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# Application of Soft Systems Methodology (SSM) to increase engineering efficiency in a globally spread elevator company

# Contents

# 1. Introduction

Otis is a 168-year-old elevator company, who are also the inventors of the safety elevators, in 1979 Otis was acquired by United technologies and in 2020 Otis was spun off as an individual and an independent company. With this spin off a new direction was envisioned to increase the engineering efficiency. Currently Otis has engineering centers all around the world with Lead Design Centers (LDC) and System Engineering Elevator (SEE) who are responsible to designing and sustaining elevators in their respective regions. The centers currently operate in a dispersed manner with regions in the same continent having more interactions and intercontinentally interaction and exchange being relatively low. One of the main reasons for this type of interaction is since elevators market segment is relatively similar in a region, however for Otis to stay ahead of their competition and satisfy the constantly updating market demand, it has understood the necessity to leverage its global nature of the organization and enable more interactions and communication between its sister engineering centers. Otis has acknowledged this and has setup a global technical data center whose role is to be the driver for change in the organization by bringing all centers to the same level and efficiently handle engineering design and change. The report provided here takes up the task of helping Global Technical Data center in solving this complex issue as will be highlighted below in our analysis using soft systems methodology.

Talking about the type of product under consideration for bringing more insights into the complexity, elevators are generally “Build to order” type of industry. This means only after a customer order is confirmed the elevators are fabricated, assembled, and sent over to customer site. This is mainly because, elevator designs need to be very dynamic or parametric in nature which needs to conform to the shaft size of the customer building. Hence design data needs to be handled differently from conventional and centers have come up with their own method and product configurators have been built around these data handling methods.

# 2. Looking at the problem scenario

We use rich picture to understand the problem from the perspective of different stakeholders simultaneously. This is done to understand the current scenario of the situation without any bias with all related stakeholders in place.

The rich picture brings a lot of clarity into our situation here where we can observe some key points here which are

- There are 3 main grouping of entities namely entities from – Europe, Middle east and Africa (EMEA), Americas – South and North (AMER) & Asia pacific (APAC) which are found to have a good relationship internally
- Their strengths are mutually exclusive, that is, every region is a specialist in one type of family of elevator.
- Operations of every region are agitated if they feel their configurators are impacted.
- Apart from the three grouping, other key stakeholders that are to be considered here are our clients who are located at the center of the rich picture – Global Technical Data Center & World Head Quarters.
- Language compatibility seems to be a commonly recurring issue.
- There is a need to exchange data between all 3 centers.

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# UNDERSTANDING THE RICH PICTURE

**EMEA** - Europe, Middle East and Africa
**APAC** - Asia Pacific
**AMER** - North, Central & South America
**LDC** - Lead Design Center
**SEE** - System engineering centers located across globe collects data from LDC
**Heavy Duty elevators** - Group of high duty load low rise elevators
**Light Duty elevators** - Group of low duty low rise elevators
**Mid Rise elevators** - Group of medium duty and medium rise elevators
**High Rise elevators** - Group of heavy duty and high rise elevators
**Entry Level elevators** - Group of low duty cost efficient elevators

