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PRICING TOOL FOR CUSTOMIZED ELEVATOR CARS – CASE KONE

Master's Thesis
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Abstract of master's thesis

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Abstract

This master's thesis focuses on developing a custom elevator car pricing tool to be utilized in elevator car tendering operations. The thesis project is conducted in co-operation with KONE, an engineering and service company from Finland. The demand for a new tool arises from current daily operational issues, where multiple contrasting and inconsistent tools utilizing outdated data are used to face the challenges of the current business. With the new tool, all previous tool solutions can be replaced with one comprehensive solution, while also initiating ownership roles, streamlined processes, centralized data storing solutions, and flexible car tendering operations.

Aside from the tool development, data analysis on historical car delivery performance is conducted. This analysis is supported by a theoretical framework consisting of transfer pricing methods and the basics of optimal-bidding strategy. The analysis is focused on supply line-level car pricing accuracy metrics and profitability insights. More closely, the latter aspect addresses car-specific characteristics and other conditions that could cause profitability issues in car deliveries. The analysis results are then utilized as benchmark data points for future business development and process enhancement actions.

The analysis findings suggest that although car pricing operations function sustainably, there nevertheless is room for improvement in minimizing cost variation between actual and budgeted costs. The higher the deviation between actual and budgeted costs is, the more inaccuracies in car price prediction and budgeting exist. As the target is to have as accurate car pricing as possible, understanding the causes of what causes deviation in actual and budget costs is essential in enabling better business performance. The new tool and the analysis discoveries support in reaching that goal.

Keywords Elevator car, Pricing tool, Tendering,

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Tiivistelmä

Tässä maisterintutkielmassa keskitytään hissien erikoiskorien hinnoittelutyökalun kehitykseen, jonka tuloksena työkalu on tarkoitus ottaa käyttöön hissikorien tarjouslaskennassa. Tutkielmaprojekti on toteutettu yhteistyössä suomalaisen teknologiayritys KONE:en kanssa. Tarve uudelle korihinnoittelutyökalulle on muodostunut päivittäisissä prosesseissa ilmenneiden haasteiden kautta, jotka johtuvat nykyisten työkalujen keskinäisestä erilaisuudesta ja epäjohdonmukaisuudesta, sekä vanhentuneesta tietovarannosta. Uuden työkalun ansiosta nykyiset työkalut voidaan korvata yhdellä kokonaisvaltaisella työkalulla, alustaen samalla uudenlaiset työkalun omistajuusroolit, virtaviivaistetut prosessit, keskitetyt tietokannat ja hissikorien tarjouslaskenta-aktiviteetit.

Työkalukehityksen lisäksi projektinviitekehyksen sisällä suoritetaan data-analyysi historiallisille hissikoritoimituksille. Analyysin tueksi tutkielmassa esitellään relevantteja siirtohinnoittelumetodeja ja optimaalisen hintatarjousstrategian perusteita. Analyysi keskittyy toimituslinjatason korihinnoittelutarkkuuden mittareihin ja kannattavuuslöydöksiin. Jälkimmäisen näkökohdan ajatuksena on tarkastella hissikorien ominaisuuksia ja muita muuttujia, jotka saattavat aiheuttaa kannattavuusongelmia hissikorien toimituksissa. Analyysin löydöksiä ja mitattuja lukuja tullaan käyttämään tulevaisuudessa vertailupisteenä liiketoiminnan kehittämisessä ja prosessien tehostamisessa.

Analyysin tulokset viittaavat siihen, että vaikka hissikorien hinnoittelu on kestävällä pohjalla, todellisten ja budjetoitujen kustannusten eron minimoimisessa on parantamisen varaa. Mitä suurempi todellisten ja budjetoitujen kustannusten ero on, sitä enemmän korien hintojen ennustamisessa ja budjetoinnissa on epätarkkuuksia. Koska hintabudjetoinnin on tarkoitus olla niin tarkkaa kuin mahdollista, on todellisten ja ennustettujen kustannusten eron syiden ymmärtäminen välttämätöntä paremman liiketoiminnan suorituskyvyn mahdollistamiseksi. Uusi työkalu ja analyysin havainnot tukevat tämän tavoitteen saavuttamisessa.

Avainsanat Hissikori, Hinnoittelutyökalu, Tarjouslaskenta

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Abbreviations and Definitions

BB	Car shell width (from unfinished side wall to unfinished side wall)
BOM	Billing of Material
CCP	Custom Car Pricing (Tool)
CH	Clear height (from floor coating to the lowest surface of the ceiling)
CUP	Comparable Uncontrolled Price (Method)
DD	Car shell depth (from the car shell floor plate edge at the front to unfinished rear wall)
ECU	Elevator Component Unit (KONE Factory)
ESU	Equipment Supply Unit
FL	Front Line, local sales, and administrative units
GM-%	General Margin Percentage
HH	Clear height of the door opening
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
KSC	KONE Supply Chain
KTOC	KONE Tendering and Ordering Configurator. All-in one tendering, pricing, and ordering tool in SAP, which covers all of KONE's main business areas and products.
LL	Clear width of the door opening
MP	Major Projects
MSF	Major Project Supply Finland
MUC	Manual User Comment (C-process feature)
NEB	New Equipment Business
OECD	Organization for Economic Co-operation and Development
PLX	Price List X
R&D	Research and Development
SAP	ERP software (Systems, Applications, and Products in Data Processing)
SL	Supply Line
SLTP	Supply Line Transfer Price
SOF	Supply Operations Finland
SOI	Supply Operations Italy
TE	Tender Engineer
TP	Transfer Price
TRB	Tendered Repair Business, supply unit offering modernization services.

A-process	Standard process.
Arm's Length Principle	Condition that the parties of a transaction are independent and on an equal footing.
Cost-Plus Pricing	Pricing strategy, where selling price is determined by adding a fixed markup to the unit cost.
C-process	Generic name for a special process, which involves customized products, methods, complex communication, and partially non-predefined information needs.
Front Wall	Wall that provides the car entrance, as standard on A or C side – C-process also on side walls.
Incoterms	International Commercial Terms, series of pre-defined commercial terms published by the International Chamber of Commerce and applied to international commercial law.
Marine	Special business unit of Major Projects providing services for the marine industry.
Markup	Overhead element consisting of material overhead, G&A allocation, material risk factor and profit element.
Master Price List	Database, collection of materials and material prices.
Module	Elevator component group.
MSF Tendering	Hyvinkää SOF and MP tendering operations.
MUC Pricing Tool	Pricing tool for determining value of elevator C-process features.
Platform	Elevator category type.
Qlik Sense	Cloud analytics platform for data analysis collecting business-related SAP-data
Sales Document	Elevator unit-specific identification number.
Tendering	Process of determining a price *(internal, transfer)* for a planned elevator.

1 Introduction

1.1 Motivation

Pricing refers to the practices, strategies, and processes in business that define how prices for services and products are determined. Lee (1999, p. 10) describes that pricing refers to procedures business enterprises use to set prices of goods before they are produced and placed on the market. A business's pricing strategy generally follows internal and external guidelines and customs to allow for financial, competitive, and sustainable success in their operating environment. There are multiple different aspects and matters a business must consider in its pricing strategy to succeed, such as market condition, competitive environment, manufacturing and other costs, brand value and customer preferences. The goal of a business after all is to maximize profits for its owners or stakeholders, and therefore, applied pricing practices and strategies have a fundamental role in the success of a business.

Pricing has a fundamental role in product management and is one of the four Ps of the marketing mix in addition to product, place, and promotion. While the other three Ps have a cost driver role in the mix, price is the only component that has a revenue generating role. Pricing strategy, on the other hand, defines the way a business determines a price for its products and services. To find the most efficient pricing strategy, a company's executives are required to first identify the company's pricing position, pricing segment, the competitive pricing reaction strategy and pricing capability (Smith, 2016, p. 55). There are multiple ways the business can approach its pricing strategy by choosing a pricing method they want to utilize. The price setting can be used, for example, to maximize market profits or for each unit sold, or to establish, increase or defend market share in the markets. Choosing the right strategy is crucial for a business's success and could be a defining factor in determining if it will succeed or fail.

This thesis introduces certain pricing and tendering activities and processes of a case company, KONE. KONE is an international engineering and service company from Finland, who builds and maintains moving walkways, automatic doors, gate solutions, elevators, and escalators. The company operates in over 60 countries and has 12 manufacturing units in 8 countries as of 2020. 54 % of sales in 2020 consisted of new equipment deliveries, 32 % of maintenance services, and 14 % of modernization activities. During the same year, new equipment orders received in the elevator and escalator segment accumulated to approximately 180 000 units (KONE Oyj, 2020). Main pricing aspects to be covered in this study are tendering activities involved in custom elevator car deliveries and one of the targets is to analyze what type of issues are faced in the current state. These issues are being addressed by creating a new custom car pricing tool to enable better and more accurate car pricing, and to determine ways of making better business decisions in terms of tendering activities in the future. In addition to this, an analysis on historical car deliveries is conducted to gain an understanding of pricing and tendering performance at the time of the study. The findings and discoveries made in the analysis will be utilized in supporting future development actions and process enhancement measures.

1.2 Industry-specific Terminology and Case Company Review

An elevator is a device, that transports objects and people between different levels, floors, or decks by lowering and raising a platform or a compartment. Since the early implementations of elevators in the pre-industrial and industrial eras, technological advancement over the centuries has allowed us to create more sophisticated and state-of-the-art elevator solutions to enable more efficient and productive transportation activities. These modern solutions include, but are not limited to outdoor elevators, elevator cars that move horizontally, and so-called experience elevators. Experience elevators, in addition to their functional benefits, also hold recreational value by providing entertainment for passengers while simultaneously fulfilling transportation duties. Regardless of these modern and special elevator concepts, the fundamental role of an elevator remains the same: to transfer objects from one place to another. Especially in urban environments, the role of elevators in enabling an effortless and rapid flow of people and items is significant.

At KONE, an elevator and its components are split into multiple different **modules**, which essentially are designated groups of components. Some of these modules are - but are not limited to - machinery, mechanics, doors, and the signalization system. These modules together form a device that is called an elevator. One of the most important modules and component groups in terms of the elevator's overall structure, functionality, and design is the elevator car. In its purest form, it consists of four walls, a floor, and a ceiling. These components form the basic structure of the elevator car, but additional elements such as handrails, mirrors, windows, and other accessories are also considered as part of the car module. There are also components that are attached to the car or move in the elevator shaft along with the car but are not part of the car module. These components are the sling, car doors, and the car operating panel. This study covers exclusively elevator cars and KONE's elevator car deliveries. Therefore, although elevator deliveries consist of multiple different modules, the focus in this project is on the car module.

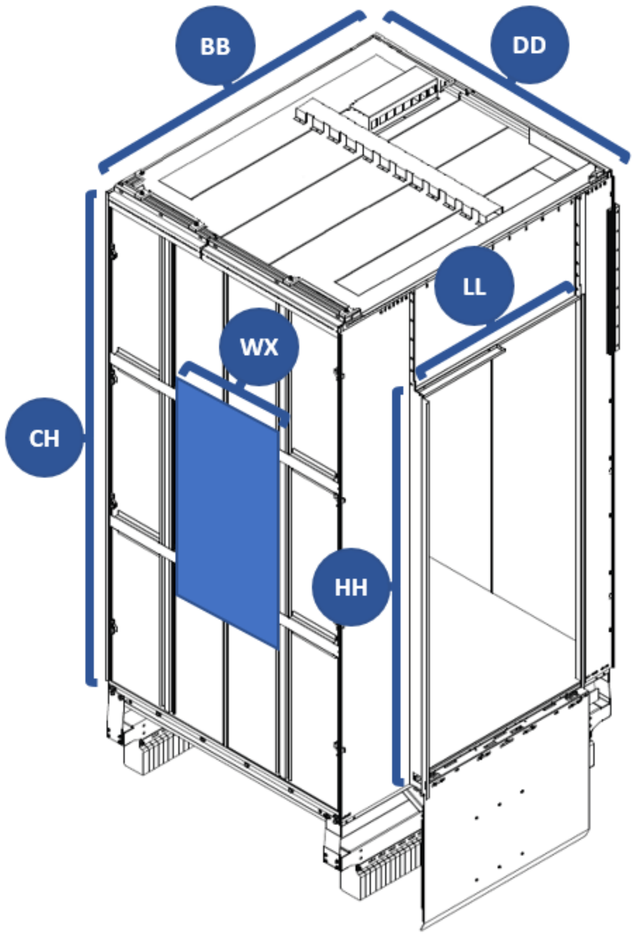


Figure 1. Elevator Car and Car Dimensions.

An elevator car's structure is determined by its dimensions, which have assigned abbreviations. The **BB** and **DD** dimensions are the width and depth of the car shell, whereas **CH** indicates the clear height of the car. The clear height length is measured from the highest point of the flooring to the lowest point of the ceiling, giving us the clear height inside the car. The **HH** and **LL** dimensions denote the width and height of the car doors. As mentioned earlier, the car doors are not part of the car module but considered as their own car door module. The **WX** dimension indicates the width of a window, which can be implemented on any of the walls that do not have a door (named **Front Wall**). This group of measures has the most significant impact on the car's structure, regardless of the car type.

There are several different car types in KONE's portfolio, for example, HMC, TranSys, MCD, and GDS. What is to be noted is that car type is not equivalent to elevator type, which is equal to the term **platform**. These platforms include, for instance, TranSys, MonoSpace, MiniSpace, and Scenic elevators. The applied elevator and car type in an elevator delivery is determined by the intended use of that specific elevator. TranSys elevators are designed for heavy-duty manufacturing use, whereas the MonoSpace platform and HMC car can be used, for example, in commercial or residential buildings. The car type is not necessarily dependent on the elevator type or vice versa, but certain elevator and car types are mostly paired with each other.

KONE New Equipment Business (NEB) is a business segment that operates under KONE Corporation and is responsible for driving profitable growth by developing and delivering solutions and services for new construction customers, and customers with existing constructions who are implementing new elevator solutions. NEB also refers to certain global organizational functions responsible for new equipment business. The product portfolio consists of innovative, intelligent, and sustainable elevators, escalators, automatic building doors, and integrated access control solutions to deliver the best people flow experience. The biggest growth drivers are urbanization and changing demographics. Main customers include developers, builders, architects, consultants, and building owners.

Kone Supply Chain (KSC) organization supports KONE's strategy and growth by providing customers and intercorporate **front line (FL)** contact points with competitive solutions and services. It consists of supply operation units across the globe, whose activities include supply line **(SL)** tendering, order management, engineering, procurement, and manufacturing activities to serve solutions needed in customer delivery projects.

Elevator Supply Units (ESU) function as the administrative units for delivery projects and **Elevator Component Units (ECU)** manufacture the elevators. ESU's aggregate deliveries consist of equipment deliveries either to distribution centers or countries of destination, depending on International Commercial Terms (**Incoterms**), including potential design and planning elements. The intercorporate front line units then handle the freight to the site, the installation, and any other activities performed after the responsibility has been transferred from ESU to the front line unit. The supply units order elevator components from ECUs and external component suppliers and after listing and engineering activities, the components are manufactured and shipped to the distribution centers. There they are consolidated into elevator deliveries and finally will be transported to work sites.

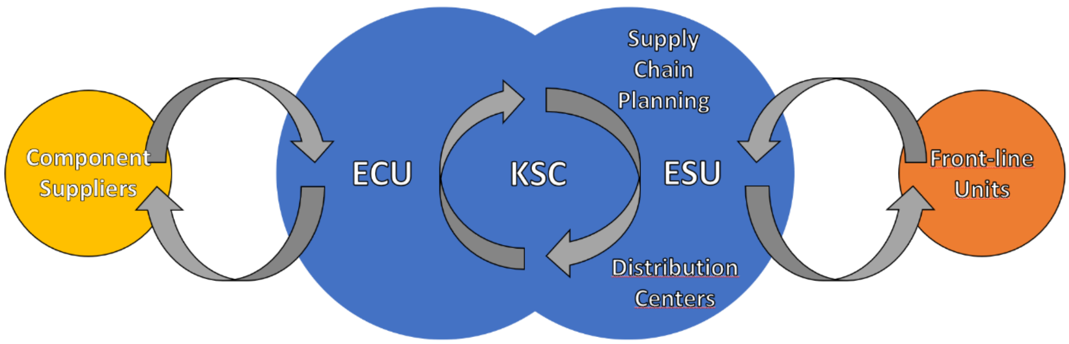


Figure 2. KONE Supply Chain Process.

Supply Operations Finland (SOF) is one of the supply units under Kone Supply Chain that specializes in custom elevator deliveries. KONE's elevators can be classified as **A-process** (standard) or **C-process** (custom) based on the level of standardization and customization. In addition to this, each elevator contains an elevator car that can also be either of custom or standard type. Any elevator with a custom car is classified as a custom elevator, but a custom elevator can also have a standard car. Standard cars are configurable volume products with no tailor-made elements, whereas custom cars deviate from a standard specification and therefore do not fit in the A-process pipeline. In other words, A-process elevators are highly configurable, but even slight customization outside of the pre-determined customization boundaries shifts the elevator into a C-process delivery. A-process deliveries are supplied through **Supple Operations Italy (SOI)** and C-process deliveries globally through SOF and **MP (Major Projects)** from Hyvinkää, Finland (KONE, 2021).

Aside from SOF and MP, there are other supply lines operating in Hyvinkää: **Marine** and **Tendered Repair Business (TRB).** As SOF focuses in delivering more ordinary and typical C-process solutions, MP specializes in the most demanding projects, such as high-rise buildings, infrastructure projects, medical facilities, and other special buildings. The Marine supply line provides equipment for marine environments, whereas TRB serves clients who desire to modernize and upgrade already existing equipment. SOF and MP have a joint tendering team, **MSF Tendering**, which consists of **Tender Engineers (TE).** Their role is to perform tender phase pricing for delivery projects. The other supply lines have their own tendering operations that are separate from the MSF Tendering team.

1.3 Project Objectives and Thesis Scope

The main concrete objective of this thesis project is to develop a custom car pricing tool (later **CCP-tool**) to be utilized in custom elevator car tendering activities. The project is facilitated by SOF pricing team, albeit all Hyvinkää tendering operations participate in the tool development and are intended to utilize the tool in daily tendering operations. The tendering activities fundamentally cover all elevator modules, but as also in the scope of the whole project, only the car module will be considered in tool development. Therefore, in this study, all tendering activity refers exclusively to car pricing and car cost budgeting that tender engineers perform to determine a budget and an internal transfer price for a custom car, including all car components, accessories, and custom characteristics. Another term used for this pricing activity in the scope of the study is "car budgeting", as the car pricing is directly based on budgeted costs, and therefore, essentially both refer to the same notion. The pricing method applied is **cost-plus** based transfer pricing.

