%
50	Mid	99.00%
75		99.50%
100	Best	100.00%



Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Not exclusively for Polivy but for all in country SKUs

Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Expectation of OTIF set at the higher bound from the study with the assumption that this is attainable with CGT/PHCP using a specialty distributor. Partners responsible for last mile distribution in alternative 2 and 3 will be held at the same standard. Expected service level in both cases will therefore be the same.

Sub-Criteria #12: Perfect Order KPIs

Definition: Perfect Order KPIs are defined by the tracking precision of deliverables leading to order fulfillment. Establishing strong credibility with achieving perfect orders has demonstrably become not only a critical service metric, but an expectation for CGT products and treatments.

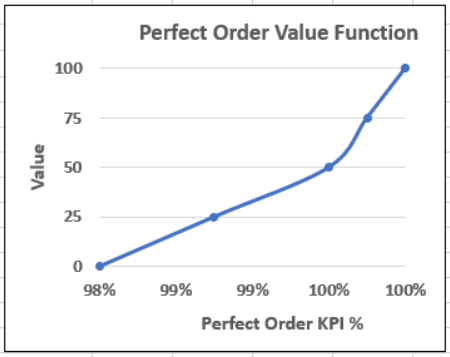
Units: % of Invoices filled Perfectly, as given by the function here:

Invoices free of Errors / Total # of Invoices Placed

Function Creation: Representative of best practice for reputable pharma companies in developed market (Dhanya, 2014).

Graphical Input					
OT & Comp %	100.00%	99.75%	99.50%	98.75%	98.00%
Value	100	75	50	25	0

OUTPUT



Value Function Elictation - Bisection		
Vf	Rank	Level - Fuzzy Logic
0	Worst	98.00%
25		98.75%
50	Mid	99.50%
75		99.75%
100	Best	100.00%

Alt 1. Valuation:

Data Source: Primary Data - Collected from Roche

Limitations & Assumptions: Value generated using only Invoice accuracy KPI

Alt 2. & Alt. 3 Valuation:

Data Source: Secondary data generation

Limitations & Assumptions: Different study area - southern India. Trigger for source study, decreasing efficiency of 3PL services so 3PL efficiency can actually be better than this outcome. Potential to maximize invoice accuracy using robotic invoice automation was given 100% in this study. Assumes that inhouse invoice generation and verification by Pharma company will be done using similar robotic invoice automation techniques (Sahu, 2020).

10 Appendix C – Weights Adjustment & Evaluation

Taiwan CGT/PHCP Scenario Weight Adjustment & Evaluation:

Weight Adjustment					
Objective Weight Inputs					
Objective	Support Roche	Empower Patients	Satisfy HC System	Weight Sum	Required Sum
Weight	0.37	0.34	0.29	1.00	1.00
Criteria Weight Inputs					
Criteria	Total Cost	Treatment Adherence	Compliance		
Weight	0.53	0.36	0.44		
Criteria	Inventory Mgmt.	Care Accessibility	Fulfillment Mgmt.		
Weight	0.47	0.64	0.56		
Weight Su	1.00	1.00	1.00		
Required	1.00	1.00	1.00		

Sub-Criteria Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.09805
Cost-To-Manage	0.09805
Inventory Accuracy KPIs	0.08695
Product Loss KPIs	0.08695
Case Support Management	0.0612
Care Reminder Frequency	0.0612
Patient Reach %	0.1088
Community Presence	0.1088
Data Visibility	0.0638
Tender Processing	0.0638
OTIF KPIs	0.0812
Perfect Order KPIs	0.0812
Sum	1

Thailand CGT/PHCP Scenario Weight Adjustment & Evaluation:

Weight Adjustment					
Objective Weight Inputs					
Objective	Support Roche	Empower Patients	Satisfy HC System	Weight Sum	Required Sum
Weight	0.333	0.333	0.333	1.00	1.00
Criteria Weight Inputs					
Criteria	Total Cost	Treatment Adherence	Compliance		
Weight	0.5	0.5	0.5		
Criteria	Inventory Mgmt.	Care Accessibility	Fulfillment Mgmt.		
Weight	0.5	0.5	0.5		
Weight Su	1.00	1.00	1.00		
Required	1.00	1.00	1.00		

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.083
Cost-To-Manage	0.083
Inventory Accuracy KPIs	0.083
Product Loss KPIs	0.083
Case Support Management	0.083
Care Reminder Frequency	0.083
Patient Reach %	0.083
Community Presence	0.083
Data Visibility	0.083
Tender Processing	0.083
OTIF KPIs	0.083
Perfect Order KPIs	0.083
Sum	**1.000**

Taiwan High Volume Product Scenario Weight Adjustment & Evaluation:

Objective Weight Inputs					
Objective	Support Roche	Empower Patients	Satisfy HC System	Weight Sum	Required Sum
Weight	0.37	0.29	0.34	1.00	1.00

Criteria Weight Inputs			
Criteria	Total Cost	Treatment Adherence	Compliance
Weight	0.53	0.36	0.44
Criteria	Inventory Mgmt.	Care Accessibility	Fulfillment Mgmt.
Weight	0.47	0.64	0.56
Weight Su	1.00	1.00	1.00
Required	1.00	1.00	1.00