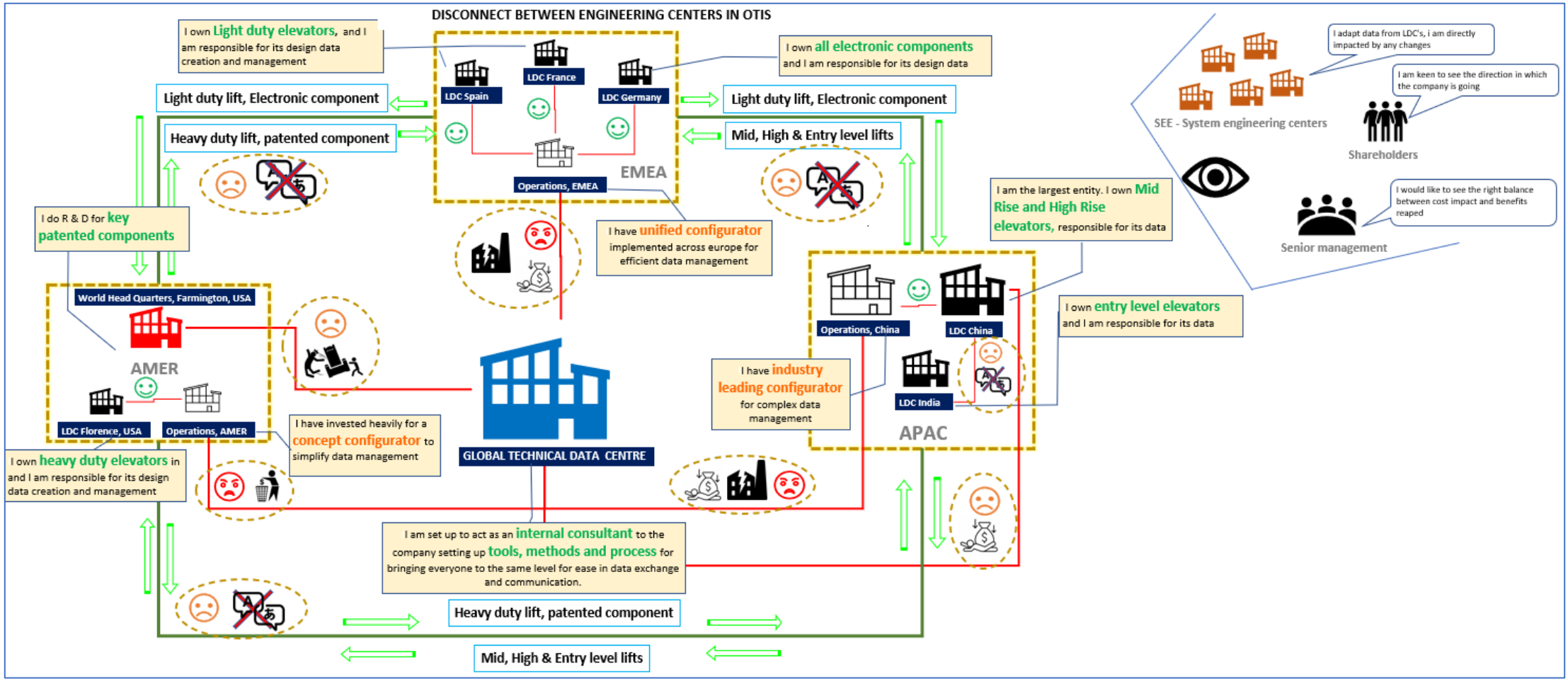
**Purpose statement**

Cost burden
Opertions impact
Language barrier
Loss of power

**Relationship deliberation**

**Medium conflict - Dissatisfaction**
**No Conflict - Satisfied**
**High Conflict - Strong dissatisfaction**

# THE RICH PICTURE



# 3. The Stakeholders

## 3.1. Global Technical Data Center

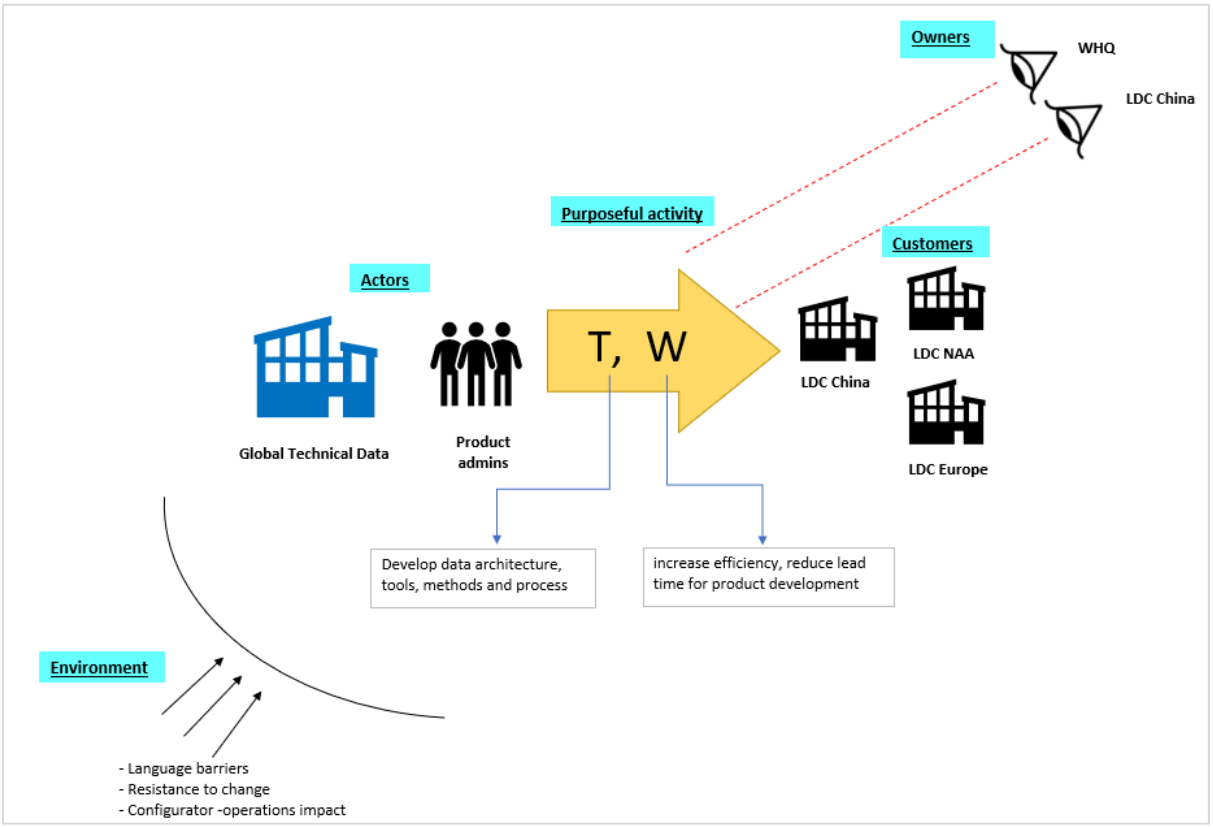
This center is created to drive the engineering change in the company as an internal consultant to the company. They are given the power and authority to take key decisions regarding development of tools, methods, and process. However, when exercising this power, they are generally bound to face lot of conflicts due to the vast number of stakeholders involved and level of impact anticipated.

The Root definition for Global Technical Data Center

*"Unify globally spread engineering centers by developing data architecture, tools, methods and process in order to increase efficiency, reduce lead time for product development"*

| CATWOE table for Global Technical Data Center | |
|---|---|
| Customer | All engineering centres, WHQ |
| Actor | Global technical data centre, product admins of each centres |
| Transformation | Develop data architecture, tools, methods, and process |
| Worldview | increase efficiency, reduce lead time for product development |
| Ownership | WHQ, LDC China |
| Environmental constraints | - Language barriers<br>- Resistance to change<br>- Configurator -operations impact |

CATWOE visual representation



## 3.2. Lead Design Center China

This is one of the major centers for Otis having the largest market share and serving lot of countries around China. They were faced with similar situation in a smaller scale with dispersed centers inside China and have come up with an efficient method for data management system.