In collaboration with SOF, three main goals have been set for the project:

1. To build a centralized custom car pricing tool for car tendering purposes with a universal pricing structure regardless of car type
2. To collect all relevant C-process price data in one location
3. To perform a cost variation dynamic and main price driver analysis for car profitability insights

The need for a custom car pricing tool emerges from the difficulties the tender engineers currently face while performing daily tendering activities. Firstly, there are multiple inconsistent C-process car pricing and tendering tools in use with no assigned owners or existing upkeeping practices. This creates one of the main issues in the current C-process car pricing practices. The tools have been created over time in an ad-hoc manner to tackle specific short-term needs, rather than keeping an eye on long-term usability. Therefore, the price data used in the tools is mostly outdated. Updating processes and practices do currently exist, but there is still lack of systemization in how these processes and practices are handled. With the new tool, this problem is projected to be solved by taking the essential functionalities from the existing tools and making it cover all C-process car tendering needs. Therefore, only one tool is needed for any custom car tendering actions. Through this arrangement, the ownership is much easier to designate under a specific role or owner. The main specifications for the tool are that it should be intuitive, flexible, and versatile on the user side while simultaneously being effortless to update and maintain on the administration side.

Secondly, the tendering phase calculations and items included in the offers are not documented or analyzed systematically. This creates challenges in pricing process enhancement as monitoring activities are not utilized to their maximum potential. Practices to conduct after-action reviews on tendering phase car pricing accuracy do exist, but they are manual and highly laborious. In addition to this, the documentation of calculations and assumptions made in the tender phase is often incomplete which makes the reviews even more troublesome to carry out. The after-action reviews have previously been viable through project-level reviews, but not to the same extent on module-level without using manual work to retrieve the required data. Recently, a system has been applied to enable automated module-level pre-to-post monitoring, but it is usable only when the collected data is coherent. By implementing a new tool that uniformly handles all kinds of car types, the collected pricing data will be consistent and therefore usable in automated pre-to-post monitoring activities. Enabled by this, pricing adjustments can be made with higher confidence as they are based on actual relevant data.

The third main objective formulates the empirical research element of the thesis. Historically, no detailed or comprehensive profitability and main price driver mass analysis have been conducted on C-process cars. One of the main reasons for this is that the data is not easily available in a standardized form in a single system, which has created barriers for extensive analysis previously. Therefore, aside from the custom car pricing tool creation, a mass analysis of historical C-process tenders is being conducted as part of the thesis to gain an understanding of the difficulties and challenges the tender engineers face in C-process car tendering. The analysis also provides an order of magnitude view of what are the historical tender phase accuracy levels, so that pre-to-post monitoring data collected in the future can be put into context. By utilizing both the historical and newly collected data, the pricing accuracy can be improved by setting accuracy level goals by leaning on the analysis findings. The empirical analysis is narrowed down to custom cars delivered between the years 2019 and 2021 by the SOF and MP supply units.

Table 1: Project Evaluation Rubric

Tool pilot built and thesis completed in 2021	Tool in limited pilot use in 2021	Cost Variation Dynamics and Main Price Drivers analyzed during 2021 as part of Thesis Work
MIN	ON TARGET	MAX

The minimum, on target, and maximum evaluation rubric for the project is established directly from the project objectives. The "minimum" level is that the tool pilot (first version) has been developed and the thesis project is completed by the end of year 2021. The "on target" level includes the minimum target goal, but also that the tool would be in limited pilot use in the Hyvinkää supply operations in the same year. The maximum level requires that also the cost variation dynamic and profitability analysis has been conducted and findings submitted for KONE to be utilized in process improvement and business development.

1.4 Structure of the Thesis

In the theoretical background review, first, a short introduction to transfer pricing and its methods and optimal bidding strategy will be covered. KONE utilizes **Comparable Uncontrolled Price (CUP)** and cost-plus transfer pricing methods, which are two of the five primary transfer pricing methods acknowledged by the **OECD** Transfer Pricing guidelines (OECD, 2017). The goal of this chapter is to gain an understanding of the practices, terminology, and guidelines that lead the transfer pricing strategies and how optimal bidding-strategy elements direct and steer pricing and tendering activities. Optimal bidding strategy theory is mostly applicable and relevant in competitive environments, where a company competes directly in competitive-bidding situations. Although the environment in the business case does not strictly contain characteristics of a competitive-bidding condition, the same pricing and game-theory principles nevertheless are involved in the tendering activities, which are being carried out in the company on daily basis. The study is focused on operative tendering activities but also concerns OECD guidelines and optimal bidding strategy theory as a general framework. Following the theory review, a detailed consideration of the business case is executed to recognize the case-specific characteristics and focus areas by taking a deep dive into the current state of the case company. This practical approach combined with the findings made in the theory review demonstrate what kind of challenges are involved in the case company's tendering processes and how those challenges could be approached.

By utilizing these findings, a first version of the CCP-tool is developed and implemented to support the daily tender activities. The CCP-tool will not be available for public distribution due to confidentiality reasons. However, the study is publicly available and released in a form to be readable without having access to the tool. For clarity, all processes, charts, calculations, and specifications in this study are car module-specific, unless stated otherwise.

Finally, considering the key findings of the theory and business case reviews, an empirical data analysis is conducted for cost variation and profitability insights in custom car pricing and delivery processes. The study is concluded with an evaluation of the project successfulness and a discussion on how the questions and further development areas which emerged during the project could be approached in the future.

2 Theoretical Background

The aim of the theory review chapter is to discuss the principles of transfer pricing and optimal bidding strategy to act as a framework for the empirical parts of the study. This approach gives justification for the development propositions and recommendations suggested in the study, so that business critical questions and issues could be faced with the best available methods and solutions. The theory review acts primarily as a background framework for the business case, rather than having a direct explanatory relation to the business case operations.

2.1 Transfer Pricing and Comparable Uncontrolled Price (CUP) Method

Transfer pricing as a concept refers to the methods and policies for pricing transactions between companies that are related through common control or ownership. These transactions could cover selling of goods and services, compensation for utilization of intangible assets or intellectual property, financing, and any other pricing transactions between the companies (Finnish Tax Administration, 2021). The entities could be, for example, separate divisions within a company or a company and its subsidiary. As the companies in the corporate or company group are part of the same entity, the terms of intra-group transactions are generally not determined in accordance with normal market behavior. The price setting and other conditions for the transactions are often done centrally. However, the terms of intra-group transactions must be market-based or denoted as dealing at "**arm's length**". Intra-group transactions must therefore be subject to the same pricing and other conditions as transactions that would take place under similar conditions between independent companies (Tuovila, 2021). The goal of following the arm's length principle is that the income is being accumulated and taxes being paid in the correct country. Without existing transfer pricing policies and the arm's length principle, a company would have incentive to optimize transactions in a way that would alter the financials of the companies in a favorable way for either or both entities. There are several methods to verify if the arm's length principle is being applied, which are determined in the OECD Transfer Pricing Guidelines.

The Comparable Uncontrolled Price (CUP) method is a transfer pricing method which compares the price charged for a property or service transferred in a controlled transaction with the price charged for property or service in a comparable transaction undertaken between independent parties (OECD, 2017, p. 70). To be considered CUP eligible, an uncontrolled transaction must meet high standards of comparability. One of the advantages of CUP that it is one of the most direct ways of determining an arm's-length price of a controlled transaction as it is the "open market" price of a tested transaction between related parties.

There are essentially two variations of CUP method: internal CUP and external CUP. To determine arm's length transfer price with the internal CUP, a company must hold examples of comparable transactions it has previously made with third parties. To be compliant with transfer pricing regulations, the CUP method requires that the terms of transactions with related parties must be the same as those of the third-party transactions. In external CUP, the company seeks to find comparable transactions and prices applied exclusively between third-party entities. This method may be challenging to approach as external pricing data may be difficult to find and utilize.

One of the most essential benefits of CUP method is that it is close to being fully reliable, if not actually being guaranteed, as the transfer price risk is very low. That is due to the nature of the method, as it is the most exact way to determine and justify transfer prices. Therefore, most tax authorities recommend using this transfer pricing method when possible. However, the method also has its downsides, for example, it is very demanding in terms of its standards. The number of factors, including volume, profit potential and terms of contract, that are required to be comparable is significant for the method to be qualified. The transaction conditions must be nearly identical, which could be a challenge to fulfill and would require an extensive number of resources to find (Valentiam Group, 2021).

OECD and most countries that follow OECD guidelines consider CUP method the most direct method, provided that any differences between the controlled and uncontrolled transactions have no material effect on price or their effects can be estimated, and corresponding price adjustments can be made. Adjustments may be appropriate where the controlled and uncontrolled transactions differ only in volume or terms; for example, an interest adjustment could be applied where the only difference is time for payment. For undifferentiated products such as commodities, price data for arm's-length transactions between two or more other unrelated parties may be available. Therefore, CUPs are most commonly available for transactions in products that are traded on commodity-type markets. The homogenous nature of the product and the availability of pricing information to both buyers and sellers means that prices are driven by equilibrium between supply and demand, and it is possible to be sure that the tested transaction and the uncontrolled transaction occur in comparable circumstances.

2.2 Cost-Plus Method

Cost-plus pricing is a pricing method, where a fixed **markup** is added to the cost of service or goods to determine the selling price. Generally, direct material costs, direct labor costs and overhead costs are added together after which the final price is derived by adding a markup percentage on top of the costs (Bragg, 2021). Cost-plus transfer pricing follows this concept but applies it in transfer pricing environment, where the markup forms the profit element of the entity who is offering the asset for the other related entity.

There are several advantages to cost-plus pricing. First is that it is a simple pricing strategy, as it is straightforward to derive a price using this method, though an overhead allocation method should be defined to ensure consistency in calculating prices for multiple products (Hughes & Nicholls, 2010). Secondly, on the contractor side it is a viable method to accept since costs are covered and profit is being made with full certainty as pricing is based on the costs, on top of which the markup is being added, which finally is the contractor's profit element. Lastly, it is a method that has high level of justifiability in terms of the supplier price. As the price is strictly cost-based, the supplier can demonstrate why possible price increases are required by pointing out the increases in costs.

Cost-plus pricing also has some disadvantages compared to other strategies. Firstly, it ignores competition as a company may set the price based on the cost-plus formula and then be surprised when it finds that competitors are charging substantially different prices. This has a huge impact on the market share and profits that a company can expect to achieve. There is a risk of the company either ending up pricing too low and giving away potential profits, or pricing too high and achieving minor revenues or even losing customers. A second disadvantage is that the contractor does not have an incentive to work or design a product or service with the right features efficiently as cost overruns do not contain a substantial risk element. This is since there may not be transparent budget cap set as the pricing is cost-based, and therefore, budget overrun does not compromise the contractor's profitability. Implementation of cost-reduction incentives could help tackling this issue, so that moral hazard could be avoided.

2.3 Competitive-Bidding Strategy

Bidding in its purest form refers to a process, where an offer (bid) is set to determine a price tag by a business for a product, service or to fulfil a demand. The entity who puts an asset or opportunity up for a bid determines the rules for the bid, after which opposing bidders compete for the asset or opportunity by handing in their offers. Usually, one bid per competitor is allowed and the highest or lowest bid is accepted. In an auction type of bidding, the highest bid wins, but for example in a case of a bidding competition to find a contractor for a construction project, the lowest bid could determine the winning bid. Bidding activity often occurs in competitive environments and is used in business context as a competition for contracts. As the business case in the scope of the project does not consider customer interface bidding activities, the theorems portrayed in this chapter do not apply directly, but instead offer a valid and solid theoretical basis for the case.

Lawrence Friedman (Friedman, 1956) introduces competitive-bidding strategy as a concept to determine how companies could enter bidding competitions. He approaches the theme by describing a setting, where a government agency invites variety of companies operating in the same industry to bid for contracts. Each company is allowed to submit one closed bid and the lowest bid gets the contract. He then discusses the different possible strategies a company could adopt, which should be determined by their objectives. There are several objectives a company could have. Firstly, the objective could be to maximize total expected profits or to gain at least a certain percentage of investment. On the other hand, the goal could be to minimize expected losses, to minimize competitor profits or to get the contract even with a loss to keep production going. These are not the only objectives found in a bidding setting, but could contain elements of these or be combination of multiple ones. Nevertheless, it must be known that each problem has a different solution depending on the company objectives and the problem-setting. In the example presented here, the company's only objective is to maximize total expected profits.

For determining the way of finding an optimal bid, Friedman introduces a general model that takes several elements into consideration. In the model, the expected profit *E(x)* is determined by a formula:

$$E(x) = \int_0^\infty P(x)[x - SC]\, h(S)\, dS \qquad (1)$$

where *x* represents the bid, *C* the estimated cost of fulfilling the contract, *P(x)* the probability that a bid of *x* is lowest and wins the contract, *S* the ratio of the bid to estimated cost (*x/C)* and *h(S) dS* the probability that the ratio of the true cost to the estimated cost is between *S* and *S + dS.* The example case utilizes past data to shape a reliability distribution of the cost estimate (Figure 3), where probability is on the Y-axis and the ratio of true cost to estimated cost on the X-axis.

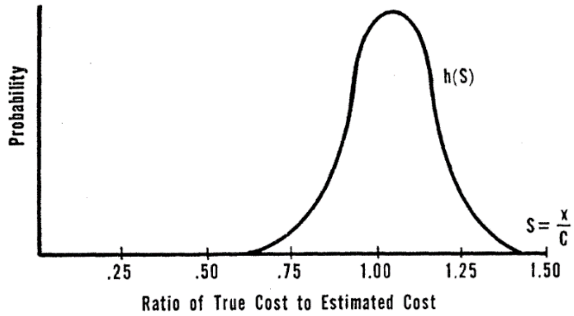


Figure 3. Reliability of Cost Estimate (Friedman, 1956).

Since *P(x)* is independent of S and $\int_0^\infty h(S)\, dS = 1$, equation (1) becomes

$$E(X) = P(x)(x - C') \tag{2}$$

where $C' = C\int_0^\infty S\, h(S) dS$ represents the bias-corrected estimated cost. This, *E(x)* now follows a curve visualized by Figure 4.

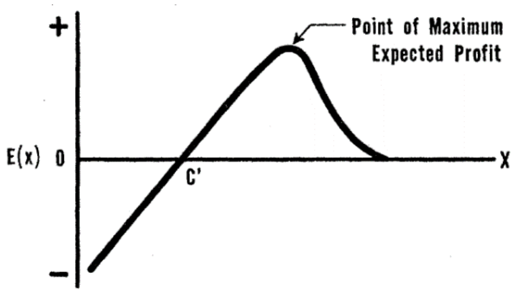


Figure 4. Expected Profit vs. Amount Bid (Friedman, 1956).

The bid that maximizes the profits can now be easily found from the curve. The probability of winning is not easy to determine and requires a separate analysis of bidding patterns of partaking competitors. However, this simplified description of the model demonstrates that there are multiple factors to consider in bidding: the objectives, competitors, estimated and actual costs and their ratio, expected profits and the probability of winning the bid. Considering the business case, understanding the company objectives and the relation of estimated and actual costs is crucial in pursuing profitable business.

3 Business Case Review

The business case review chapter introduces the current processes, challenges and profitability measurement methods that are involved in the case company's business processes. The focus is in reflecting KONE's implementation of transfer pricing practices to the theory reviewed previously and in describing existing issues and profitability monitoring procedures.

3.1 Supply Line - Front Line Price Setting

In the tendering phase car pricing, the tender engineer calculates, forecasts, and budgets the costs for a project car deliverable. This price will be used to construct a transfer price**, TP** (also **SLTP, Supply Line Transfer Price**), which is an intercorporate transaction the front line fulfills for the supply unit, who is the supplier of the elevator. The transfer price is determined by the supply unit and is based on the cost-based budget created by the tender engineer, and thus, cost-plus transfer pricing method is being utilized. Therefore, the tender engineer is not only calculating the budgeted cost for the car (supply line perspective) but also simultaneously the internal transfer price (front line perspective). For clarity and readability purposes, the expression used for this tendering phase custom car pricing and cost budgeting activity is "car pricing" throughout the scope of this study.

Both A- and C-process elevator car pricing are performed utilizing the cost-plus method. However, the difference between the two processes is that C-process elevator cars are always priced specifically for the individual projects, whereas A-process car prices are determined annually upfront in budgeting for the following year. Also, C-process cars generally contain unique or custom items that don't have an existing list price available, and therefore, their costs can be difficult to predict. Therefore, due to C-process pricing's case-by-case nature, it is more complex and challenging to perform. To guide with the C-process pricing, there are rules defined in KONE Supply Chain C-process Pricing Policy (2021), which steer the internal calculation practices followed in transfer price setting between the supply line and the front line units.

The C-Process Pricing Policy addresses various aspects, such as the tender validity periods, order validity periods, how pricing errors are administrated in the pipeline, and how tender and order variations are handled during the process (KONE Corporation, 2021). The policy provides general guidelines on how the price setting between the supply line and front line units should be conducted. Additional, more specific documents are utilized to determine the details related to price setting, such as how the full cost basis is formed. Full cost basis in this context refers to the transfer price in its entirety and the components it consists of.

In terms of supply line tendering activities, the KONE Supply Chain C-process Pricing Policy determines that car tender phase pricing follows cost-plus pricing methods and practices. What is to be noted is that the customer price setting is done in the local front line units and tender engineers on the supply unit level define the ESU Transfer Price (see 5.3.1 "ESU Transfer Price (SLTP) Structure" for full breakdown and explanation). Ultimately, this cost-plus based transfer price is the monetary amount a supply unit receives from the front line as an exchange for a project delivery.

3.2 Project Delivery Process

To proceed with a more practical standpoint, a brief introduction to the elevator project delivery process and related key definitions and terminology is carried out in this chapter. A surface-level look at the customer delivery project pipeline from start to finish will be conducted and parts and areas that are relevant in the scope of the project work are determined. A more detailed look on specific processes in these areas will be taken while simultaneously presenting relevant terminology and definitions needed in understanding the business dynamics and processes.