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.098
Cost-To-Manage	0.098
Inventory Accuracy KPIs	0.087
Product Loss KPIs	0.087
Case Support Management	0.052
Care Reminder Frequency	0.052
Patient Reach %	0.093
Community Presence	0.093
Data Visibility	0.075
Tender Processing	0.075
OTIF KPIs	0.095
Perfect Order KPIs	0.095
Sum	**1.000**

Thailand High Volume Product Scenario Weight Adjustment & Evaluation:

Weight Adjustment					
Objective Weight Inputs					
Objective	Support Roche	Empower Patients	Satisfy HC System	Weight Sum	Required Sum
Weight	0.4	0.2	0.4	1.00	1.00

Criteria Weight Inputs			
Criteria	Total Cost	Treatment Adherence	Compliance
Weight	0.5	0.5	0.5
Criteria	Inventory Mgmt.	Care Accessibility	Fulfillment Mgmt.
Weight	0.5	0.5	0.5
Weight Sum	1.00	1.00	1.00
Required Sum	1.00	1.00	1.00

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.100
Cost-To-Manage	0.100
Inventory Accuracy KPIs	0.100
Product Loss KPIs	0.100
Case Support Management	0.050
Care Reminder Frequency	0.050
Patient Reach %	0.050
Community Presence	0.050
Data Visibility	0.100
Tender Processing	0.100
OTIF KPIs	0.100
Perfect Order KPIs	0.100
Sum	**1.000**

11 Appendix D – Alternative value calculations

Taiwan PHCP/CGT:

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.098
Cost-To-Manage	0.098
Inventory Accuracy KPIs	0.087
Product Loss KPIs	0.087
Case Support Management	0.061
Care Reminder Frequency	0.061
Patient Reach %	0.109
Community Presence	0.109
Data Visibility	0.064
Tender Processing	0.064
OTIF KPIs	0.081
Perfect Order KPIs	0.081
Sum	**1.000**

Value Function Computation			
Criteria Name	Alt. 1 Vf	Alt. 2 Vf	Alt. 3 Vf
Cost-To-Serve	1.00	0.74	0.85
Cost-To-Manage	1.00	0.69	0.88
Inventory Accuracy KPIs	1.00	1.00	-0.02
Product Loss KPIs	0.19	1.00	0.19
Case Support Management	0.50	0.75	0.25
Care Reminder Frequency	0.75	1.00	1.00
Patient Reach %	0.49	0.81	0.74
Community Presence	1.00	0.75	0.50
Data Visibility	1.00	1.00	0.18
Tender Processing	0.49	0.36	0.27
OTIF KPIs	0.47	0.74	0.74
Perfect Order KPIs	0.90	0.92	1.00

Weighted Value Computation - Sub-Criteria			
Criteria Name	Alt. 1 Total	Alt. 2 Total	Alt. 3 Total
Cost-To-Serve	0.09805	0.072557	0.0833425
Cost-To-Manage	0.09805	0.0678506	0.086284
Inventory Accuracy KPIs	0.08695	0.08695	-0.0016694
Product Loss KPIs	0.0166944	0.08695	0.0166944
Case Support Management	0.0306	0.0459	0.0153
Care Reminder Frequency	0.0459	0.0612	0.0612
Patient Reach %	0.053312	0.0884	0.080512
Community Presence	0.1088	0.0816	0.0544
Data Visibility	0.0638	0.0638	0.011484
Tender Processing	0.031262	0.02291	0.017342
OTIF KPIs	0.0378392	0.060088	0.060088
Perfect Order KPIs	0.07308	0.074704	0.0812
Total	**0.7443376**	**0.8129096**	**0.5661775**

Thailand PHCP/CGT Scenario:

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.083
Cost-To-Manage	0.083
Inventory Accuracy KPIs	0.083
Product Loss KPIs	0.083
Case Support Management	0.083
Care Reminder Frequency	0.083
Patient Reach %	0.083
Community Presence	0.083
Data Visibility	0.083
Tender Processing	0.083
OTIF KPIs	0.083
Perfect Order KPIs	0.083
Sum	**0.999**

Value Function Computation			
Criteria Name	Alt. 1 Vf	Alt. 2 Vf	Alt. 3 Vf
Cost-To-Serve	1.00	0.74	0.85
Cost-To-Manage	1.00	0.69	0.88
Inventory Accuracy KPIs	0.00	0.49	-0.02
Product Loss KPIs	0.08	0.49	0.11
Case Support Management	0.50	0.75	0.25
Care Reminder Frequency	0.75	1.00	1.00
Patient Reach %	0.49	0.81	0.74
Community Presence	1.00	0.75	0.50
Data Visibility	1.00	1.00	0.18
Tender Processing	0.23	0.36	0.27
OTIF KPIs	0.55	0.74	0.74
Perfect Order KPIs	0.98	0.92	1.00