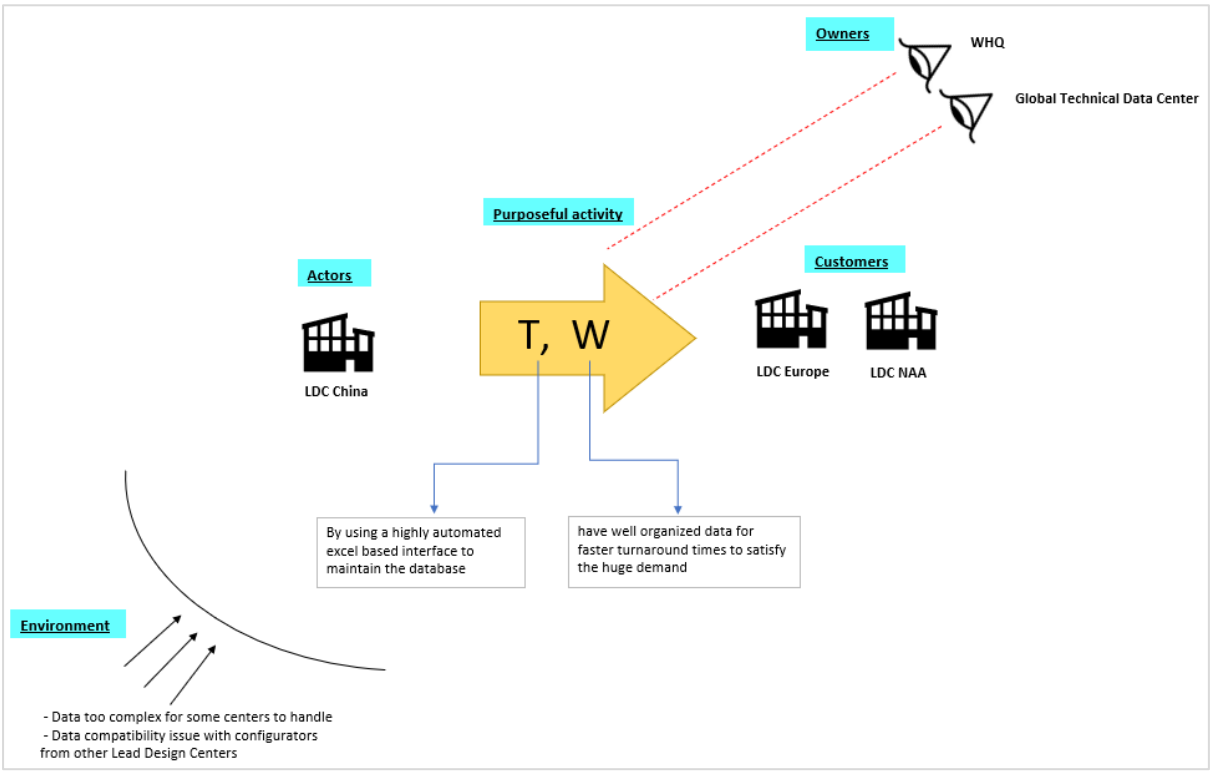
### The Root definition for Lead Design Center China

*"Manage largest set of design data of high rise and midrise elevator family by using a highly automated excel based interface to maintain the database in order to have well organized data for faster turnaround times to satisfy the huge demand"*

CATWOE table for Lead Design Centre China

| | |
|---|---|
| Customer | Engineering centres except China who take and utilize data from China |
| Actor | LDC China |
| Transformation | By using a highly automated excel based interface to maintain the database |
| Worldview | have well organized data for faster turnaround times to satisfy the huge demand |
| Ownership | WHQ, Global Technical Data Centre |
| Environmental constraints | - Data too complex for some centres to handle<br>- Data compatibility issue with configurators from other Lead Design Centres |

### CATWOE visual representation



## 3.3. Lead Design Center Europe

This center is made to represent the whole of Europe who run a similar configurator system, they haven't fully utilized the PLM (Product Lifecycle Management) system which was deployed recently by Otis World Head Quarters.

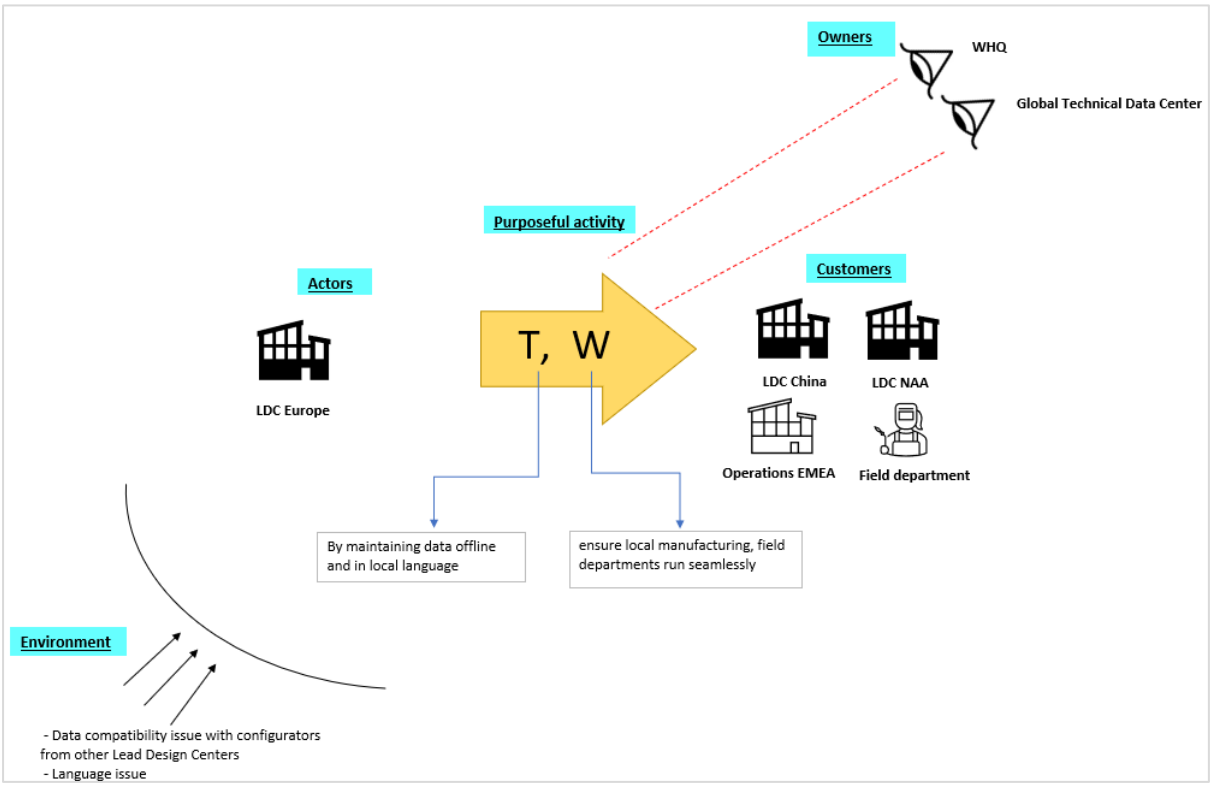
The Root definition for Lead Design Center Europe

*"Manage oldest set of design data of light duty elevator family and electronic components by maintaining data offline and in local language ensure local manufacturing, field departments run seamlessly"*

CATWOE table for Lead Design Centre Europe

| | |
|---|---|
| Customer | Engineering centres except Europe who utilize this data, Europe manufacturing, field operation |
| Actor | LDC Europe |
| Transformation | By maintaining data offline and in local language |
| Worldview | ensure local manufacturing, field departments run seamlessly |
| Ownership | WHQ, Global Technical Data Centre |
| Environmental constraints | - Data compatibility issue with configurators from other Lead Design Centres<br>- Language issue |

CATWOE visual representation



## 3.4. Lead Design Center NAA

This center manages data in a unique way, they have also recently started working with a third-party vendor to create a concept configurator to automate 3D model based on customer input.