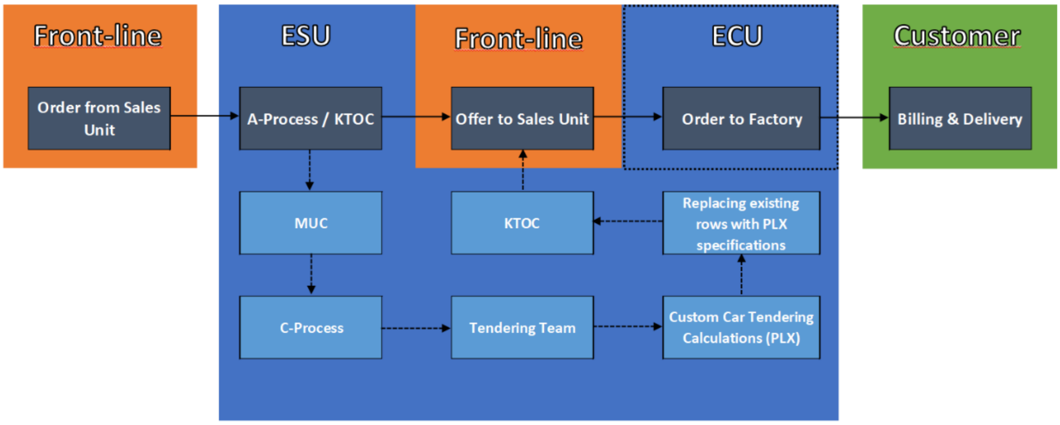


Figure 5. Simplified Order Process Flow, Tendering Actions (Car Specific).

A customer project starts with an order from the front line or sales unit, who operate directly in the customer interface. This order determines the specifications and requirements for the elevators and cars. If the order contains only standard elements, it is processed through the A-process pipeline in the supply unit and configurated in the **KONE Tendering and Ordering Configurator (KTOC).** KTOC is KONE's tendering, pricing, and ordering tool, which covers all of KONE's main business areas and products. After the order has been configured in KTOC, an offer is being forwarded back to the sales unit. If the offer is accepted, the order will be forwarded to the factory, and finally billing, and delivery processes take place to finalize the project.

In case the order contains custom or special requirements or elements, it is being handled as C-process, which contains more steps and actions before the offer is being forwarded back to the sales unit. What separates A-process from C-process, is that C-process orders contain a **manual user comment (MUC)**, which includes the specifications for the custom features. This is when the tendering team takes control, and with support from other departments, reviews the offer specifications until it's being sent forward.

The tender engineers utilize **PLX**-tools (Price List X) and other tools to assist with the C-process calculations and to determine required changes in the specifications. These C-process adjustments are then brought to KTOC to replace the existing A-process items, after which an offer (tender) is forwarded to the sales unit. From there on the C-process process flow is reminiscent of the A-process, except order pipeline content may be different despite having equivalent milestones. C-process also has more confirmation rounds between the front line and the supply line.

The most significant stages in the project delivery process in the scope of this thesis project, are the tendering phase C-process car pricing, and specification actions. With the implementation of the new CCP-tool, it is projected to replace the existing car pricing PLX-tools to streamline and standardize C-process car pricing.

3.3 Challenges in Car Pricing

The main challenges in the car pricing processes are that the current pricing tools are incoherent and the utilized price data is incomplete and outdated. Therefore, the pricing process is by force based on a subjective estimate rather than objective knowledge or coordinated presumptions to compensate for the inadequacies. Secondary challenges are related to resource and time scarcity. The tendering time per case is usually relatively limited (2 to 4 days) and the number of active cases per tender engineer is high. Also, there is no standardized way to prioritize cases to another, which can cause timing issues and scheduling pressure for certain projects. With the joint effect of limited time and outdated pricing data for special items in the existing systems, the tender engineer usually lacks the required time to ask for supplier offers for special items. This leads to a condition where the tender engineer is pressured to guess or predict prices for items with limited information, which inevitably gives more significance to speculation and uncertainty. This is not an ideal condition, as a higher level of uncertainty generally leads to a higher deviation between budgeted costs and actual costs. With the implementation of the new CCP-tool, it is not possible to get rid of guessing completely but it should increase the consistency level in pricing significantly as all special materials are priced using the same principles and practices. This way the inconsistencies between budgeted and actual costs can be comprehensively detected, which on the other hand provides a lot better possibilities to adjust the product selection prices towards a state where in the long-term, budgeting matches actual costs as accurately as possible.

There exist other issues in car pricing that are related to cooperation with other parties involved in the process. Lack of communication or understanding of front line or customer specifications and having no dedicated tender support resources in ECU are some of the challenges that may be faced during the tendering phase. These other challenges, however, are matters that could be ironed out through higher-level process development and resource allocation, rather than adjusting internal processes and tools in car pricing. Therefore, in this thesis project, the focus is on the firstly presented challenges, for which the solutions could be approached through the implementation of the CCP-tool.

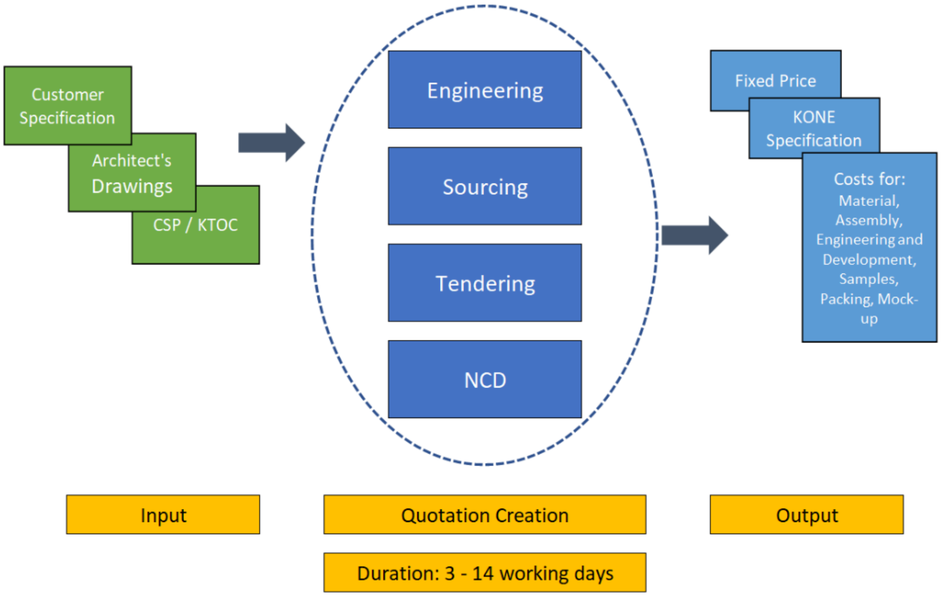


Figure 6. Pricing Process.

3.4 Biweekly Project Profitability Analysis

Certain key figures are used at KONE to follow and monitor project profitability. **General Margin Percentage (GM-%)** considers the Supply Line Transfer Price from where full material-, process-, and engineering costs and administrative cost allocation are deducted. The GM-% ultimately indicates how much profit the supply unit is left with after the appropriate deductions.

At the time of the study, project delivery gross margin percentage is not evaluated through mass analysis on module level, but instead via individual examination of preselected projects in a biweekly project profitability analysis workshop. In other words, the total portfolio of all equipment (equivalent to elevator) deliveries is monitored as a mass on project level, but module-level mass reviews have not been conducted previously. These reviews are possible to perform manually but require a substantial amount of manual work to break down equipment deliveries into modules. A system to allow module level mass analysis is being worked on at the time of the study and will be utilized for future reviews, but due to data limitations, cannot be utilized for historical cases retroactively.

The premise for selecting the cases for the project profitability analysis is based on their total profitability, or moreover their level of deviation from forecasted profits, meaning that cases that have had significant fluctuation are mainly the ones considered. Therefore, the emphasis is placed on cases that could be labeled as outliers in the data. This approach is great for making discoveries in single cases and in gaining an understanding of what has caused profit fluctuation in the short term. It simultaneously acts as a great learning environment for supply units' operative teams but does not support in explaining the whole picture of module level profitability challenges. Occasionally, projects that have reached the target profit are also considered. When total profits align with the target levels, module-specific profits could nonetheless have substantial variation. This may lead to a condition where two modules, out of which the first one would be heavily unprofitable and the second substantially profitable, cancel out each other's effects in total profits. Therefore, also understanding the module-level cost variation is essential to reduce project-level profitability fluctuation.

Although the individual project profitability analysis is a great tool for research, a large-scale module-specific mass analysis is beneficial to complement the analysis. Discoveries in single cases may not represent well the characteristics of, for example, car deliveries of a given period, as coincidence and unconventional features may have a more substantial role. Therefore, a mass analysis for custom cars will be conducted as part of the study as an introduction for car module profitability analysis, which could subsequently be utilized as a reference to develop more sophisticated long-term performance measurement practices and techniques. As the forthcoming module-level review automation does not consider historical data retroactively, the analysis supports in providing a head start by generating initial benchmark values for performance monitoring. Otherwise, it would require years of organic data collection in the new system as opposed to this alternative solution.

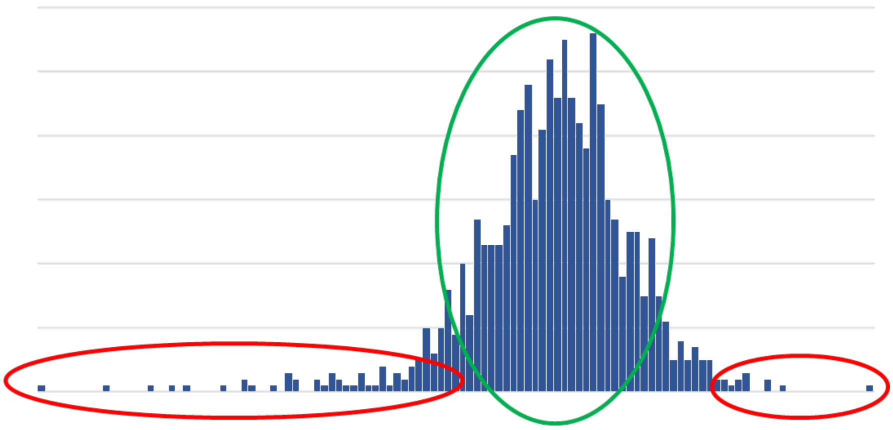


Figure 7. Project Profits and Focus of Attention, Artificial Data.

In Figure 7 it is detectable how altering the focus between single cases and the larger mass changes the analysis perspective. In an individual review, there is visibility to elevator level profits and the causes of profit deviation in single cases, but it does not provide capabilities to work on macro-level, long-term profitability. The findings discovered in the elevator-level inspection are certainly valuable in understanding exceptional cases, but the focus is put on outliers instead of systematic error.

A mass analysis complements the individual review by focusing on finding the reasons why recurring pricing deviation occurs in car module pricing. The purpose is to find causes for recurring car pricing errors so that by implementing corrective measures, the cost variation could be made narrower. This would result in a condition where car pricing is more accurate as car profit data points are spread less extensively around the average profit level, as cost variation has an impact on the profits. The average profit point could be on the negative or positive side but is not directly dependent on car pricing accuracy, but instead on the prices assigned for products and items used in tender phase pricing. The car pricing accuracy determines the variation, whereas the price level determines the location of the total data point population on the X-axis. The prices are derived from a price list which is a predetermined list of elevator component prices that are used for car pricing. It is based on supplier prices, company-level markups, and other factors. The price lists should be revised in regular intervals so that tender phase car pricing is always performed with up-to-date pricing information.

Hypothetically, if car pricing would be completely accurate every time, the profit variation would be zero. In that case, all the data points in Figure 7 on the X-axis would be located at point zero. This, however, does not directly indicate that profits would be on the same level case-by-case as target profit depends also on factors than just pricing accuracy, such as the product platform, product release, car features, the general and administrative **(G&A)** allocation and discounts. Generalizing all this, the profit level can be altered (movement of the whole mass of data in Figure 7 along the X-axis) by fine-tuning the profit element and other overhead factors, while the spread of data points is determined by the cost budgeting accuracy.

4 Creation of the CCP-tool

One of the main objectives of the thesis project is to create a new custom car pricing tool for tendering purposes. In this chapter, the design and features of the first version of the CCP-tool are reviewed, as well as the calculation logic and background processes that actuate it. Finally, an introduction to the tool user interface is being undertaken.

The tool is developed using methods that allow the user to configure a car of any type as it dynamically interprets a **master price list**, where car-related items, materials, and their costs are listed. The item rows on the list representing distinctive car parts and materials are either car type-specific or universal, the latter implying that they are eligible to be used with any car type. The car type-specific items are either designed specifically for a distinct car type or are compatible with any car type but have a different cost depending on which car type it is being used for. The latter may come into question when a shift from a car type to another changes the structure of the car and, therefore, causes more costs in manufacturing. For example, a wall may require extra reinforcement when used in a heavy-duty car compared to a conventional one. Therefore, the price is higher although the wall finishing material and key characteristics (size, nominal panel thickness, etc.) would be the same.

The master price list can be expanded when new items, materials, and prices are added to the product range portfolio. As new items and materials are introduced on the price list, they appear usable in the CCP-tool automatically, enabled by a dynamic price list interpretation. Implementation of this feature is an important step forward as a paradigm shift in custom car pricing has been introduced: if the cost of utilizing a specific item-material combination is the same regardless of the car type, the price used in tendering phase pricing should also be the same. This has not been the case previously as car types have been priced inconsistently using dissimilar logic, although they would utilize the same items or materials. This on the other hand has caused discrepancy in pricing over time. An exception to this is items that require extra work or materials when used in different car types, as mentioned in the previous subsection. Also, multiple C-process components have been priced based on subjective assumptions without relation to coordinated or jointly set prices. The implementation of the CCP-tool is an excellent opportunity to overcome these inconsistency issues by harmonizing car pricing and highlighting the fact that different car types should have similar pricing logic since uniform car pricing streamlines car tendering activities. Centralization of the pricing master data also makes administrative and maintenance activities less laborious as instead of multiple custom car pricing tools, only one is being used.

4.1 General Design

The first version is developed as an Excel tool and is stored in a network drive so that all stakeholders have access to it regardless of their physical location or time of the day. The users are expected to download a local copy of the tool file to be used as a personal car pricing template. The tool's design is split into three different entities, and they are stored in individual worksheet tabs specified for each one. These three main entities, **the master price list**, **the data processing and calculation logic**, and **the user interface**, form the structure of the tool which collectively facilitate the tool's performance.

The master price list is the main source of pricing data, which acts as a database for the price calculations. The list is a separate database file, and its contents can be retrieved to the tool's "working memory", which is on a specified worksheet in the tool. The price data is therefore managed separately from the tool and is not dependent on which copy of the tool version is being used. In addition to this, the data processing and calculation logic entity is an abstract, built-in feature part of the tool, which is not directly visible to the user. Its role is to administrate the available user inputs that are presented for the user through the user interface. The logic affects all parts of the tool but operates directly from a specified worksheet tab and carries out the tool's technical processes, such as limiting the user selections to certain materials if a specific car type has been chosen, fetching correct pricing information from the master price list based on the user selections, and conducting the square area and price calculations that determine the final item prices for the car. The tool user interface is the visible part of the tool which the user controls by selecting and inserting inputs based on car characteristics. The three main tool entities in interconnection collect the car characteristics and item pricing data, process that information into monetary values, and provide the final price for the custom car which will be used as a transfer price for the car.

4.2 Master Price List

The master price list is created to function as a material price database for the tool. It is a collection of items, materials, and prices used in car production. More correctly, the rates on the master price list are not prices from tendering perspective, but material usage **costs** which incur if chosen materials are utilized. Therefore, the master price list includes purely material usage costs. As the tool is being used to determine a price for an elevator car, it retrieves costs found on the master price list for the selected materials and items and adds a pre-determined markup on top of the costs. This value consisting of the price list value (cost) and the markup is then being used as the transfer price. Markup in this context refers to an overhead element consisting of a material overhead, G&A allocation, material risk factor and a profit element.

Thus far, car material pricing has been carried out based on car load (in kilograms), intending that for most car types the load defines a default car size (BB x DD x CH) and based on this size, a precalculated price has been determined for different load levels. For certain special car types, a coefficient has been used to scale the prices equally concerning the rate the car load deviates from a reference point. For example, if the tendered car load is 150 % relative to the reference car load, the material price is then being multiplied by a factor of 1.5 (if 80 %, then 0.8). This approach may work reasonably well, but also has its issues, as car load may not be the main price driver for most car pricing cases. If two cars have the same load, but the other one is double in size, the pricing will most likely not hit its target in both cases as much more material is being used for the car with larger dimensions. To address this issue, a new approach in pricing is being taken by implementing a square meter-based costing logic. This means, that a shift from load-based and other pricing methods to square-meter-based pricing is initiated, and therefore, the tool and the price list also utilize this feature. The square meter-based logic is being used for materials that can be without excessive work measured in square areas, such as walls, roof, and floor, and meter-based logic for materials that are most convenient to measure in length, such as handrails. Additionally, a fixed unit cost is used for items such as a car seat, which are more manageable to price by using fixed monetary values.

The master price list is based on known A-process square meter, meter, and unit prices, but also contains recurring C-process elements that have a valid and verified price. Identical to A-process materials, C-process materials can be added on the list if they are being used frequently and a square meter, meter, or unit price can be defined. This is a significant step forward in custom car pricing as recurring C-process materials don't need to be added manually every time in the tool by the user, which has been the case previously. Now by adding the material on the master price list, they appear as a prefixed item in the tool automatically alongside the other price list items. Another benefit of implementing the square meter-based logic is that supplier price lists for square meter-based items are generally also received in square-meter format and, therefore, less work is needed to transform the supplier price data into a usable form for the CCP-tool. Before, it was required that all supplier price lists had to be converted into a format that was compatible with the car load-based logic, regardless of their initial format.

The original copy of the master price list is stored in a network drive as a separate object from the CCP-tool. The tool has a specified price list tab with a built-in query to fetch the master price list data from the original master price list file whenever the user refreshes the sheet. The query replicates the data found in the original file and applies it to the tool's price list tab. This allows to have up-to-date data available at any given time for all tool users as long as they have access to the company resources via an internet connection. The tool usage itself does not require an active internet connection, so offline use is also supported. However, in offline use, the data represents the state of the price list data from the point of time it was previously refreshed in that specific local file. The master price list data is not expected to be updated daily, so this arrangement is a great balance in providing the latest pricing data whenever needed, while also giving the chance of performing car pricing activities in conditions where there is no access to the web-based company resources. It also minimizes the risk of having faulty pricing data by limiting access to the original master price list data by giving permission only for the administrators of the tool.