Weighted Value Computation - Sub-Criteria			
Criteria Name	Alt. 1 Total	Alt. 2 Total	Alt. 3 Total
Cost-To-Serve	0.08325	0.061605	0.070763
Cost-To-Manage	0.08325	0.057609	0.07326
Inventory Accuracy KPIs	0	0.040793	-0.001598
Product Loss KPIs	0.00666	0.040793	0.00888
Case Support Management	0.041625	0.062438	0.020813
Care Reminder Frequency	0.062438	0.08325	0.08325
Patient Reach %	0.040793	0.067641	0.061605
Community Presence	0.08325	0.062438	0.041625
Data Visibility	0.08325	0.08325	0.014985
Tender Processing	0.019225	0.029894	0.022629
OTIF KPIs	0.045621	0.061605	0.061605
Perfect Order KPIs	0.081585	0.07659	0.08325
Total	**0.630946**	**0.727904**	**0.541065**

Taiwan High-Volume Scenario:

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.098
Cost-To-Manage	0.098
Inventory Accuracy KPIs	0.087
Product Loss KPIs	0.087
Case Support Management	0.052
Care Reminder Frequency	0.052
Patient Reach %	0.093
Community Presence	0.093
Data Visibility	0.075
Tender Processing	0.075
OTIF KPIs	0.095
Perfect Order KPIs	0.095
Sum	**1.000**

Value Function Computation			
Criteria Name	Alt. 1 Vf	Alt. 2 Vf	Alt. 3 Vf
Cost-To-Serve	1.00	0.62	0.81
Cost-To-Manage	1.00	0.24	0.69
Inventory Accuracy KPIs	1.00	0.74	0.48
Product Loss KPIs	0.19	0.74	0.19
Case Support Management	0.50	0.75	0.25
Care Reminder Frequency	0.75	1.00	1.00
Patient Reach %	0.49	0.81	0.74
Community Presence	1.00	0.75	0.50
Data Visibility	1.00	1.00	0.18
Tender Processing	0.49	0.36	0.27
OTIF KPIs	0.47	0.74	0.74
Perfect Order KPIs	0.90	0.92	1.00

Weighted Value Computation - Sub-Criteria			
Criteria Name	Alt. 1 Total	Alt. 2 Total	Alt. 3 Total
Cost-To-Serve	0.09805	0.060791	0.079666
Cost-To-Manage	0.09805	0.023532	0.067851
Inventory Accuracy KPIs	0.08695	0.064343	0.041771
Product Loss KPIs	0.016694	0.064343	0.016694
Case Support Management	0.0261	0.03915	0.01305
Care Reminder Frequency	0.03915	0.0522	0.0522
Patient Reach %	0.045472	0.0754	0.068672
Community Presence	0.0928	0.0696	0.0464
Data Visibility	0.0748	0.0748	0.013464
Tender Processing	0.036652	0.02686	0.020332
OTIF KPIs	0.044363	0.070448	0.070448
Perfect Order KPIs	0.08568	0.087584	0.0952
Total	**0.744762**	**0.709051**	**0.585747**

Thailand High-Volume Scenario:

Weight Evaluation	
Criteria Name	Weight
Cost-To-Serve	0.098
Cost-To-Manage	0.098
Inventory Accuracy KPIs	0.087
Product Loss KPIs	0.087
Case Support Management	0.061
Care Reminder Frequency	0.061
Patient Reach %	0.109
Community Presence	0.109
Data Visibility	0.064
Tender Processing	0.064
OTIF KPIs	0.081
Perfect Order KPIs	0.081
Sum	**1.000**

Value Function Computation			
Criteria Name	Alt. 1 Vf	Alt. 2 Vf	Alt. 3 Vf
Cost-To-Serve	1.00	0.74	0.85
Cost-To-Manage	1.00	0.69	0.88
Inventory Accuracy KPIs	1.00	1.00	-0.02
Product Loss KPIs	0.19	1.00	0.19
Case Support Management	0.50	0.75	0.25
Care Reminder Frequency	0.75	1.00	1.00
Patient Reach %	0.49	0.81	0.74
Community Presence	1.00	0.75	0.50
Data Visibility	1.00	1.00	0.18
Tender Processing	0.49	0.36	0.27
OTIF KPIs	0.47	0.74	0.74
Perfect Order KPIs	0.90	0.92	1.00

Weighted Value Computation - Sub-Criteria			
Criteria Name	Alt. 1 Total	Alt. 2 Total	Alt. 3 Total
Cost-To-Serve	0.09805	0.072557	0.083343
Cost-To-Manage	0.09805	0.067851	0.086284
Inventory Accuracy KPIs	0.08695	0.08695	-0.001669
Product Loss KPIs	0.016694	0.08695	0.016694
Case Support Management	0.0306	0.0459	0.0153
Care Reminder Frequency	0.0459	0.0612	0.0612
Patient Reach %	0.053312	0.0884	0.080512
Community Presence	0.1088	0.0816	0.0544
Data Visibility	0.0638	0.0638	0.011484
Tender Processing	0.031262	0.02291	0.017342
OTIF KPIs	0.037839	0.060088	0.060088
Perfect Order KPIs	0.07308	0.074704	0.0812
Total	**0.744338**	**0.81291**	**0.566177**