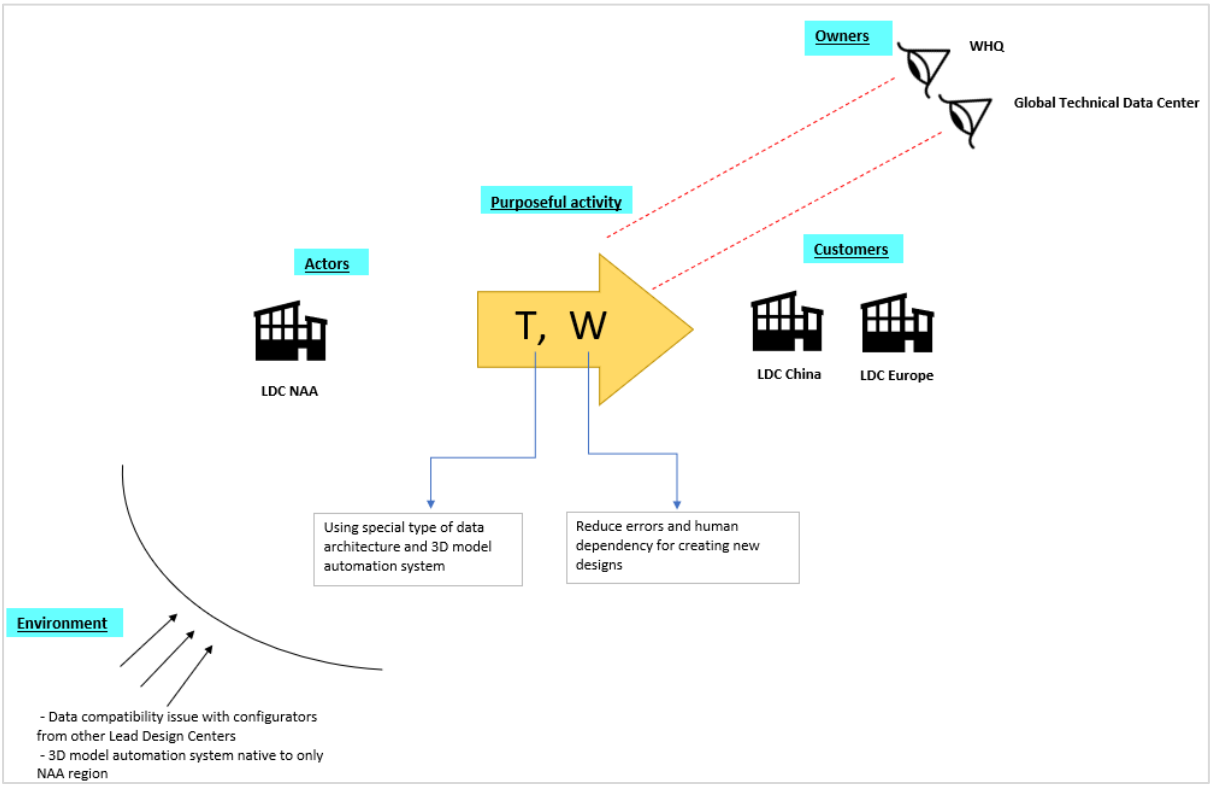
### The Root definition for Lead Design Center NAA

*"Manage design data of heavy-duty elevator family by using special type of data architecture and 3D model automation system in order to reduce errors and human dependency while creating and updating new designs"*

CATWOE table for Lead Design Centre NAA

| | |
|---|---|
| Customer | Engineering centres except NAA |
| Actor | LDC NAA |
| Transformation | Using special type of data architecture and 3D model automation system |
| Worldview | Reduce errors and human dependency for creating new designs |
| Ownership | WHQ, Global Technical Data Centre |
| Environmental constraints | - Data compatibility issue with configurators from other Lead Design Centres<br>- 3D model automation system native to only NAA region |

### CATWOE visual representation for Lead Design Centre NAA



## 3.5. World Head Quarters USA

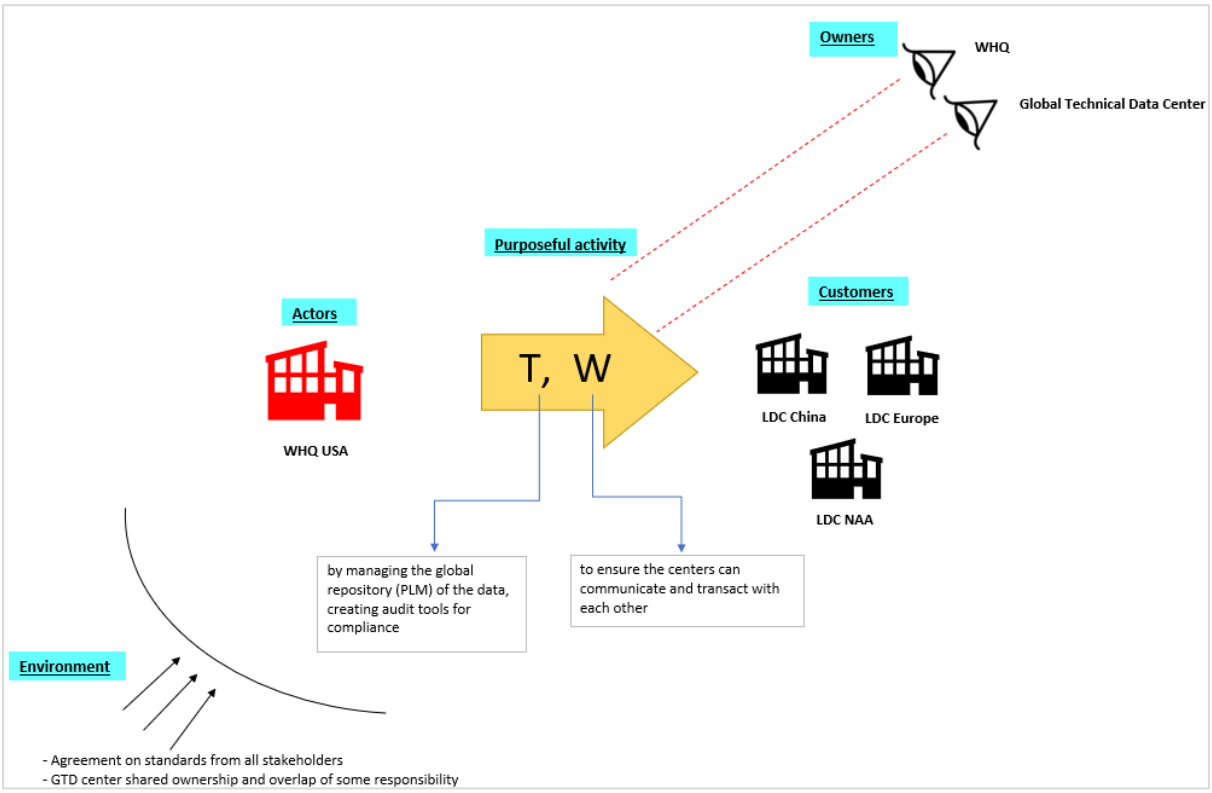
This center had a lot of power and responsibilities with regards to deciding the standards for the data management, even though the standards are not completely followed by everyone. They also handle and set the rules for the Product Lifecycle Management (PLM) system of the company.