Release	Full ID	Module	Type	Device	Var1	Var2	Var3	Description	Base (cost)	Each (cost)	Pricing date
R20.2	WALL_VER_1.0_Z	Mod 6	HMC	WALL	VER	1.0	Z	Zinc coated steel	5	1000	31.12.2019
R20.2	WALL_VER_1.5_Z	Mod 6	HMC	WALL	VER	1.5	Z	Zinc coated steel	5	1500	31.12.2019
R20.2	WALL_HOR_1.0_Z	Mod 6	HMC	WALL	HOR	1.0	Z	Zinc coated steel	5	1000	31.12.2019
R20.2	WALL_HOR_1.5_Z	Mod 6	HMC	WALL	HOR	1.5	Z	Zinc coated steel	5	1500	31.12.2019
R20.2	WALL_VER_1.0_F	Mod 6	HMC	WALL	VER	1.0	F	Brushed stainless steel, AISI441	2000	10	31.12.2019
R20.2	WALL_VER_1.5_F	Mod 6	HMC	WALL	VER	1.5	F	Brushed stainless steel, AISI441	2500	10	31.12.2019
R20.2	WALL_HOR_1.0_F	Mod 6	HMC	WALL	HOR	1.0	F	Brushed stainless steel, AISI441	2000	10	31.12.2019
R20.2	WALL_HOR_1.5_F	Mod 6	HMC	WALL	HOR	1.5	F	Brushed stainless steel, AISI441	2500	10	31.12.2019

Figure 8. Screen Capture: Master Price List, Artificial Data.

The price list sheet contains several columns, which are based on item features and properties. The relevant features in terms of the tool's functionality are in the **Full ID, Module, Type, Device, Var 1, Var 2, Var 3, Description, Base (Cost), Each (Cost),** and **Pricing Date** columns. The Full ID is a unique ID for an item and material combination that acts as an identifier in finding specific item rows from the master price list. Basically, the tool combines a text string based on user inputs and then fetches the row-specific price information from the master price list from the row that has a Full ID matching the string.

Module-column indicates which module that item belongs to, and as the project is focused on car pricing, only Module 6 item rows can be found in the master price list. The Type-column determines for which car type the item applies to and if the cell for an item in this column is blank, it is usable for any car type. The Device-feature indicates what is the main component group for this specific item, for example, "wall", "roof", "ceiling", "handrail", etc. Variables (Var) 1, 2, and 3 are variables that differentiate specific items and materials in each main component group. For example, in the case of device “wall”, Variable 1 determines the orientation of the wall panel, Variable 2 the thickness of the panel, and Variable 3 the material used. These variable features are different for each main component group. The Description feature has a string of text to describe the item and material that a specific row represents. For example, the description for a row containing an item that is of the main component group “wall”, has Variable 1 value of “VER” and Variable 3 value of “Z” is: “Vertical car wall – Z – Zinc coated”. This description is shown for the user through the interface to explain the properties of the item the user has chosen to use in the car specification. The Base and Each cost-columns are fixed, pre-determined values that express the costs of using that material per square meter, meter, or as a fixed number. Lastly, the Pricing Date feature provides information on when the Base and Each cost were last time verified. This is useful information indicating for the user if the price of an item has not been verified for a long time so that the price should be reviewed rather than using outdated pricing data.

4.3 Data Processing and Calculation Logic

Most of the data processing takes place in the “Data”-tab which is hidden from the general user and therefore is accessible only by the administrators. Its main function is to generate and store available user inputs by interpreting the master price list data. This information is then transferred to the user interface section, allowing the user to use items and materials found in the master price list in the car specification. The process is a combination of using dynamic data validation techniques, named ranges, and pre-determined item grouping methods. As an example, when an item that has a Device-value of "wall" is being added to the master price list, it is being classified in the "wall" main component group. However, if an added item belongs to the main component group "accessories", it is not being classified in that group automatically as the accessories don't have a uniform Device-value. Therefore, administration actions are required in some cases when new materials and items are added to the master price list.

The other aspect of this entity, the calculation logic, has a close relation to the master price list and the format the list has been created in. Most of these calculation operations are carried out in the user interface part but are supported by the data processing operations. As the items are measured either in square meters, meters, or units, the calculation formulas differ slightly between these instances.

$$Square\ Meter\ Based = Base\ Price + Square\ Meters * Square\ Meter\ Price \tag{3}$$

$$Meter\ Based = Base\ Price + Meters * Meter\ Price \tag{4}$$

$$Unit\ Based = Base\ Price \tag{5}$$

The base price covers the starting costs of utilizing a specific item and the square meter- or meter-based portion is an addendum to the price based on how much of the material is being used. This approach is simultaneously a lot more accurate and simpler compared to pricing the car based on load, as the material cost is based on actual material usage. Base price is included in all three different calculation variations and is the total unit price for unit-based items, such as in the case of a fan or car seat.

4.4 User Interface and Usage

As the requirements for the tool are that it should be intuitive, flexible, and versatile on the user side, it is required to make the usability and user experience a priority. Hence, the user should be able to perform a wide variety of custom car tenders from very simple ones with low-level custom elements to complex ones with high-level tailoring. The challenge is to enable this kind of flexibility, while simultaneously requiring as little user input as possible to keep the usability as simple as possible. Albeit there are technical structures and calculation logic steps implemented in the tool, no comprehensive technical knowledge is required from the user to conduct custom car pricing. Next, a review of the tool and its features from the user point of view is undertaken, complemented with actual screen capture images of the tool.

Figure 9. CCP-tool User Interface Overview.

The tool user interface is placed on one single sheet under the name “Car”. The interface is divided into three main sections which are **the input-**, **the car area and price calculation-,** and **the cost calculation-sections**. In short, the user inputs are used to determine the dimensions of the car and its elements, whereas the item rows in the cost calculation-section determine which items and materials are being used in the car. All this information is transferred to the car area and price calculation-section, where car area dimensions and prices are calculated to determine a total price for the car. In the following subchapters, a more detailed look at these sections is taken one by one.

	Inputs	
	Custom Name	
*	Car Type	
*	Panel Orientation	
*	Panel Thickness	
	SEC / TTC	
*	Width (BB) [mm]	
*	Depth (DD) [mm]	
	Car Ceiling Height (H) [mm]	
*	Car Internal Height (CH) [mm]	
*	Car Load (kg)	
	Reservation for Car Floor (SS) [mm]	
	Car Top Ballustrade height (HK) [mm]	
	Front Return (A-Side) [mm]	
*	Door HH [mm]	
*	Door LL [mm]	
	COP Width	
*	Number of Cars	
*	Platform	
*	Markup	

*) Required input

Window Width (WX) [mm]	
B-Wall	
C-Wall	
D-Wall	

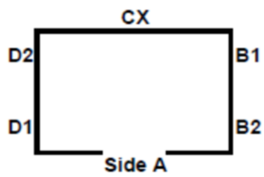


Figure 10. CCP-tool UI, Input-section.

In the input-section, the user is required to insert and choose the characteristics of the tendered car. The inputs that require a numeric value are free-form cells, whereas inputs that have a pre-determined selection of possible values are implemented as drop-down cells. All cells that require user input are marked with a light-yellow color, but in case the cell is a required input and does not have any contents set by the user, it is color-coded with red. This tells the user that their attention is needed in the input-section before a valid price can be determined for the car. The required inputs are vital features of the car that are being used to either determine the dimensions of the car or for operations in the price calculations. The first three of these required inputs are the **car type**, **wall panel orientation**, and **wall panel thickness**. All three input cells are drop-down cells as there is a finite number of options to choose from, as they are based on the master price list data. The different car types to select from are determined by the car types available in KONE’s portfolio, whereas panel orientation can be either horizontal or vertical. Wall panel thickness as standard varies from 1 millimeter up to 2 millimeters in 0.5-millimeter intervals.

In addition to the width, depth, and clear height dimensions of the car shell, the car load is also required at this stage as some special cases are still being priced based on load, although pricing for the most part follows square meter-based logic. The car door area is calculated by multiplying the door width (LL) with the door height (HH). However, the door area is not considered when calculating the front wall area, as an average sized door is already taken into account in front wall material prices. Although the door size does not have a price impact on the car, it is an important detail from engineering and design perspective. Another variable closely related to the doors, but not a required input, is that whether the car is a **single-entrance (SEC)** or **through-type (TTC)** car. A single-entrance car has one wall with a door and three closed walls, whereas the through-type car has two walls with doors on two opposite walls and two closed walls. There exist also other more unconventional door arrangement solutions, such as an "adjacent" car that has two walls with doors on adjacent walls. However, the single-entrance and through-type cars cover most car deliveries. The other inputs and variables required by the tool are essential car characteristic information but not relevant for car pricing and are therefore excluded from this review.

Along with the car characteristic inputs, the user is also required to select the elevator type (platform) and markup type (supply line) for markup calculations. The markup percentage is directly dependent on the platform and supply line used and consists of different overhead components. Using the elevator and markup types specified by the user, a markup coefficient is retrieved from a two-dimension table that contains different markup combinations. This value is then used to calculate the final price for each item included in the car specification by multiplying the item cost retrieved from the price list with the markup coefficient.

	Inputs	
	Custom Name	Project Arasaka
*	Car Type	HMC
*	Panel Orientation	VER
*	Panel Thickness	1.0
	SEC / TTC	SEC
*	Width (BB) [mm]	1400
*	Depth (DD) [mm]	2400
	Car Ceiling Height (H) [mm]	
*	Car Internal Height (CH) [mm]	3000
*	Car Load (kg)	1600
	Reservation for Car Floor (SS) [mm]	
	Car Top Ballustrade height (HK) [mm]	
	Front Return (A-Side) [mm]	
*	Door HH [mm]	2500
*	Door LL [mm]	1300
	COP Width	
*	Number of Cars	10
*	Platform	MiniSpace
*	Markup	SOF

*) Required input

Window Width (WX) [mm]	
B-Wall	
C-Wall	1200
D-Wall	

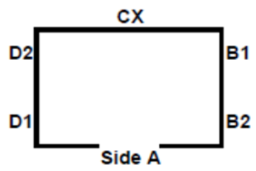


Figure 11. CCP-tool UI, Input-section, Artificial Data.

Enclosed above is a screen capture of the input-section with example values included. As seen in the capture, all required inputs are filled in and no color-coded cells are indicating missing inputs. The tool uses these values to determine the square areas for the car elements, which can be found in the calculations-section. In the screen capture below, the tool has calculated the areas for the ceiling, roof, walls, and floor. These measurements are used to calculate item and material prices with appropriate formulas as presented earlier in this chapter.

Element	SQM	Prices	Confirmed Prices
Ceiling / Roof	3.36	0 €	0 €
Front Wall	4.2	0 €	0 €
B-Wall	7.2	0 €	0 €
C-Wall	4.2	0 €	0 €
D-Wall	7.2	0 €	0 €
Floor	3.36	0 €	0 €
Handrail		0 €	0 €
Buffer Rail		0 €	0 €
Ballustrade		0 €	0 €
Car Outside Paint		0 €	0 €
Emergency Door		0 €	0 €
Other		0 €	0 €
Accessories		0 €	0 €
Scenic		0 €	0 €
Marine		0 €	0 €
Total Material Per Car		**0 €**	**0 €**
(Raw Car / Black Box)		*0 €*	*0 €*
Production Per Car		0 €	0 €
Engineering Per Car		0 €	0 €
Total Per Car		**0 €**	**0 €**

Figure 12. CCP-tool UI, Price Calculation-section.

As the square areas for the elements have now been determined, the next step of the process is the cost calculation. This section is divided into three subsections: **material**, **production**, and **engineering costs**, out of which material costs are the most substantial, not only based on the level of costs but also the number of configurable items. The material section covers the direct material costs and labor costs which are related to item manufacturing, whereas production costs involve other labor costs related to car production, such as assembly activities. Engineering costs contain all engineering related work, such as the creation of structural drawings or any additional planning and design costs. Generally, the more complex the car is, the more production and engineering hours are needed, and therefore costs are incurred. The production and engineering costs are inserted by the user manually, as these costs are difficult to determine in a formulated way based on any car characteristics or features, and therefore implementing automation for calculating these costs is not feasible at this stage.

In the material subsection, the car elements have been divided into different item groups. These groups are divided as follows: **ceiling and roof**, **walls**, **floor**, **handrails**, **buffer rails**, **balustrades**, **car outside paint**, **other items**, **custom other items**, **accessories**, and special groups which apply to special car types. All these material groups have different items listed underneath them and every item row represents a single item in the car. Also, any prices or markup coefficients presented in this example are not based on any actual cost or price levels.

Group	Yes	Q	Item	Type	Device	Variable 1	Variable 2	Variable 3	Full ID	Description	Base Price	SQM / M Price	SQM / M / Load	Pricing Date	Cost	Price
Ceiling / Roof	☑	1	Roof	HMC	ROOF	STD			ROOF	Standard	200 €	238 €	3.36	31.12.2020	1 000 €	2 000 €
	☑	1	Ceiling		CEILING	LF1	F		CEILING_LF1_F	StSt AISI441 Scotch Brite	500 €	744 €	3.36	31.12.2020	3 000 €	4 000 €
	☐		Special Rows													

Figure 13. CCP-tool UI, Material Subsection, Artificial Data.

In Figure 13 the “ceiling/roof” group is used as an example. It contains three rows, which all represent different items in the group: the roof, ceiling, and lastly the special rows which is a master special row for multiple individual ceiling and roof-related special rows. These special rows are subordinates to the master special row and can be accessed by activating the master special row in the specification. Most of the item groups have this special row solution implemented into them, which allows flexible use of custom items and materials through manual input, in case items and materials are not available on the master price list. The user is expected to insert details about the material and its price which are then considered in the car cost and price calculations.

The columns represent different features of the items. In the first column is the name of the group, followed by a checkbox that is configurable by the user. The checkbox determines whether the item is included in the car specification or not. Next to the checkbox is a column named “Q”, which determines the quantity of the item included in the specification. This is a useful feature in several ways, for example, if the user wants to include multiple units of a particular item. Another way to utilize this feature is by extrapolating the item costs with a coefficient. For example, if it is known that a specific custom wall material that cannot be found on the master price list costs 1.5 times more compared to a standard wall material that has a known price, a coefficient of 1.5 can be used to receive a price for the custom material.

The item, type, and device columns are for the most part predetermined and cannot be changed by the user. These unchangeable cells are marked with a light blue color and their contents are taken from the price list directly. The number of configurable variables of items in each row depends on the item and how many variables have been initialized for that item on the price list. As detectable in Figure 13, the roof has only one variable whereas the ceiling has two. Currently, the maximum number of variables is three.

The required inputs, that are used for determining the price for the roof and ceiling, are filled in the example. The tool then retrieves the data from the price list based on the inputs and fetches the information that can be found in the rest of the cells on the item rows. The base price for the roof is 200 euros, square meter price 238 euros and the square meter area is 3.36 square meters, which is visible in the car area and price calculation-section. Using the square meter-based price calculation formula, the cost for the roof with the example values is 1000 euros. The square areas for the different car elements are determined automatically by the car size based on the car specification, and therefore, the user is not required to calculate areas manually. As the platform and the supply line have also been determined, the markup is being added to that rate and the final price consisting of the cost and the markup is 2000 euros in total.

The individual item prices for the items under the "ceiling/roof" item group have now been determined, which all together form the total price for the item group. All other item groups follow the same logic while considering which of the square meter-, meter-, or unit-based costing logic is being applied for each item. Below is a visualization of the car area and price calculation section when all item groups have been configured.

Element	SQM	Prices	Confirmed Prices
Ceiling / Roof	3.36	6 000 €	6 000 €
Front Wall	4.2	5 000 €	5 000 €
B-Wall	7.2	3 000 €	3 000 €
C-Wall	4.2	8 000 €	8 000 €
D-Wall	7.2	5 000 €	5 000 €
Floor	3.36	7 000 €	7 000 €
Handrail		500 €	500 €
Buffer Rail		500 €	500 €
Ballustrade		600 €	600 €
Car Outside Paint		0 €	0 €
Emergency Door		0 €	0 €
Other		1 300 €	1 300 €
Accessories		1 500 €	1 500 €
Scenic		0 €	0 €
Marine		0 €	0 €
Total Material Per Car		**38 400 €**	**38 400 €**
(Raw Car / Black Box)		*30 000 €*	*30 000 €*
Production Per Car		1 380 €	1 380 €
Engineering Per Car		460 €	460 €
Total Per Car		**40 240 €**	**40 240 €**

Figure 14. CCP-tool UI, Price Calculation-section, Artificial Data.

The "Total Material Per Car"-row shows the total material usage and prices for the car, including the markup. The production and engineering prices are calculated and determined by the user manually by using external references or tools. Finally, the total price of the car including materials, production, and engineering prices can be found from the "Total Per Car"-row. This value is brought forward as a transfer price for the car module in this specific elevator configuration. What is to be noted, is that in this section there are two columns that contain calculated price values: “Prices” and “Confirmed Prices”. The first one takes the latest price list data, tool inputs and calculation logic to determine the prices for the different elements. The cells in the latter column are initially blank, until the user clicks a specified price confirmation button established in the tool, after which the values from the first column are copied to the latter one. This operation is done to save and “lock” the prices that are valid at the time of performing the car tender. The values in the “Confirmed Prices”-column then stay unchanged unless the user manually executes this operation again. It is essential to include this feature as the price list data, and therefore also the values in the “Prices”-column, change over time when price list refreshes are carried out. However, these changes are not always wanted in the confirmed prices-section as the confirmed prices represent the price data the tender was made with. The user is nonetheless enabled to update the confirmed prices manually based on latest “Price”-column information when required, for example as tender revisions are made.

4.5 Benefits

There are several projected benefits of implementing the CCP-tool. Firstly, from the structure point of view, car pricing logic is simplified and streamlined compared to its previous form. By having fewer interphases in the pricing process, it allows for more reliable and accurate pricing while simultaneously using fewer resources. Secondly, the number of price keys is set to decrease to one-tenth from the original, which in practice means that there are fewer rows needed in the master price list to include the same number of materials as previously. This makes upkeeping and maintaining activities a lot more agile and less demanding. By using a master price list as a database for the pricing information, all pricing data can be centralized so that inconsistent and scattered price data is minimized. This consequently increases pricing quality as all tendering activity is based on the same uniform pricing data, combined with standardization of the tool, processes, and pricing logic. Therefore, as similarly priced cars are henceforth comparable, there is a better foundation to implement development actions in pricing to reach better car pricing performance. For instance, if a certain car type is consistently being underpriced with the tool in the tendering phase, the problematic areas can be detected in retrospect and price list prices can be adjusted accordingly to match with incurred costs.