The Root definition for Lead Design Center USA

*"Define design standards globally by managing the global repository (PLM) of the data creating audit tools for compliance to ensure the centers can communicate and transact with each other"*

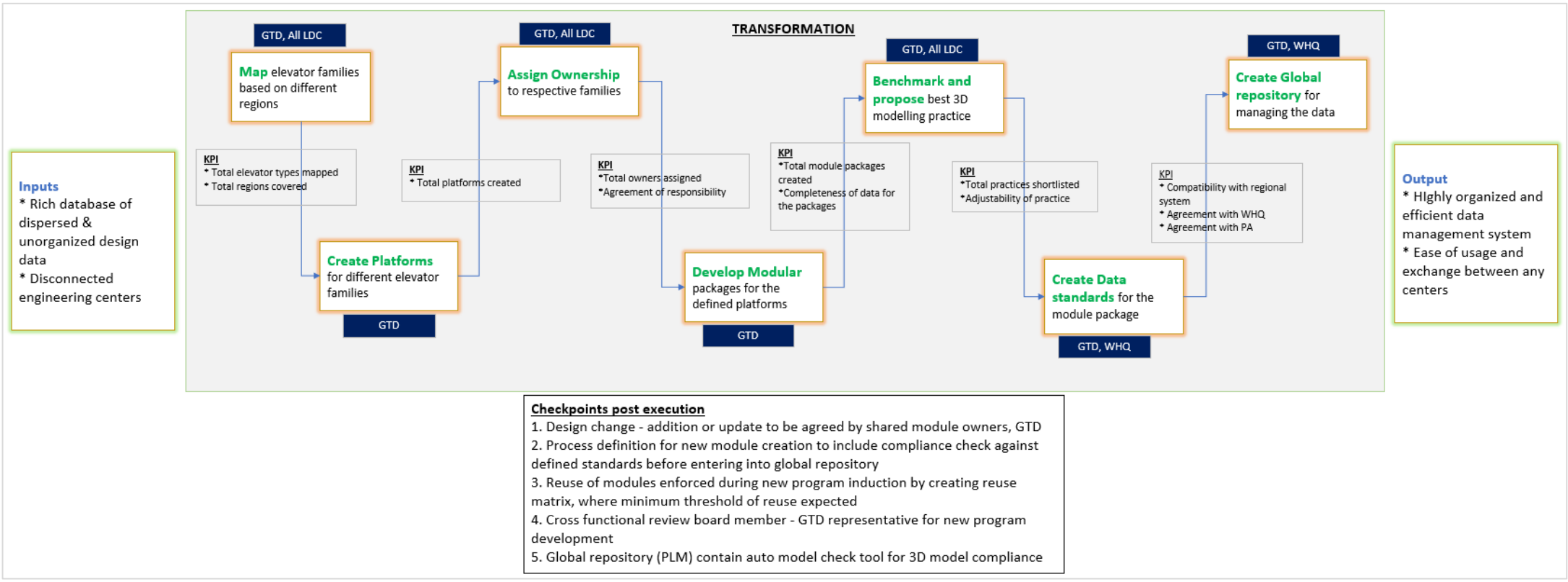
| CATWOE table for World Head Quarters USA | |
|---|---|
| Customer | All Engineering centres |
| Actor | WHQ engineering |
| Transformation | by managing the global repository (PLM) of the data, creating audit tools for compliance |
| Worldview | to ensure the centres can communicate and transact with each other |
| Ownership | Global Technical Data Centre |
| Environmental constraints | - Agreement on standards from all stakeholders<br>- GTD centre shared ownership and overlap of some responsibility |

CATWOE visual representation for Lead Design Centre NAA



# 4. Analysis – 1

## 4.1. Conceptual model



Coming up with the perfect solution for the problem faced is very challenging in our scenario without taking a big cost impact and operations disruption, hence the key idea in drafting the conceptual model is to ensure utilization of all the existing resources while keeping stakeholders satisfied and content. The conceptual model involves product complexity management techniques namely platforming and product modularization, whose usage is already seen extensively in automobile industry. We justify the model with the 3E's depicted as below.

Three 3E's + 1E

Efficacious: By employing the strategies of **platforming, modularity** the model aims to achieve exactly the output that is expected by the center which is to have highly organized and efficient data management system while enabling ease of exchange between centers

Efficient: One of the main objectives of the company is to focus on utilizing the vast existing resources without being a major cost burden and avoid operations impact. By creating the modular packages is to mainly **reorganize rather than recreating** data, the model can be hence justified in this regard and, we **leverage the strengths of each stakeholder** rather than restructuring the whole system for assigning platform ownership.

Effective: The end goal is always kept in mind with every single step of the model, which is to achieve better organized data, this can be proved by the **collective output of every step** highlighted in bold green in our conceptual model which relates in one way, or another the output highlighted.

Elegant: There is a create flow established in the model with regards to the steps that need to be taken and **KPI for each step** is highlighted in the model with all the **checkpoints** points to ensure the proposed architecture shall stay in place and be **self-sustaining** in the future to avoid situation that happened with the standards released by World Head Quarters which have not been seriously considered by the engineering centers.

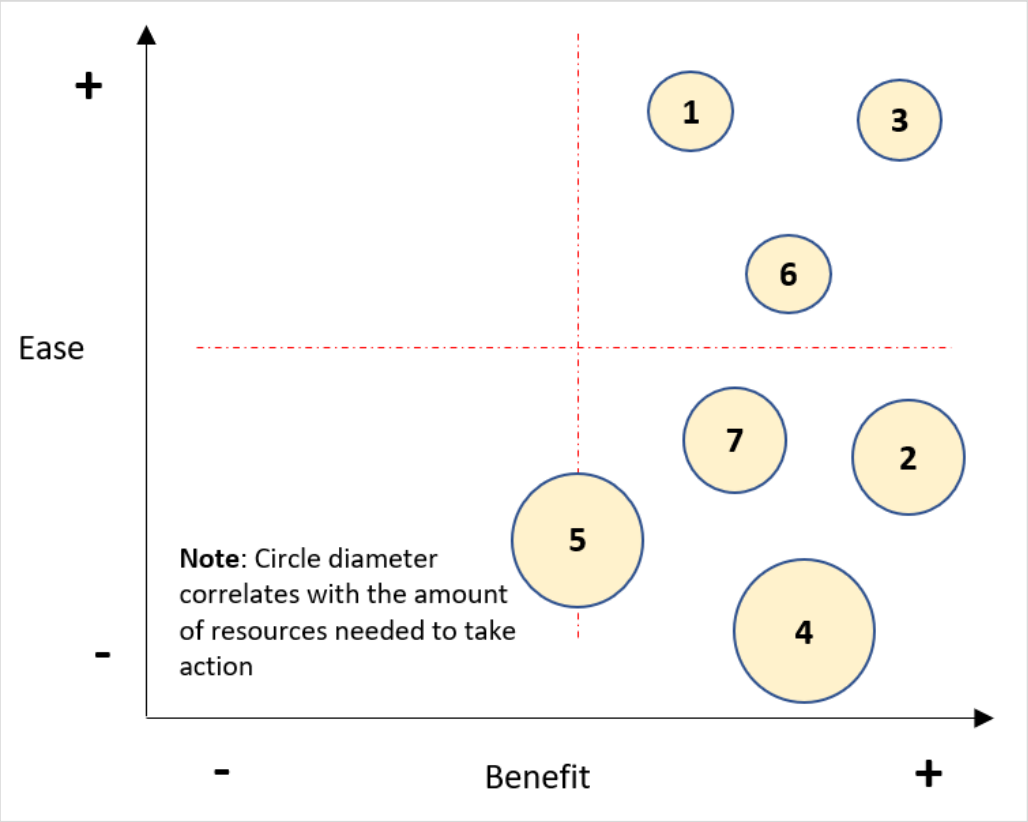
## 4.2. Table of recommendation based on the conceptual model

Due to the highly complex nature of the engineering system we try to provide a logical solution to the company by considering multiple factors such as current state, owner for the proposed change, feasibility difficulty, priority of the solution and the compromise for non-feasible proposals. To summarize in general terms the sequence of steps the company must take based on our analytical study is as follows

1. Map elevator families and based on the regional strength in their respective elevator segments assign ownership and detail out their accountability and responsibility create ownership.
2. Develop module packages of the elevator design while also ensuring flexibility in architecture and no recreation of data. This is a key step which can define the success of our model since the successful reuse of a module implies our model has been successful.
3. Data standards creation- keep a future focus while creating data standards to ensure the model eventually leads to the ideal state envisioned that is to bring everyone to the same level of interaction and also such that language issue is resolved by enforcing 1 common language, have 2 strategies to handle current data by simply putting them in their respective module groups and new data created to be in a globally accepted format.
4. Make sure everyone uses the online product lifecycle management tool to handle their data, moving away from offline storage, keeping future focus in mind where everyone is eventually expected to come together to the same architecture, tools, methods, and process.

| Step # | Ideal state activities | Current state | Proposed changes | Who performs it | Feasibility difficulty | Priority | The Compromise |
|---|---|---|---|---|---|---|---|
| 1 | Map elevator families based on different regions | No specific grouping of elevators done | Create a region wise elevator option offered matrix for analysis | GTD team | Easy | High | Null |
| 2 | Create Platforms for different elevator families | No clear data regarding core components which can be made common | Perform research, define elevator platforms and categorize elevator families under each platform | GTD team with external technical support for Research | Difficult | High | Null |
| 3 | Assign Ownership to respective families | No clear responsibilities & ownership assigned | Appoint leaders who are completely responsible and accountable for the defined platforms | All LDC owning platforms | Easy | High | Null |
| 4 | Develop Modular packages for the defined platforms | Common components and reuse opportunities unknown | Create a dictionary of modules, with respect to each platform under which all the components of elevators can be sub-grouped | GTD to perform with agreement of all LDC centres | Very difficult since data architecture various heavily region to region, finding common architecture nearly impossible | Low | A system of flexible modularity can be implemented |
| 5 | Benchmark & propose best 3D modelling practice from the world | Various approaches utilized for managing 3D data | Come to a common method of 3D modelling approach between all centres | All LDC centres | Very difficult again since data architecture varies heavily and 3D modelling is done based on the architecture | Low | Short term solution of working with existing data and enforce the new rule for upcoming designs |
| 6 | Create Data standards for the module package | Data standards developed by WHQ outdated and not enforced | Newly developed tools and processes to be released as global standards and existing outdated standards to be updated, make common language usage English | GTD team with WHQ team | Difficult - Since coming to a common agreement between product admins of each centre is difficult, however this step is crucial | High | Null |
| 7 | Create Global repository for managing the data | PLM system access restricted to non-native regions | Create new repository, move existing data to the created repository | GTD team with WHQ team | Very difficult since moving data to an open repository has the danger of unauthorized viewing in-work models and doing unnecessary changes | Low | Short term solution of opening up the local PLM access to required engineers who share the design data |