From the user's point of view, the existing car pricing tools (PLX's) do not allow extensive customization possibilities in terms of the car. Using the CCP-tool, the user can specify custom elements in any car item group. The customization possibilities, therefore, are a lot higher than in previous solutions. Also, as there is now one comprehensive tool for all car pricing tasks, user competence is required only for one single tool.

To summarize the benefits, by having a standardized way of pricing cars, centralized pricing data, and one comprehensive car pricing tool, the calculation interphases, required resources, competence requirements, and the number of tools can be cut down while simultaneously carrying out better quality car pricing, that can be enhanced even further through standardized monitoring allowed by the tool.

5 Empirical Data Analysis

5.1 Analysis Design and Approach

As brought up in previous chapters, no mass analysis for C-process car profitability has been conducted prior to this thesis project. The actualization of such an analysis is justified as long-term profitability can be approached through inspecting wide variety of cases and making corrective measures based on the evidence of an extensive case population.

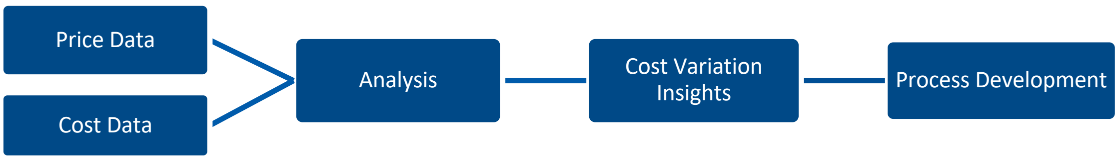


Figure 15. Analysis Blueprint.

The blueprint for the analysis consists of four main stages. The first stage is to collect historical A- and C-process price and equivalent cost data of delivered custom cars. A- and C-process prices are both included as C-process prices are often delta prices with respect to standard A-process prices. In the second stage, the compiled datasets are utilized for a cost variation dynamic analysis. Through this comparison and analysis, the goal is to find phenomena or characteristics that repeatedly cause pricing accuracy and profitability issues in car pricing. Simultaneously, it is possible to gain an understanding of the current status of pricing accuracy so that a reference index can be set for future cost budgeting development actions. These findings could assist in understanding what type of cases tend to be over- or undervalued in the tendering phase car pricing and budgeting. In the final stage, adjustment and process enhancement proposals based on discovered insights are made to enable more profitable custom car pricing in the future. For confidentiality reasons, no actual numerical values are provided in the analysis and graph axes are hidden.

5.2 Data Collection

The data used in the empirical data analysis was collected from multiple different platforms and sources in separate stages. Firstly, a population of 900 delivered elevators (**Sales Documents**) was extracted from **Qlik Sense** as an initial dataset for the analysis based on the following requirements: delivery timeframe between years 2019 and 2021 and must have gone through the C-process delivery pipeline. The sales document number is an elevator unit-specific identification number, and as a unit has only one car, in this case it can also be used as the identification number for the car. This extract contains mostly meta data and sales document identification records for the elevator units and is therefore a rational extract to be used as the first building block for a completed dataset to be utilized in the analysis.

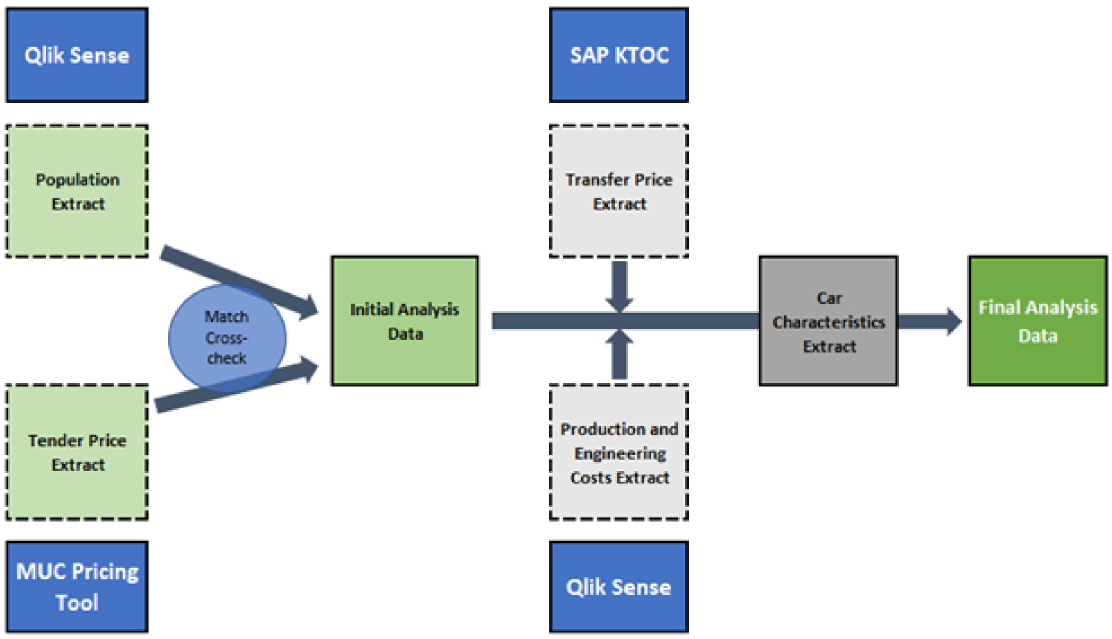


Figure 16. Data Collection Process.

Following this, an extract of tendered prices for elevators delivered during the same period was extracted from the **MUC Pricing Tool.** This extract was filtered with the criteria that only elevators with a C-process **car** MUC were considered. By using the sales document number, a cross-check for both the Qlik Sense extract containing the meta data and the MUC Pricing Tool extract containing the pricing data was executed to find elevator units that have records in both extracts. This filtering and collection process resulted with a population of 65 unique cars, which were used as the initial analysis data.

As the tender price data of the elevator cars is under review, an actual car cost and actual price data is also needed to supplement the initial analysis data. On the cost side, an extract of incurred and actual production and engineering costs was obtained from Qlik Sense. The production costs are an essential component in the analysis, so that tendered prices and actual costs can be compared to determine how accurate the budgeting in the tendering phase has been. The engineering cost figures complement the production costs in a supporting role and will be examined in case there has been extensive upward price fluctuation moving from budgeted costs (tendered prices) to actual costs, as the deviation could be a result of extensive use of engineering work in car production. In the analysis, the engineering expenditure is expressed in work hours instead of monetary values to eliminate the effects of alternating hourly rates.

Comparable to the cost data, an extract of transfer prices was extracted from **SAP KTOC**. From the supply unit's perspective (ESU), a clear-cut description of the transfer price is revenue (cash flow coming in from the front line as a payment for the elevator, out of which a segment is allocated for the car module) and the production costs to be the equivalent costs for the elevator (car). However, this simplified explanation is not necessarily completely true as production and engineering costs mostly incur for ECU, not for the supply unit. Therefore, before the figures can be utilized in the analysis, the data requires preprocessing to be qualified for a viable comparison. This issue will be considered in the following chapters when conducting the cost variation analysis.

The car characteristics extract is the last component needed for the analysis and was also imported from **SAP**. These records give the specifications and features each car under review have been shipped with. The features include the measurements of the car, car load capacity and material selections. The focus in the features included in the data is in the ones that could have a substantial impact on the car price, and therefore potentially being a main price driver for the car.

5.3 Data Pre-processing and Breakdown

Due to the data existing in wide range of different data management and warehousing systems with inconsistent data points and description factors, a lot of data preprocessing was required before an analysis could be conducted. The Qlik Sense data extract included most of the identifying records, out of which the most essential ones are the KONE equipment number and sales document number (elevator unit specific) and opportunity, tender and tender version numbers. The KONE equipment and sales document numbers are unique serial numbers, out of which the first is a unique identifier for the elevator unit and the latter a common binder identifier for the supply line delivery project, which contains both elevator materials, but also other costs allocated to the delivery. The opportunity number is a unique sales opportunity number for the project, whereas tender number indicates a tender project related to a specific sales opportunity. Tender version number expresses the version of the tender, and the versions can be branching in content. There can exist multiple tender versions under a specific tender number.

In addition to having these same identification numbers as in the Qlik Sense extract for cross-checking, the MUC Pricing Tool data has the tender price specific data of the cars, out of which the C-process Car Impact and C-process Engineering impact figures are the main ones used in this analysis. The tender price extract includes the transfer price (i.e., ESU Revenue) without C-process Car Impact, which must be added separately to get the actual final transfer price set by the ESU for the FL.

As there are internal transactions fulfilled between different function levels inside the company, the prices and values are also derived from different levels and therefore must be considered in a bilateral fashion between the parties. The main parties in the analysis are the Elevator Supply Unit (ESU), Elevator Component Unit (ECU) and the front line units (FL).

The following figures were derived from the data sources and calculated to be used as main inputs in the analysis: **ESU Transfer Price** (ESU Revenue, also SLTP), **ESU Budgeted Cost** (ESU Forecasted Cost), **ECU Actual Cost, ECU Theoretical Revenue** (ESU Theoretical Cost), **ECU Budgeted Cost** (ECU Forecasted Cost) and **ECU Actual Revenue** (ESU Actual Cost). Breakdowns off all these elements are presented in the following chapters.

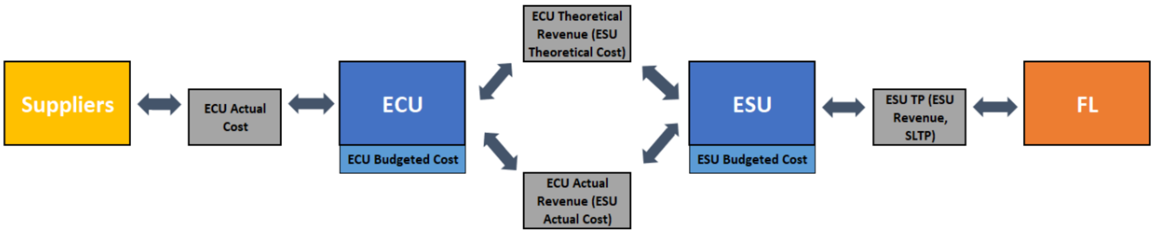


Figure 17. Simplified Price Data Relation.

5.3.1 ESU Transfer Price (SLTP) Structure

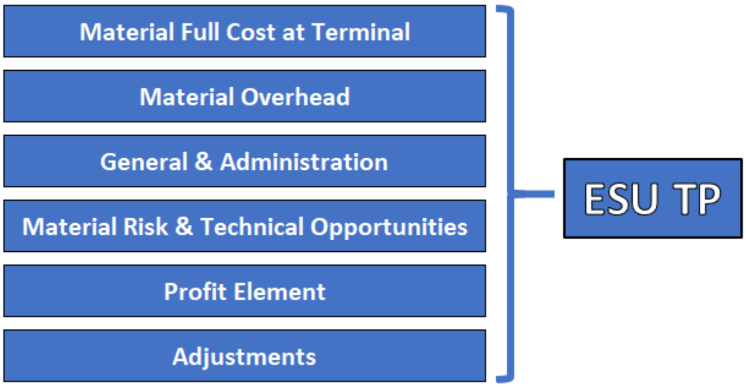


Figure 18. ESU Transfer Price Structure.

The **ESU Transfer Price** consists of full material cost at terminal, material overhead, general and administration costs, material risk and technical opportunities elements, profit element and adjustments. The relation of these components is not presented due to confidentiality reasons. The factors and figures, excluding the material cost, which is car specific, are predetermined for a given period. The final total ESU transfer price, or SLTP, indicates the monetary amount received from the front line to ESU for a delivered car.

5.3.2 ESU Budgeted Cost Structure

$$ESU\ Budgeted\ Cost = \frac{A - Process\ TP}{A - Process\ Total\ MU} + \frac{Car\ C\ Impact\ TP}{C - process\ MU} \quad (6)$$

The **ESU Budgeted Cost** consists of the A-process KTOC TP without a total markup and the Car C Impact without a C-process markup. The A-process TP is divided by the A-process Total MU Factor and the Car C Impact by the C-process markup factor to normalize the values, which after the two are summed together to form the ESU Budgeted Cost. This is a simplified version of the actual calculation formula, as the way of handling delta costs, prices and markups is varying from case by case. As it is troublesome to track which markups have been used in individual cases, an approximation value is being used. The ESU Budgeted cost indicates the monetary value the tender engineer has forecasted or budgeted as expenditure for ESU for a specific car, which is based on their approximation of the cost incurred for ECU of manufacturing a car. In other words, the tender engineer estimates what are the costs for ECU to manufacture a car, and by using that value, estimates what is the total cost for ESU to receive the car from ECU after adding an internal profit element used for transactions between ECU and ESU (ECU Fixed Profit Factor). This results as the car's ESU Budgeted Cost.

5.3.3 ECU Actual Cost Structure

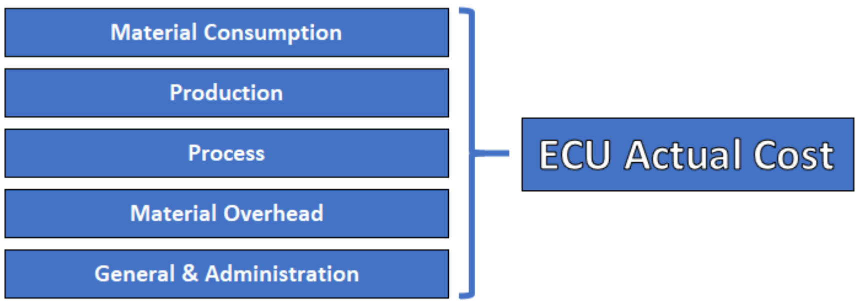


Figure 19. ESU Actual Cost Structure.

The **ECU Actual Cost** is derived directly from Qlik Sense and is divided into five components: material consumption-, production-, process-, material overhead- and G&A costs. Material consumption costs refer to direct material costs incurred in the car production, whereas production costs are labor costs accumulated in the production. Process costs include, for example, the costs of indirect operatives, staff, facility, and other indirect costs that are not directly related to production. Material overhead covers other material costs that do not have a predetermined **BOM** line item, such as packing materials and inbound logistic costs. Finally, the G&A costs are incurred in the day-to-day operations but are not directly tied to a specific function. These components together form the ECU Actual Cost, which is the monetary amount ECU spends to manufacture a specific car.

5.3.4 ECU Theoretical Revenue Structure

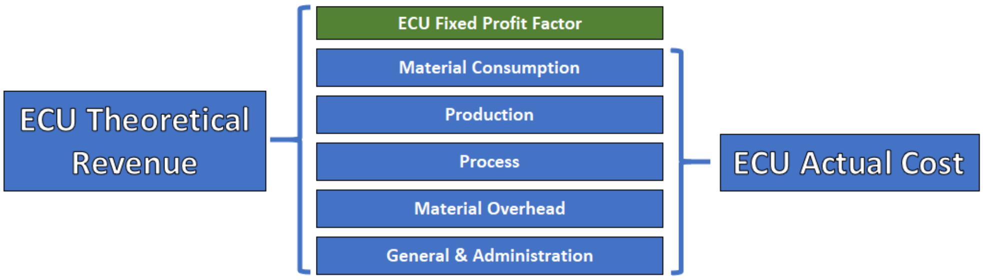


Figure 20. ECU Theoretical Revenue Structure.

As the intention is to evaluate budgeting accuracy in the cost variation analysis, it is required to compare the budgeted costs with actual costs. Initially, it may seem feasible to use the ESU Budgeted Cost and actual ESU-level costs (ESU Actual Cost) for this comparison. However, although this evaluation would disclose the factual total cost variation value, it is not necessarily a legitimate way to approach this issue. ESU Actual Cost is derived directly from ECU *Budgeted* (planned) Cost, and by utilizing this cost element in the equation, would mean that a value which is based on an intermediate approximation and a forecast is utilized.

To eliminate this problem, the ESU Theoretical Cost (also **ECU Theoretical Revenue**) is calculated and used in the cost variation comparison. The ESU Theoretical Cost is derived in retrospect from the ECU *Actual* Cost, to which an internal transaction profit element is added, which finally gives a total value that represents the total monetary value the car should have cost for ESU, in case ECU would have billed ESU with perfect accuracy. To allow the ESU Theoretical Cost and ESU Actual Cost to be equivalent, it would require that ECU budgets their costs precisely before production, which is not likely as there are several variables and unknown elements involved still in the pre-production phase. However, the ESU Theoretical Cost can nevertheless be used in the ESU cost variation analysis to determine ESU Budgeting Accuracy.

5.3.5 ECU Budgeted Cost Structure

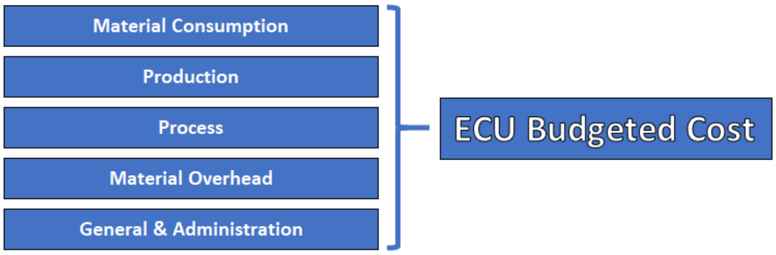


Figure 21. ECU Budgeted Cost Structure.

The **ECU Budgeted Cost** is not directly available as a record, and therefore must be derived from the ECU Actual Revenue. However, as a matter of fact, in practice the ECU Actual Revenue is based on ECU Budgeted Cost, not the other way around. As the ECU Actual Revenue is a known value and the ECU Budgeted Cost is not, it is required to execute this backwards operation. The difference between the two figures is that ECU Actual Revenue includes an internal transaction profit element. Therefore, by eliminating the profit element from the ECU Actual Revenue, the ECU Budgeted Cost for each car as an output is received. The ECU Budgeted cost is the cost budget ECU has established for a car and consists of the same components as ECU Actual Cost, except that the values are pre-production estimations, not actualized values. Therefore, budgeted costs are not always equal to actual costs.