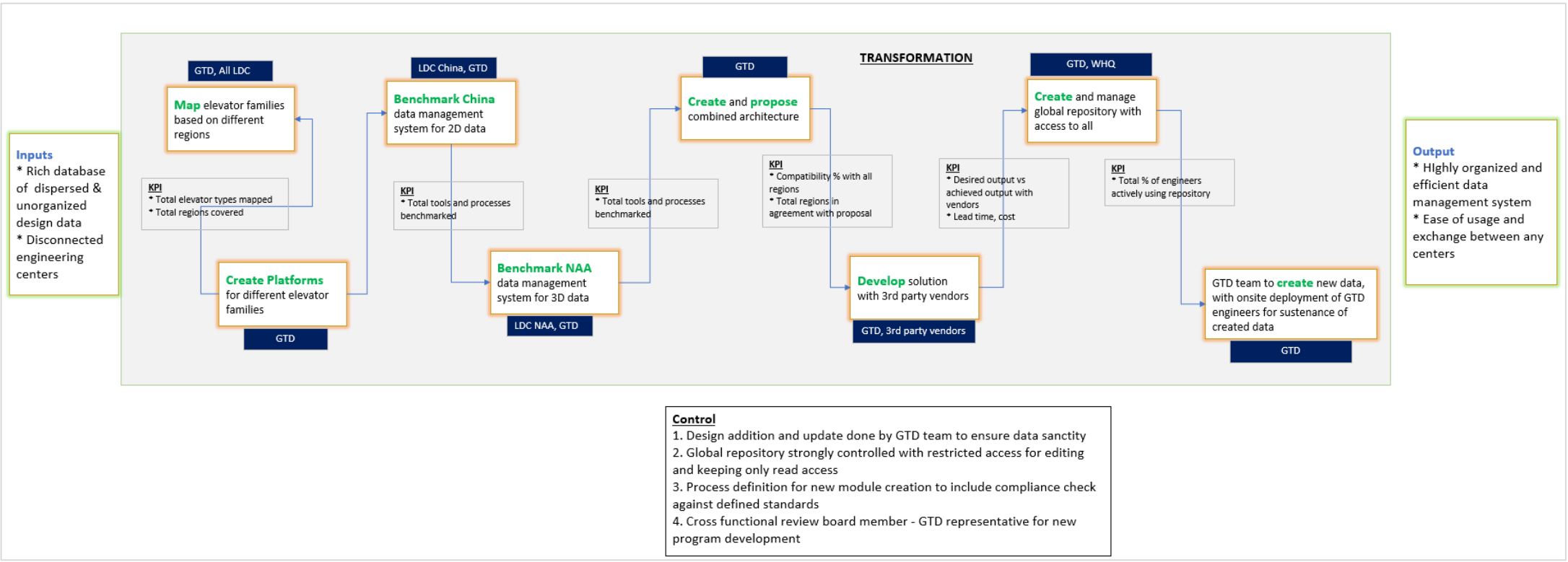
### 4.3. Ease benefit matrix




## 5. Analysis – 2

### 5.1. Conceptual model

The conceptual model created from this analysis provides an alternate strategy to Otis which is looking to increase its engineering working efficiency. This strategy focuses on an aggressive approach of controlling the data structure by utilizing the best practices of 2D & 3D management already being utilized & tested in Otis to eventually lead to a unified operating mechanism.




## Three E's

**Efficacious:** The model ensures organization of data by **enforcing this through process change** and bringing best 2D and 3D management practices for the defined platforms to the common use of all.

**Efficient:** The model aims to bring out the best practices for 2D and 3D data management by **benchmarking and utilizing existing** best practices around the world without the need to invest in anything new.

**Effective:** The model is effective since the end goal is attained through the **strict enforcement and metrics definition to track the progress** through each transformative step

**Elegant:** The model can be claimed to be elegant since the sequence of steps that needs to be followed shall eventually lead to vision set by the company, the checkpoints established in the control box shall ensure all steps are self-sustaining in the future.

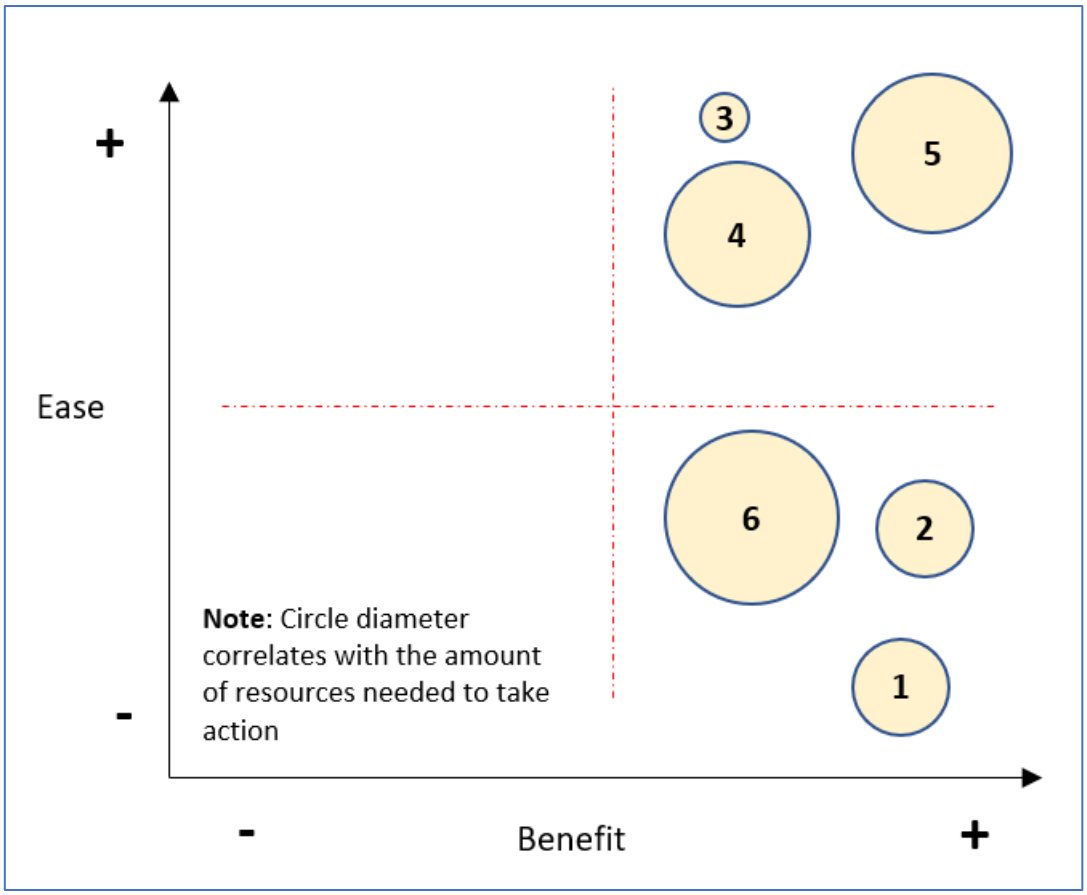
## 5.2. Table of recommendation based on the conceptual model