5.3.6 ECU Actual Revenue Structure

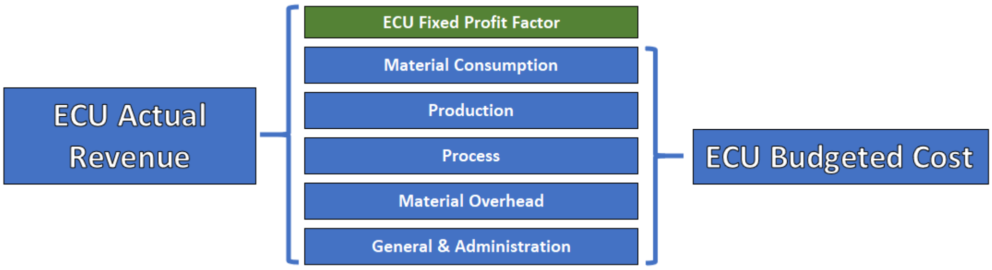


Figure 22. ECU Actual Revenue Structure.

The **ECU Actual Revenue** (also ESU Actual Cost), which is obtained from the production and engineering Qlik Sense extract directly, is the ECU Budgeted cost plus the ECU Fixed Profit Factor calculated by the ECU themselves. This value essentially is the price transferred from ESU to ECU as a payment for the car that ECU delivers for ESU. In other words, it is an internal price ESU pays ECU to buy the elevator car. Initially, ECU Actual Cost added with the ECU profit factor should be equal to the ECU Actual Revenue in tender price calculations. However, in terms of real-life figures, this is not the case as ECU also estimates the ECU costs on their end before production, and this forecast consequently forms the ECU Actual Revenue (ESU Actual Cost). This estimate can either exceed, be less or equal as the ECU Theoretical Revenue (ESU Theoretical Cost).

The difference between ECU Actual Revenue and ECU Theoretical Revenue, is that the actual revenue is the real-life value that has been transacted based on ECU's own budgeted costs, whereas as mentioned earlier, the theoretical revenue represents the amount that should have been transacted and is derived in retrospect from actual ECU costs. This may lead to a condition where ECU has forecasted their costs to be lower (for example 900) than the actual costs (1000), and therefore, it may appear that on the ESU side, the tender engineer forecast has not been accurate, although the estimate (1000) would be spot-on. This deviation is caused by a loss on ECU side (900 – 1000 = -100) created by the under-estimated ECU cost budget made by ECU, which leads to a loss of 100 on the ECU side, but to a profit of 100 on the ESU side. On the other hand, if ECU budgets the ECU cost higher than the ECU Actual Cost, this appears as a loss on the ESU side but profit on the ECU side. Therefore, instead of using ECU Actual Revenue in the cost variation calculations, the ECU Theoretical Revenue is used so that the tender engineer price forecast accuracy is evaluated correctly using comparable values. The tender engineer's goal is to budget the costs as accurately as possible, not to maximize the ESU profit to the detriment of ECU's profitability.

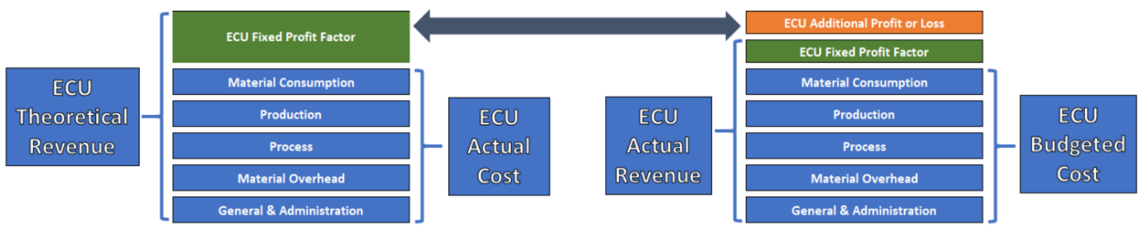


Figure 23. ECU Theoretical Revenue vs. ECU Actual Revenue

5.4 Analysis

With the data pre-processing and merging operations, a foundation for the data analysis is now established. In the next step the analysis approach and the areas to be analyzed in the scope of the project are determined. The two main study areas are **cost variation dynamics** and **profitability analysis**.

5.4.1 Cost Variation

The main goal of the cost variation review is to determine how well budgeted costs align with actual costs for individual car modules. The denomination for this action used is cost variation or budge accuracy analysis, where variation determines the difference between actual and budgeted costs. As discussed in the competitive-bidding strategy chapter, an important relation between estimated and incurred costs exists in competitive bidding environments, but also in this empirical case in terms of optimizing performance. In the theory example, a general formula could be used to find the bid with the highest expected profits, whereas in this analysis, the goal is to find the procedures to narrow down the variation between estimated and incurred costs. Therefore, although the conditions in these cases are not fully comparable, the emphasis is put on the estimated-incurred cost relation. In this analysis, the **ESU Budgeted Cost** and **ESU Theoretical Cost** are reviewed and compared to each other.

To get an overview of the cost variation for the population of the 65 cars, a simple value comparison between the budget and actual costs for every car is done. This represents the ESU Budgeting accuracy in monetary values and is presented in Figure 24. Graph and axis values are hidden for confidentiality reasons. The black line indicates the point where cost variation is zero, indicating where budgeted costs are equal to actual costs. In case the costs fall below the budget, the result most likely is positive. In that case the data point is located on the right side of the black line. On the other hand, if the costs are higher than the budget, the result is most likely negative, and the data point is on the left side. This, however, is not an absolute implication as the cost element here consists of also other components than purely costs. Therefore, although budget would be exceeded, there may still be profit generated. The visualization however provides a general overview of the project population budget accuracy.

$$ESU\ Budgeted\ Cost - ESU\ Theoretical\ Cost \quad (7)$$

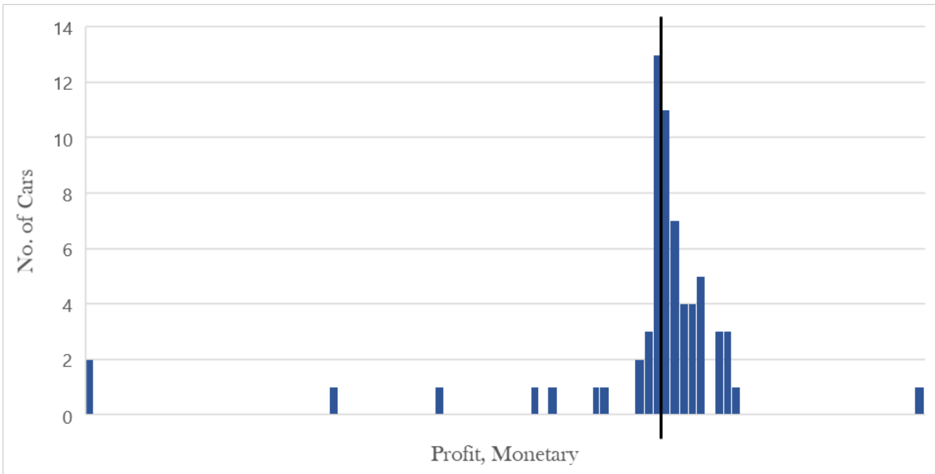


Figure 24. ESU Budget Accuracy, Monetary Values.

The visualization indicates that there are cases on both ends of the spectrum that significantly deviate from the major population. These samples can be described as outliers, as the definition by (Maddala, 1992, p. 89) for an outlier is as follows "*An outlier is an observation that lies in abnormal distance from other values in a random sample from a population.*" These samples need some degrees of attention for two reasons. Firstly, as the object is to gain comprehensive understanding of the whole population of cars, their cost variation and characteristics that may cause deviation in costs and profits, it may require us to exclude these samples as outliers may negatively bias the result of the analysis. The bias could be a result of incorrect calculations, inaccurate distribution of costs among the sales documents under a project or some other reasons that are unknown at this stage. With this action, it is also possible to reduce the influence of coincidence, in case extraordinary factors have had an impact in the pricing process.

Secondly, on the other hand, it may be that these samples have in fact had profit levels the visualization demonstrates, which justifies their inclusion in the analysis as part of the major population. In that case, extremely valuable insights could be derived from those cases to be used as process development input in car pricing to enable better car pricing accuracy, and therefore, less variation in profitability. As the goal is to gain a comprehensive understanding of wide range of cases, development actions to more challenging areas on a larger scale can be targeted without focusing on trivial peculiarities that don't have critical, long-term impact. For example, if a particular car type tends to be consistently underpriced, more attention should be focused on this recurrence rather than on individual, one-of-a-kind cases that are not priced accordingly. All cases, however, without a doubt are valuable material for future benchmarking purposes but discoveries can - and should be - prioritized by their long-term financial impact on the business.

For the reasons mentioned above, outliers will be excluded from the analysis in certain parts of the study and some samples will be taken under more explicit review in the following chapters, in case it is expected to find beneficial insights through the reviews. Utilizing these reviews, the aspiration is to determine what are the causes for significant under- or overpricing, or if there are other factors that cause considerable fluctuation.

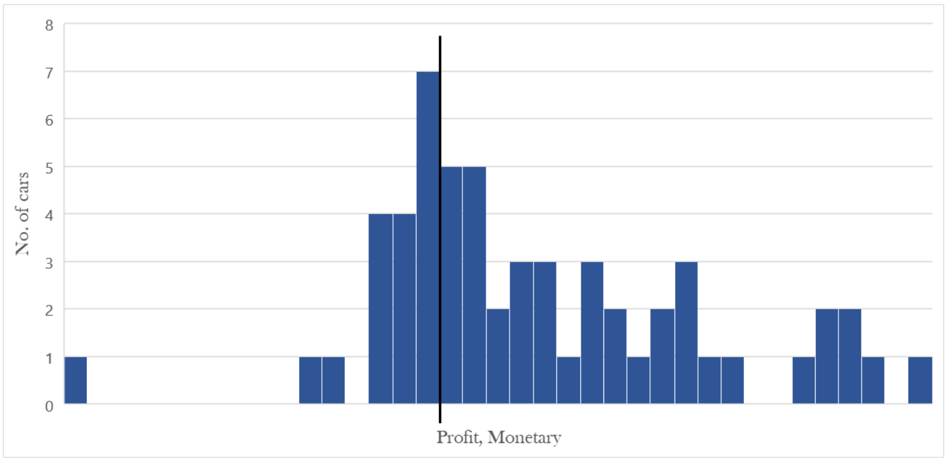


Figure 25. ESU Budget Accuracy, Outliers Excluded.

In Figure 25, the same dataset is utilized as in Figure 24 with the exception that outlier samples have been removed. These outlier samples were selected purely based on visual inspection for exploratory data analysis purposes, to allow a simple surface-level review of the dataset. The base data for these figures is not being used as an actual **KPI** or for any further analysis as the monetary profit is intrinsically dependent on the total cost of the car. Therefore, only certain visual observations are made with these graphs and no actual analysis findings are made based on them.

Through a basic inspection of the latter visualization, it is observable that most cars tend to be slightly overpriced but the monetary range for underpriced cases is a lot wider compared to overpriced correspondents. As it's not viable to make definitive implications without presenting true values or considering the vicinity of the car's total costs, the cost variations are inspected with relative figures to have more abilities for further analysis. By doing this, the pricing error can be normalized with respect to the price level of the elevator car. To demonstrate the issue of using absolute values, a comparison of two elevator cars with monetary values of 1 000 and 100 000 euros can be made. If in both cases the budget fluctuation is 100 euros and by considering only this amount of deviation, it would seem like the difference between the budgeted and actual cost is not that crucial, and it would also be equal for both cars. However, in relative figures the impact of that under- or overvaluation is significant for the lower priced car but not that considerable for the higher priced car (10 % versus 0.1 % error). Therefore, the use of relative figures is justified.

The relative analysis is conducted for the total population, including the previously visually classified outliers. By dividing the Theoretical ESU Cost with Budgeted ESU Cost, it is detectable how supposed actual costs have relatively matched with tendering phase cost forecasting. This review could also be done the other way around by dividing the Budgeted ESU Cost with Theoretical ESU Cost, which would indicate how much our budgeted cost has deviated from actual costs. However, as the interest is to promote ESU-level pricing accuracy, the budget is used as the baseline to which the supposed actual costs are compared to.

$$ESU\ Budget\ Accuracy\ Factor = \frac{ESU\ Theoretical\ Cost}{ESU\ Budgeted\ Cost} \tag{8}$$

For every individual car sample, a pricing accuracy factor of > 1 indicates that actual cost has exceeded the tendering phase forecasted cost for that specific car, whereas a factor of < 1 determines that actual costs have eventually been below forecasted. The closer the factor is to value 1, the more accurate the budgeting, and therefore, car pricing has been.

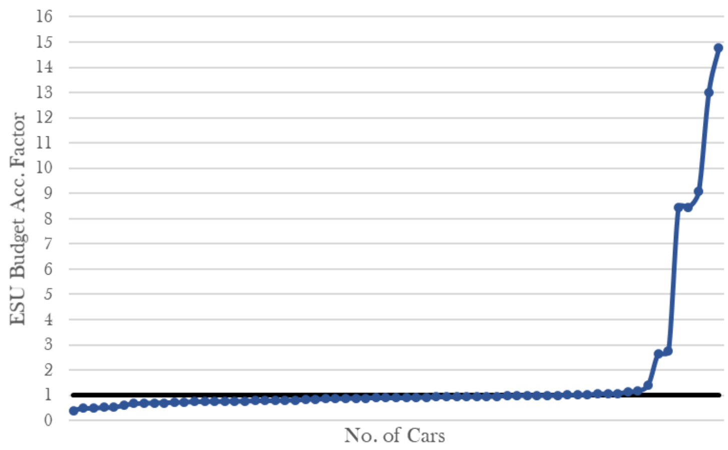


Figure 26. ESU Budget Accuracy Factor.

An alternative way to approach the budget accuracy inspection is by measuring the budget accuracy error percentage. The variables used are the same as for ESU Budgeting Accuracy Factor calculations above, with the exception that the difference of the budgeted cost and the theoretical cost is divided with the budgeted cost.

$$ESU\ Budg.Acc., error\ \% = \frac{ESU\ Budgeted\ Cost - ESU\ Theoretical\ Cost}{ESU\ Budgeted\ Cost} * 100 \qquad (9)$$

This operation gives the budget accuracy error percentage for each car, indicating how greatly the budgeted cost deviates relatively from the theoretical cost. If the value for the error percentage is negative, the theoretical cost has exceeded the budgeted cost and if positive, the theoretical cost has been below budgeted cost. Initially, a negative sign indicates that the ESU-level profit is also negative and positive that profit is positive. This is a more intuitive approach compared to the ESU Budgeting Accuracy Factor key figure, as the value sign now also directly indicates the profitability aspect: negative error percentage sign implicates initial loss and positive sign initial profit on the ESU-level. The closer the percentage is to 0, the higher the budget accuracy is. The same figure can be derived directly from the ESU Budgeting Accuracy factor with the following operation: 1 – ESU Budgeting Accuracy Factor.

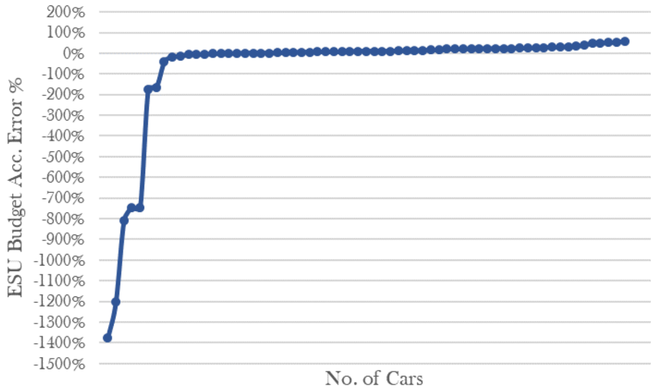
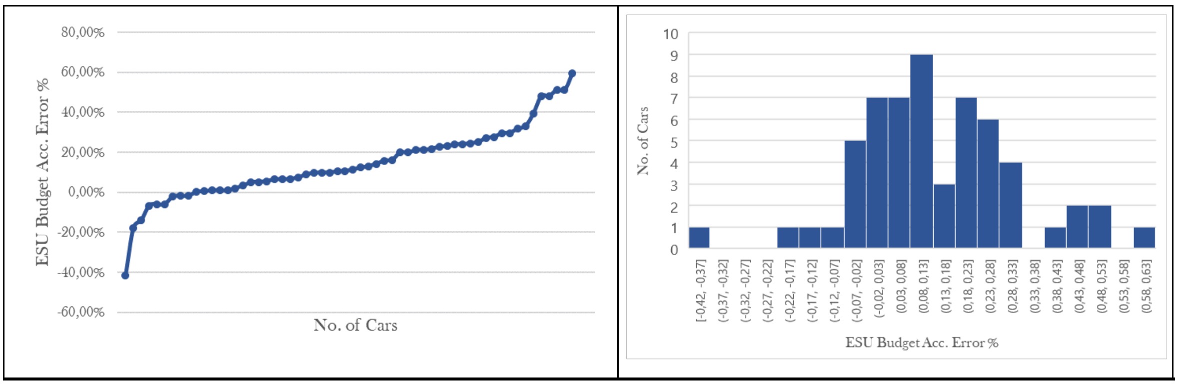


Figure 27. ESU Budget Accuracy Error %.

As visualized by Figure 26 and Figure 27, it is directly observable that out of the 65 total car population, there are seven (7) samples that have had significant inaccuracies in budgeting considering the total population. The budget accuracy error percentage as decimal for all these cars have exceeded the value of -1.66 (-166 %), while the highest has a value of -13.76 (-1376 %). In other words, the budgeting error for these cars has been at least 1.66 times more than the budgeted cost.

Next, these considerably deviating samples are excluded from the review to have a clearer overview of a sample group. Thereof, the new sample data contains 58 cars. This allows for visualizations on how accuracy has varied more closely around the ideal budget accuracy error percentage value of 0 %.



a) Scatter Plot b) Histogram

Figure 28. ESU Budget Accuracy Error %, Filtered Data.

As visualized by the charts in Figure 28, the 58-car sample pricing accuracy is relatively normally distributed. The error percentage ranges between -42 % and 60 %. Overall, in the sample data, 84 % of the cars have had lower actual costs than budgeted costs (budget accuracy error percentage > 0), which signals that most delivered cars in regular cases are overpriced, implicating that initially these cars should have been profitable for ESU. It may not always be the case as given discounts or other factors may disrupt the final figures. Overpricing in this context means, that actual costs have been below budgeted costs and underpricing, that actual costs have been above budgeted. A more comprehensive profitability analysis will be conducted in the following chapter.