| Step # | Ideal state activities | Current state | Proposed changes | Who performs it | Feasibility difficulty | Priority | The Compromise |
|---|---|---|---|---|---|---|---|
| 1 | Benchmark China data management system for 2D data handling and propose for global architecture | LDC China has state of art 2D data management system but currently restricted to only China | Create a gap analysis of China system compatibility against other centres compatibility for 2D data and finalize the architecture | GTD team, LDC China | Very difficult - To find the data architecture to fit all the regions, and configurator impact also anticipated | High | May have to omit some regions due to data structure and configurator compatibility issues |
| 2 | Benchmark NAA data management system for 3D data handling | LDC NAA has start of art 3D data management system under development | Create a gap analysis of NAA system compatibility against other centres compatibility for 3D data and finalize the architecture | GTD team, LDC NAA | Very difficult - To find common 3D modelling system globally | High | Only implement this for new product development |
| 3 | Create and propose combined 2D + 3D architecture | No common architecture present to deal with this | New combined architecture based on benchmarked best system, make common language usage English | GTD team | Easy | High | Null |
| 4 | Develop solution with 3rd party vendors | 3rd party vendors working only with LDC China and LDC NAA | Work with the vendors to extend the solution for the 2D & 3D data management globally | GTD team, 3rd party vendors | Difficult - Since vendors constraints may rise during this step | High | Null |
| 5 | Create and manage global repository with access to all | No common repository available to all | Create a new repository to control and manage the design data globally for new products | GTD team with WHQ team | Easy | High | Null |
| 6 | GTD team to create new data, with onsite deployment of GTD engineers for sustenance of created data | Data is created by local engineering teams with support from GTD engineers | Total ownership to create new design data which comply to the proposed standards | GTD team | Difficult - Since there is a period of learning for GTD engineers to get up to speed, but not impossible. However, issue rises with resource availability to take on such a huge load | High | Eventually take up the responsibility don't drastically change the system overnight |

The summary of recommendations to the company based on the table above is as follows

1. Perform extensive analysis and finalize the process change to manage 2D data management system based on LDC China
2. Perform extensive analysis and finalize the process change to manage 3D data management system based on LDC NAA
3. Work with vendors who developed the 2D and 3D management system for China and NAA and get Global Technical Data center staff trained on the new data management system. This would also automatically ensure common language usage between all.
4. Invest in increasing resources in GTD who shall turn to be the engineering backbone of the company - operating, controlling, and managing design data through a single source of truth.

### 5.3. Ease benefit matrix




## 6. Root cause analysis (Extra analysis)

The problem: Engineering centers not collaborating effectively between each other, low efficiency

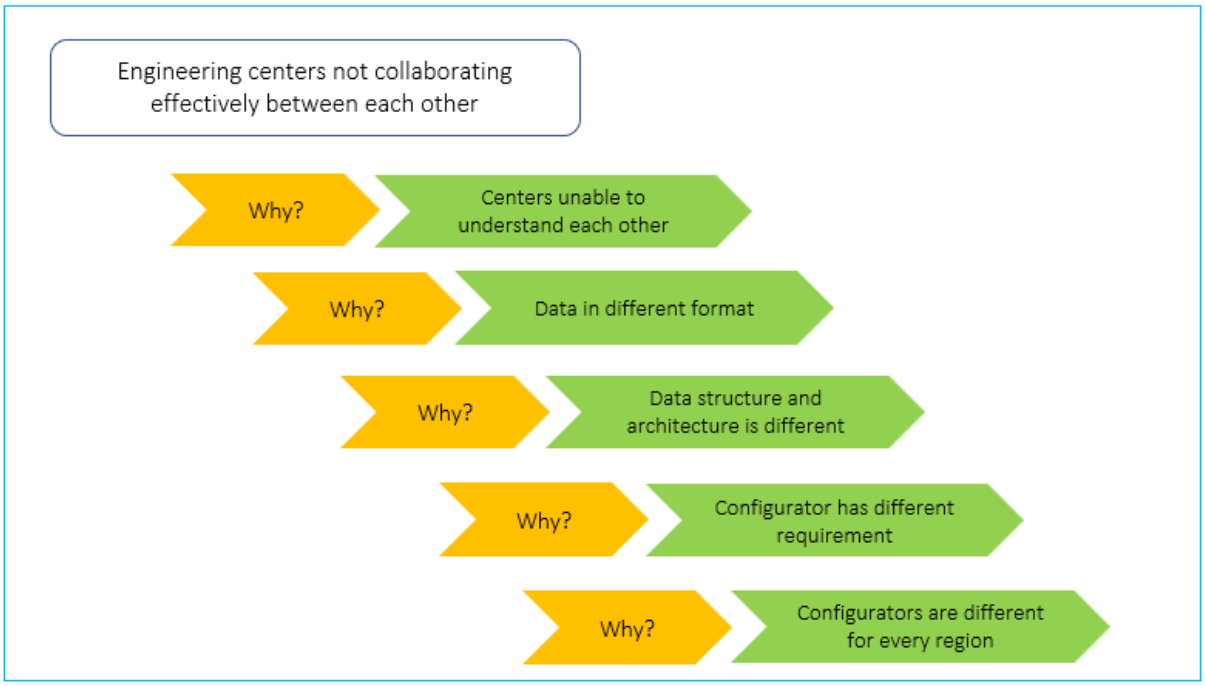
The data: This has been depicted in the rich picture in section 2

Causal factors:

1. Configurators used are different by every region, which has different requirement of data input

2. Common language English not followed by all engineering centers
3. No common database for parameters
4. Too much leniency, no common standards for data management.
5. Loose enforcement of existing standards.
6. No common process definition for change management of design

5 WHY




Solution recommendation

- As understood by the 5 WHY methodology of our root cause analysis we can confirm that **deploying a unified configurator** can easily solve the issue of engineering centers collaborating effectively between each other. This in fact is a logical solution to our problem being discussed in this report, however as soft systems have highlighted and brought out the conflicts in our problem. Unified configurator will cause a major disruption and cost impact to the company which may take longer term to reap the benefit.