Returning to the total population of 65 elevator cars, 49 (75 %) cars' actual costs were below what was budgeted in the tendering phase. More specifically, most of these overpriced cases tend to be overvalued only slightly or moderately, whereas in the case of underpriced cars the distribution is more spread out between slightly and significantly. The difference in these values can be detected by inspecting Figure 27: the budget accuracy error percentage range as decimals for undervalued cars has been [-13.76, -0.02] and for overvalued cars [0.001, 0.60]. To put in perspective through a comparison, having a car with a budgeted cost of 1000 euros, these lowest and highest error percentages give us an error of -13 760 and 600 euros. Therefore, relatively there has been more pricing accuracy variation in the undervalued cars. The dataset contains seven (7) samples that have been considerably undervalued and five (5) samples that have been to some extent overvalued (budget accuracy error percentage as decimals < -1.5 and > 0.4 respectively).

Table 2: Data Points with High ESU Budget Accuracy Error %.

Sales Document Number	Pricing Accuracy Factor	Sales Document Number	Pricing Accuracy Factor
350407785	-1,66	350412380	0,48
350466249	-1,74	350412386	0,48
350464955	-7,45	350412378	0,51
350464954	-7,45	350412383	0,51
350438147	-8,08	350377227	0,60
350449121	-12,00		
350438148	-13,76		

Table 2 represents cars that have been exceptionally under- or overvalued in the tendering phase budgeting. These twelve (12) cars will be taken into further review at the end of the data analysis chapter to determine if there are collective factors that are occurring for these specific cars that cause price fluctuation in the forecasts.

For the dataset of the total car population, the ESU-level price variation mean and standard deviation are calculated by comparing tender phase budgeted costs and theoretical actual costs. At this stage, the calculations are performed for both the total car population, but also for the sample set where samples presented in Table 2 have been excluded. Hence, comparisons between the datasets can be done, which consequently allows to gain insights on two types of sets: for the total population which includes all reviewed cases, and for a sample set which includes cases that can be described being of standard nature that represent the major population.

The mean $\bar{x}$ of the total population (65 samples) and therefore an average deviation in tendering phase cost forecasting is ≈ -68 % and the standard deviation $\sigma \approx 274$ %. This indicates that throughout the total population, car price budgeting on average has been undervaluing the car prices and the variation around the mean is rather significant. However, as observable in the figures presented earlier, there are two factors that may bias these values. Firstly, the outlier samples can have a heavy impact on the outcome as the utilized population size is rather narrow. Secondly, there is more deviation in the prices in the lower end of the spectrum, which ultimately pulls the mean towards the negative side. Therefore, additional calculations for the sample set will be performed. This is justified by leaning on the awareness that some of the outlier samples could be inaccurate or erroneous, as stated earlier.

The mean $\bar{x}$ of the sample set (58 samples) is ≈ 14 % and the standard deviation $\sigma \approx 18$ %. Self-evidently, the standard deviation or variation of the samples around the mean is much narrower than in the case of the total population as outliers are not included. What is also to be noted is that the average deviation in car pricing is a lot higher and on the positive side. Leaning on these findings, it can be assumed that majority of the custom cars have been priced accordingly, but if a car is inaccurately priced, the deviation is rather substantial and most likely has a negative profitability impact. However, this is not absolute as other factors, such as ECU-level profit, also influence the final ESU-level profit. Generally, the total population of A- and C-process cars deviates less than the population of purely C-process cars. This is mainly caused by the inaccuracy of C-process pricing, as there are a lot more uncertain and unknown factors involved, compared to A-process pricing where standard prices are utilized. As mentioned earlier, by aiming to find recurring attributes in cars where budgeting has been inaccurate, more attention can be focused on those type of cases, which additionally, reduces variation and increases budget accuracy.

As the ESU budget accuracy is now evaluated, the same can be done for the equivalent ECU budget accuracy. As demonstrated in chapter *5.3.5 ECU Budgeted Cost Structure*, the ECU Budgeted Cost is derived from ECU Actual Revenue as the latter is directly available from the data extracts. In reality, the ECU Actual Revenue is derived by summing ECU Budgeted Cost and an internal transaction profit element together. The ECU budget accuracy inspection is a valid evaluation to perform as ECU budgeting plays an essential role in how much profit ECU makes through internal transfer pricing, which continually, influences the profitability of ESU budgeting.

For this analysis ECU Budgeted Cost and ECU Actual Cost are used to determine the ECU Budgeting Accuracy error percentage. Previously, in the ESU-level calculations, ESU Theoretical Cost (ECU Theoretical Revenue) was used as incurred cost, which is based on ECU Actual Cost after eliminating the internal profit element. In ECU-level review, the ECU Actual Cost should be used to determine the ECU Budgeting Accuracy as the ECU Actual Cost is the true cost incurred on the ECU-level, which was not true in ESU-level calculations. The sample for this analysis is the total population of 65 cars.

$$ECU\ Budg. Acc. error\ \% = \frac{ECU\ Budgeted\ Cost - ECU\ Actual\ Cost}{ECU\ Budgeted\ Cost} * 100 \qquad (10)$$

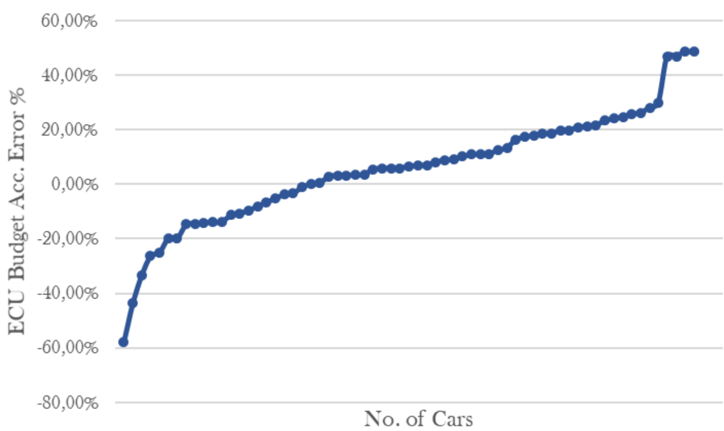


Figure 29. ECU Budget Accuracy Error % Scatter Plot.

Identically as for ESU car pricing accuracy, an error percentage of > 0 suggests that incurred cost has been below the budgeted cost for that specific car, whereas a factor of < 0 determines that actual cost has exceeded the budgeted cost. The closer the factor is to value 0, the more accurate the budgeting has been.

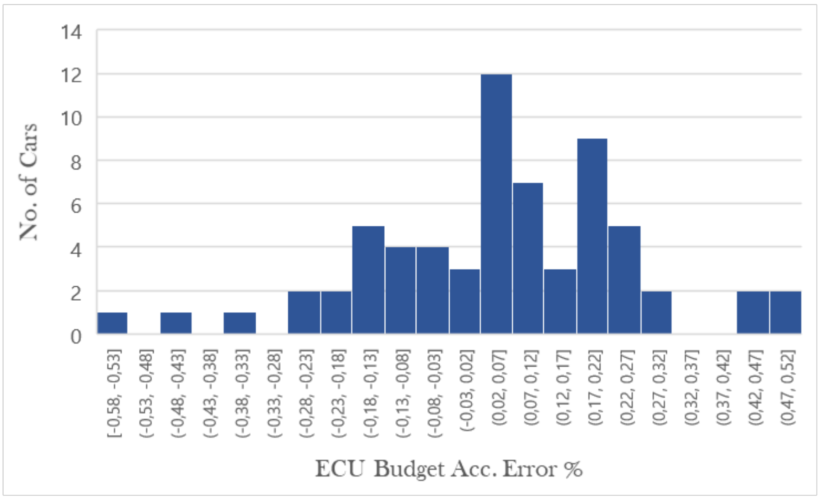
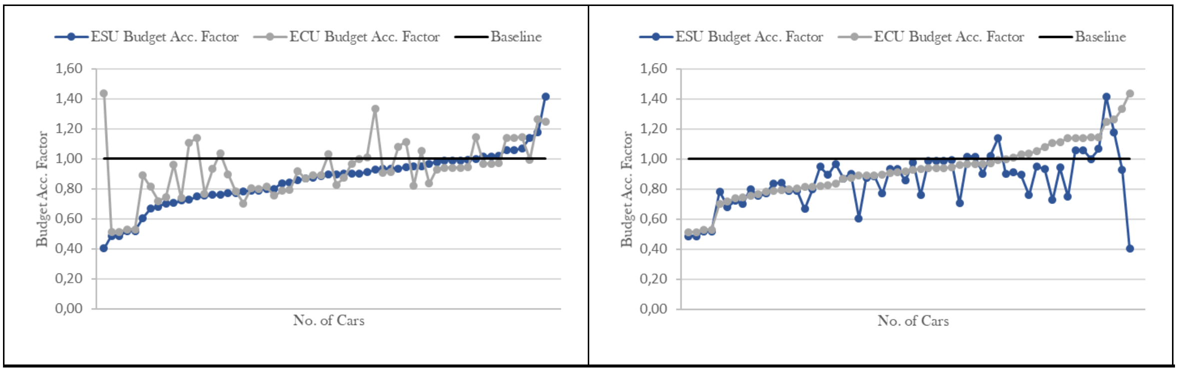


Figure 30. ECU Budget Accuracy Error %, Histogram.

The visualizations illustrate that 44 out of 65 cars (67,7 %) were overbudgeted by ECU, while on the ESU side the percentage was 75. Also, by simply comparing the charts, ECU seems to be more consistent with their price forecasts than ESU tendering. The samples are concentrated in a narrower space, except four (4) cars have been significantly overpriced relative to most samples. A detailed inspection of cars with inconsistencies discovered on the ECU side are out of the scope of this study, as the main priority is to support ESU car pricing processes. However, a comparison between ESU and ECU forecasting is being undertaken for benchmarking purposes.

The mean $\bar{x}$ of the ECU budget accuracy for the total population is ≈ 6 % while the standard deviation σ is ≈ 20 %. As can be seen, the average deviation of ECU forecasting around the mean has been considerably more accurate than on the ESU side for the total population (ESU σ ≈ 274 %). This could be due to several reasons, such as more detailed car-specific information and resources available in the ECU budgeting phase, as ESU budget pricing is done for all prospect elevators and cars, while ECU conducts calculations only for confirmed car deliveries.



a) ESU as baseline b) ECU as baseline

Figure 31. ESU vs. ECU Budget Accuracy Factor Comparison.

For the ESU and ECU budget accuracy comparison, the sample data of 58 cars is used as the outliers have an unnecessarily significant impact on the readability of the charts and the comparison. By including the outliers, the Y-axis is stretched out substantially which makes it difficult to compare individual ECU and ESU data points. Therefore, they are excluded from this part of the analysis. As the ESU and ECU budget error percentages are compared side by side, it is detectable that when ESU has moderately overbudgeted the cost, ECU has been more consistent with their evaluation in those cases. Otherwise, the visualizations don't implicate other significant differences in budget accuracy errors that could be caused by recurring phenomena. What is to be noted is that ESU and ECU have been consistently rather uniform with their budgeting, meaning that if either of the budget has been overvaluing or undervaluing the costs, the other party's budgeting has been equivalent. To simplify this implication, if the ESU budget accuracy error percentage has been positive, it has mostly been also positive at ECU-level and vice versa.

For cost variation in general, ESU tendering car pricing performs relatively consistently. Although pricing accuracy doesn't include substantial variation if outliers presented in Table 2 are excluded, the accuracy is still not on a level to be considered satisfactory. This gives confidence in finding the causes for deviation in these special cases in the following chapters, to implement process development actions in car budgeting processes. These actions are projected to enable even more consistent car pricing in the future.

5.4.2 Profitability

In addition to the cost variation dynamic analysis, the second main interest in the study is to determine the profitability of C-process car deliveries. The goal is not to find single cases that have been exceptionally profitable or unprofitable, but instead to find phenomena or reoccurring characteristics that cause these cars to be abnormally profitable or unprofitable. This analysis is only conducted for ESU-level profitability, and therefore, ESU revenue (ESU TP) and ESU Theoretical Cost are being utilized.

$$Profit\ per\ car = ESU\ TP - ESU\ Theoretical\ Cost \tag{11}$$

$$Profit\ Margin\ per\ car = \frac{ESU\ TP - ESU\ Theoretical\ Cost}{ESU\ TP} \tag{12}$$

As shown in the equations, the ESU Theoretical Cost (ECU Theoretical Revenue) is used similarly to the cost variation calculations. Again, ESU Actual Cost (ECU Actual Revenue) could be used instead, which would then represent the actual, real-life profitability of a specific car. However, by using the theoretical cost, the ECU interphase can be eliminated and through that, an understanding can be gained of what the profit level on the ESU-level budgeting should have been. This gives more accurate indication on how ESU-level budgeting performs, which on the other hand, benefits process improvement actions.

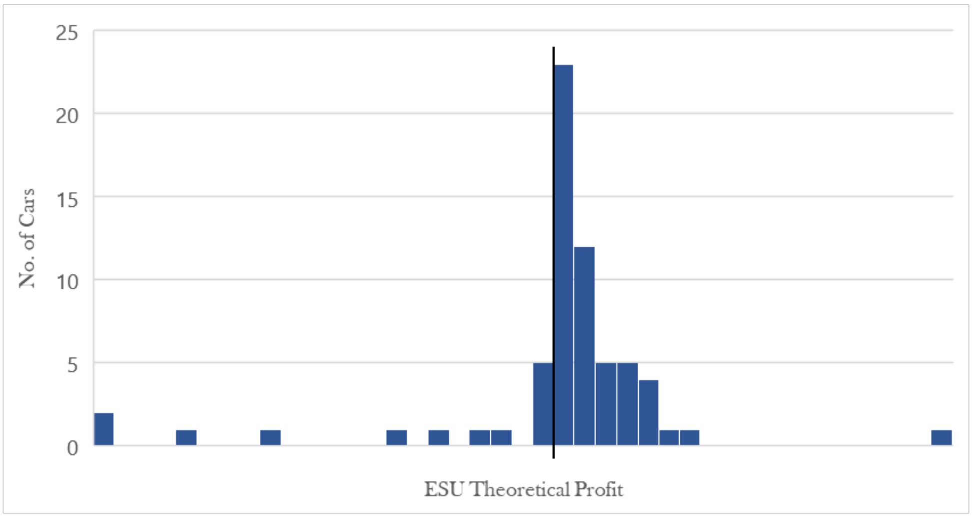


Figure 32. ESU Theoretical Profit per Car, Monetary Values.

As visualized by Figure 32, most of the cars have been either slightly or moderately profitable or unprofitable for ESU. The black line indicates where zero profit point is located. There is one (1) exceptionally profitable and four (4) unprofitable cars that have had a significant absolute profit deviation. With a quick cross-check, it is detectable that the same cars (sales documents **350377227, 35046954, 350464955, 350407785** and **350449121**) can be found from Table 2 in the cost variation analysis chapter, indicating that these samples that have had significant profitability deviation, have also had substantial cost variation. It can be seen to some extent self-evident as the more inaccurate the ESU budgeting is, the more ESU Revenue deviates from actual costs.

As a shift from absolute value comparison to relative profit margin analysis is performed, sales documents **350438147, 350438148** and **350449121** emerge from the population, containing profit margin factors of -161, -92 and 17982 respectively. The first two samples also have a C Car Impact value equal to their Transfer Price value, which does not seem like a standard condition. The third one has an ESU Transfer Price value of 0. These unconventional profit margin factors most likely indicate that there are some arranges made in the calculations and pricing that cause the fluctuation. As the variations are so substantial, these samples can be determined as outliers and will be excluded from this part of the analysis to prevent biased results. This leaves us with a sample set of 62 cars.

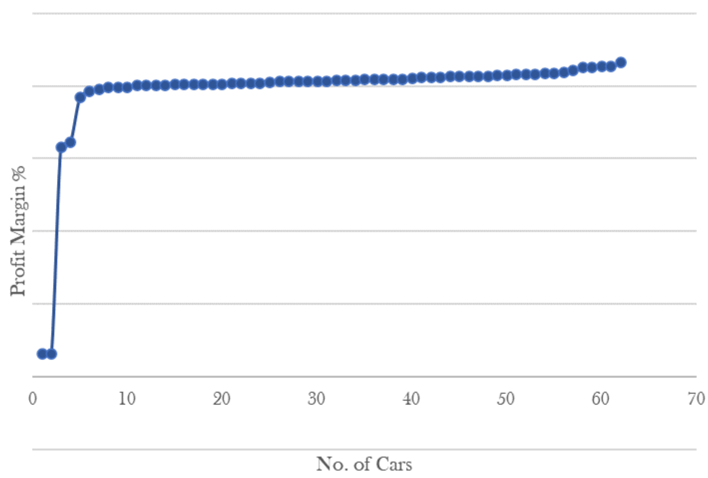
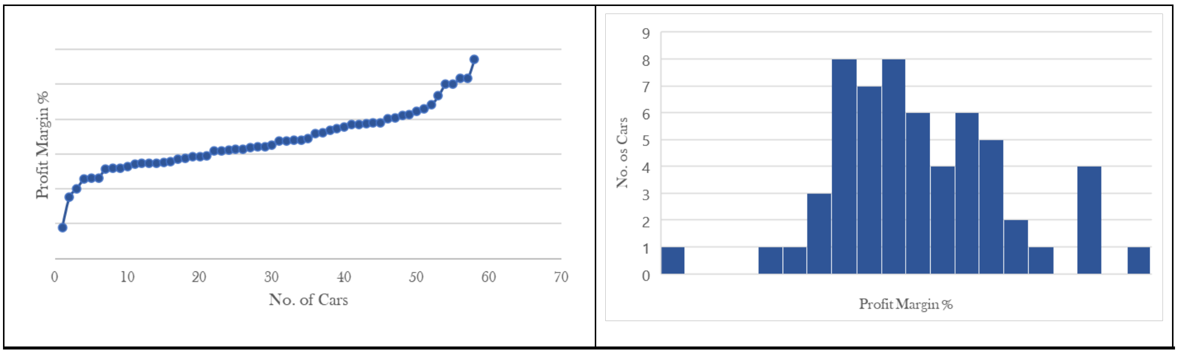


*Figure 33. ESU Profit Margin %, Outliers Excluded.**

By observing the data without the outliers, it is noticeable that four (4) cars out of sixty-two (62) cars have been abnormally unprofitable for ESU in terms of the profit margin (sales

Y-axis not in scale, gridlines randomized* documents **350438147, 350438148, 350466249 and **350407785**). The first two cars are under the same project, whereas there is no relation with the other cars. All these cars can also be found from Figure 27 as outlier samples, and therefore, will be reviewed in later chapters.

As presented by the visualizations in Figure 34, the outliers and abnormally unprofitable cars specified above have been excluded. These visualizations of the filtered 58 car sample demonstrate the performance level ESU budgeting has when unconventional samples have been excluded from the review.



a) Scatter Plot b) Histogram

*Figure 34. ESU Profit Margin %, Outliers and Abnormal Data Points Excluded.**

In the case of the 58-car sample set where the outliers and abnormally unprofitable cars have been excluded, general profitability key figures can be calculated. The standard deviation for the sample set is σ ≈ 18 %, which indicates that based on the sample data, the profit varies on average ± 18 %. This sample set standard deviation is not that significant compared to the standard deviation of the total population, which is σ ≈ 273 %. This is rather substantial and is also inflated by the abnormally unprofitable and profitable samples as the population sample size is relatively narrow. Although the sample set findings would indicate that the average profit variation is moderate, there is still room for improvement. Initiating efforts to make the cost variation narrower would plausibly also benefit financial performance, as it would aid in making the profit deviation narrower, and therefore, allow for more financial controllability.

Due to confidentiality reasons, more comprehensive analysis of the profit levels is excluded. As mentioned earlier, the profit review results may, and with high probability will differ from the actual, real-life figures as in this review the ECU interphase has been eliminated. In case ECU profit for all cars in the sample set would be equal to 0, the data would then represent the actual, real-life conditions. However, as Hyvinkää car factory (NCD,

**Axes not in scale, gridlines randomized*

ECU) and the ESU supply unit (SOF, MP) operate under the same company, the financial impact on corporate level is invariable after all.

5.4.3 Engineering Impact Review

In addition to the material costs of a car, another cost element is the incurred engineering costs. These costs are based on the number of hours spent for certain engineering activities. The reason the engineering costs are measured in budgeted and incurred hours, rather than monetary values, is that from the tendering perspective it is more relevant to understand the deviation of hours, rather than the shared effect of hours and a variable hourly rate. Therefore, the review can be simplified by excluding the effect of a changing monetary variable. The engineering impact review is appealing to perform as it may aid in detecting cars with common characteristics that continuously require significant amount of engineering work. This knowledge furthermore benefits further analysis work in understanding which car characteristics are driving the car price in terms of engineering. For example, if the data indicates that certain car type on average requires considerable amount of engineering work, that information can be utilized as a verification instrument in future tendering activities through benchmarking.

In the engineering data extract, there are 38 matches with cars found in the total analysis car population. The average hours spent for a car in this sample is approximately 17 hours. This can be used as a baseline value when taking other car characteristics into the equation to see how certain car features may have an impact on the level of required engineering work.

As it is intriguing to investigate how certain features may impact on the number of required engineering hours, a review of certain features will be taken under review and car-specific information retrieved from the car characteristics extract. Combining this data with the engineering data extract, a comparison between distinct cars, their physical features and required engineering hours in distinct occurrences can be conducted.

The car characteristics extract contains various car specification features, out of which the following are selected for a review: **car type**, **platform**, **car floor type**, **car size** and the **mass of the car**. As mentioned in the introduction, there are several different car and platform types in KONE's portfolio, for example the HMC and TranSys cars and MiniSpace and TranSys platforms. In this case, the car floor type can be either "light" or "heavy" which indicates how much weight the car floor can withstand. The interest in this review is in detecting if these different classifications have a relation with the engineering work required for the car, which initially should be expected as a car that is exceptionally large, intended for cargo transportation and requires extra reinforcement or is extremely decorated and complex to assemble, should require more engineering work than a standard and more conventional car.

In the sample set, three different car types and two different platforms can be found: HMC, MCD and TranSys cars, and MonoSpace and TranSys platforms. The average engineering hours required for the car types are 11, 20 and 24 hours respectively. For the platforms the corresponding values are 15 hours and 24. It seems like on average an HMC car requires half of the engineering work compared to the other two car types. The same effect can be seen to some extent between the platforms. This can be a result of various reasons, such as difference in complexity level of the elevators or cars in the sample or difference in delivery quantities. The latter can have an effect in the long run if certain car type is being delivered continuously and other ones rarely. Therefore, through learning and getting familiar with the characteristics of a car type which is being manufactured constantly, the required engineering work hours should decrease over time if the car specification remains mostly the same. However, justifying these kinds of phenomena can be difficult through an analysis for a limited timeframe and therefore, the focus is on aspects that can be verified through the explorable data.

Returning to the comparison, it is now known that on average the different car types require a certain level of engineering work. The car type itself may not be the cause but rather the consequence of another feature of the car impacting on the required amount of work. Next, an attempt to find relation between the car type and other features, that could disclose the explanation for the deviation in the required engineering work, is performed. For this review, the car size and mass are taken under review. The size of a car is derived from the known car dimensions (width, depth, and internal height) by calculating the areas for the floor, roof and car walls and adding the areas of these elements together. This results as the total square area for the car shell elements. Consequentially, the higher the car total area, the larger the car itself is. This on the other hand results in more materials being used for the car. The larger the car is, and the more material is being used, presumably more complex the car gets in terms of its structural elements and reinforcement qualifications. Therefore, more engineering work should be needed to make sure all specifications are considered when finally, a fully functioning product is being manufactured.

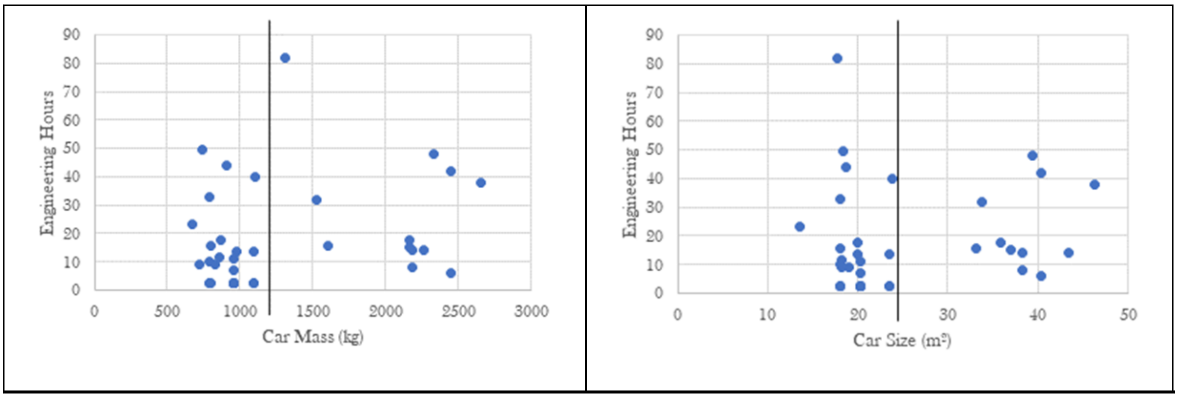
As the cars are not categorized in distinct classes based on their size or mass unlike in the case of elevator or car type, a division of cars based on size and mass into two groups in both instances is done. First, a sample mean for the feature in question is determined to find the average value. The cars are then separated into the two groups based on if their features are below or above this mean value. Now there are two groups in both instances where cars are classified in either of the two categories: above or below average size or mass. Finally, the engineering hour averages can be determined for these groups by including only cars found in that specific category in the calculations. The average car size in the sample set is 25 square meters and the average mass 1281 kilograms.

Table 3: Engineering Hours, Car Size and Mass.

Car Size	
Below Average *(25 m^2)*	Above Average *(25 m^2)*
15.44 *(27 cars)*	**22.72** *(11 cars)*
Car Mass	
Below Average *(1281 kg)*	Above Average *(1281 kg)*
12.88 *(26 cars)*	**27.66** *(12 cars)*

As displayed by Table 3, there seems to be strong relation between the size and mass of the car with the required engineering work. The bigger and heavier the car is, the more engineering work is needed for the manufacturing of that car. Therefore, the car type itself may not be the cause for more work required as the data earlier suggested, but rather the proportions of the car. This relation can be explained by the fact that the average mass of a TranSys car in the sample set is 2091 kilograms whereas it is 996 kilograms and 920 kilograms for MCD and HMC respectively. Of course, at this stage it is challenging with full certainty to prove which feature acts as the driver for the required engineering hours, but in this case with high confidence it can be determined that the proportions of the car are the actual cause and the elevator or car type are more insignificant amplifiers, albeit they would partially create deviation in required engineering hours.

Although the calculations initially display that there is a correlation between the car size and mass with the engineering hours, visualizations can be implemented to determine if the correlation is as strong as it initially seems. First, the car sizes and masses are sorted from smallest to largest and the corresponding engineering hour information for these data points is included. Utilizing this information, graphs that have the engineering hours on the Y-axis and the size or mass characteristic on the X-axis can be created. The black lines indicate the average point dividing the data.



a) Engineering hours per car mass b) Engineering hours per car size

Figure 35. Engineering Hours Distribution.

As Figure 35 demonstrates, the results generally follow the same indications which were presented in Table 3: greater mass and dimensions lead to higher required engineering work. However, the relation between the size or mass of the car and the engineering hours is not as substantial as initially predicted but is still a valid finding which is observable.

Lastly, a review at the car floor type feature is being taken. As mentioned earlier, in the sample set there are cars with either light or heavy floor type, which indicates their ability to carry weight. What is interesting, is that when the average required engineering hours for cars based on these features are calculated, the cars with heavy floor require 19 hours on average, whereas cars with light floor only 7 hours. This is a substantial difference in required work which can also been seen in the financial impact as engineering work is rather costly to arrange. This discovery also supports what was speculated in the previous subsection: the larger the car is and the greater load it is designed to transport, the more engineering hours are required to allow those requirements to be met.

What is to be noted is that heavy floor can be found in 33 out of 38 cars in the sample population and this included all three different car types found in the sample (HMC, MCD, TranSys). However, the five cars that have had a light floor consist of only MCD cars which were rather small (on average 18 square meters) and rather light in mass (average 795 kilograms). This supports the hypothesis that the larger the car is and the greater the mass it is designed to carry is, the more engineering work is needed to manufacture it.

These initial findings are valuable benchmarking figures for future advanced analysis, so that firstly, the amount of engineering work can be allocated more accurately for cars in the tendering phase and that secondly, targets and incentives can be set accordingly in engineering as future performance can be put into perspective with these initial findings. Therefore, as new technologies, practices and techniques are implemented, it can be determined if there has been improvement in engineering performance.

5.4.4 Emerging Case Analysis

In this section a review of emerging cars that stood out in the cost variation and profitability analysis segments is performed. The goal is to inspect and pursuing to find tendencies and common reoccurrences in car specifications that would expose the causes of budget forecast inaccuracies and profit fluctuation in delivery projects. This review is narrowed down to rather surface-level inspection as a thorough analysis on the cars requires substantial amount of manual work and is not beneficial considering the goals of the case company and the project. Based on earlier findings, it was assumed that the higher the cost variation of a car is, the more likely it also has variation in profitability. This hypothesis is tested by reviewing the pricing accuracy factors and profit margin percentages for cars that have had an abnormally low or high pricing accuracy factor.

Table 4: Emerging Cases, High Negative vs. High Positive Budget Accuracy Error %

Sales Document Number	ESU Budget Accuracy, error %	Profit Margin	Sales Document Number	ESU Budget Accuracy, error %	Profit Margin
350464954	-745 %	- -	350424346	39 %	+
350464955	-745 %	- -	350377227	60 %	+
350407785	-166 %	-	350412378	51 %	+
350438147	-808 %	- - -	350412380	48 %	+
350438148	-1376 %	- - - -	350412383	51 %	+
350466249	-174 %	-	350412386	48 %	+
350449121	-1200 %	+ + + +			

By observing Table 4, an initial assumption can be made that when ESU car pricing has significantly undervalued a car, the car is also very unprofitable. Sales document **350449121** is an exception, where costs have been undervalued heavily but the profit has been rather significant. There may be other factors in the elevator specification or in the tender calculations that cause this occurrence in this individual case. However, generally on the contrary, when ESU car pricing has overvalued a car, the profit margin has been profitable but not relatively as considerably as in the case of undervaluation. Therefore, for ESU there are more significant disadvantages of pricing the car under the true costs than there are advantages of overpricing the car, which is to some extent self-explanatory. Therefore, the incentive would be to avoid undervaluing the car but also the benefits of pricing the car a lot higher than the actual costs are rather limited, as when cars are priced too high in the tendering phase, the tenders have a higher risk of not being accepted at all, which is not a desired outcome. The more there are rejected tenders and offers, the less opportunities are converted to actual deliveries, and therefore less revenue is generated. Moreover, there are very few benefits of increasing the price level deliberately as accepted tenders with higher prices don't necessarily generate more profit as tendering does not set the customer price. The most optimal approach would be to narrow down the tendering phase cost variation with accurate car pricing and afterwards optimize the price and profit levels through price list adjustments and other actions.

5.4.4.1 High Negative Pricing Accuracy Error Percentage

In this subsection a review of cars that have had a high negative pricing accuracy error percentage is conducted. As shown in Table 4, all but one seem to have substantial negative profit margin percentages. High negative pricing accuracy error percentage for a car means, that the car has been underpriced in the tendering phase, and therefore, offered using a budget assumption that has not covered the actual costs. As already observed in chapter *5.4.2 Profitability,* some of the reasons these cars have relatively unusual profit margin percentages is likely caused by the fact that there have been arrangements made in pricing calculations, documentation or other parts of the data storing processes which make these data points not representative of their actual condition. Through data validation we can observe that out of these seven samples, five (350464954, 350464955, 350438147, 350438148 and 350449121) have negative C Car Impact values, which further lead to negative C-process Transfer Price values. The C Car Impact value indicates the monetary amount spent for C-process modifications for a specific car, indicating ultimately the cost of executing those modifications.

There is no direct explanation available why these sales documents have negative C Car Impact values, as a **positive** value would indicate the value of costs incurred, whereas a negative value would be the opposite of that. One explanation could be that during the tendering phase it has been determined that certain component of a car or elevator is being delivered from another source and, therefore, should not be included in the car specification. In this scenario, it would be required to remove that component from the specification which on the other hand would appear as a negative impact value, since the delta is negative with respect to a standard condition, where the component is included. Nevertheless, the negative values cause a condition where ESU Transfer Price converges to zero as it is a sum of the A-process Transfer Price value and the C-process Transfer Price value, which is based on the C Car Impact value. This also explains the abnormal profit margin percentages for these sales documents as the profit and profit margin percentage calculations are based on inaccurate or incorrect values. All in all, these aspects suggest that some manual adjustments and changes in the documentation have been done, so that the data may not be entirely correct for these samples. As these seems to be special cases where arrangements have been made that we are unaware of at this stage, they will not be examined further.

The two sales documents left in the low pricing accuracy factor group (350407785 and 350466249) have the smallest negative profit margin percentages and ESU Budget Accuracy percentages. Overall, these seem to be valid cases with accurate data so we can take a more detailed look on the characteristics of the cars to see if we are able to find the aspects causing the downside in profitability or ESU cost budgeting. In the case of 350407785, the Car C Impact has been relatively low with respect to the total value of the car. The amount of required engineering work is also moderate and has not exceeded the amount forecasted (2.8 % change from planned work to actual work). However, the data suggests that ECU actual costs have been significantly higher, over double than what was priced in the ESU tendering phase. ECU however has budgeted these costs relatively accurately by budgeting 7 % more than what actual costs were, meaning that ECU made a slight profit for this car. ESU on the other hand made a rather significant loss and most of it due to the substantial material costs, which ESU was not able to price accordingly in the tendering phase. The car is of TranSys type with a rather large car shell and significant amount of load (over 2000 kg), which would indicate that in the tendering phase the significance of these characteristics has not been considered properly, and therefore, material costs have been undervalued.

The second car has almost nonexistent Car C Impact value, so no substantial specialties in the car module have been included. However, there is an extensive amount of engineering work included in this specific car specification. The total costs for ESU compared to the generated revenue is almost double the amount budgeted, which is caused by the ESU budgeted cost being extremely low compared to other similar cars. There could be an error or misjudgment involved when the amount of required engineering work has been forecasted during the tendering phase, as this type of car does not typically require as substantial amount of engineering work as the car under review (over 4 times more). However, the total value of the car is rather low compared to the previous car reviewed, so the actual monetary financial impact is not as substantial on company level.

All in all, in cases where the pricing accuracy factor has been low, there seems to have been misjudgments in the tendering phase regarding the actual amount of material used or engineering work required. It is of course a very challenging task to predict the material usage or required work hours in the tendering phase, as it is all based on forecasts and predictions. The tender engineers have rather limited information about the car available when the price for the car must be set, so it is expected that fluctuation could happen. However, leaning on the findings it could be beneficial to try to promote collaboration between ESU and ECU entities to have more knowledge in the ESU tendering about certain car characteristics that could cause fluctuation compared to the standard amount of costs or engineering work required, so that those aspects could be taken better into account already in the tendering phase.

5.4.4.2 High Positive Pricing Accuracy Error Percentage

The sales documents included in Table 4 representing the high positive pricing accuracy error percentage cases include cars that have been exceptionally overpriced in the tendering phase. The deviation is all these cases fall in a reasonable range (39 percent to 64 percent) compared to the cars in the high negative pricing accuracy. However, the high positive error percentage itself is not seen as an ideal condition as the goal is to have as accurate car pricing as possible, meaning that the closer the error percentage is to 0, the better the tendering phase pricing is performing.

The first two sales documents (350424346 and 350377227) are under separate projects, whereas the last four (350412378, 350412380, 350412383 and 350412386) are all under the same project. The chances of a car's pricing and profitability performances to align with another car's grow when they are under the same project, as in that case they are most likely priced by the same tender engineer using the same principles, background information and tools. Therefore, it is not surprising to find multiple cars under a project to perform similarly. All six cars under these sales documents have relatively low C Car Impact value, except sales document 350377227. The A-process elements cover very little of the total transfer price (only 11 %) as the C-process cover the rest and most of it. In this case, ECU has slightly undervalued the total costs before production, meaning that their revenue from ESU has been lower than the incurred costs. ESU however has made noticeable profits for the car, as detectable in Table 3, which is due to the high tender phase pricing. It seems that this car has been a relatively standard car but with extremely high level of customization as the material consumption for the car is also relatively low. ESU tendering has overestimated the costs of these custom elements, whereas ECU has underestimated them. Benchmarking on cases like this in the future projects with similar cars as in this case, is very valuable for both ESU and ECU, so that future budgeting and pricing could be more accurate.

The other individual five cars under review have been overpriced both on the ESU and ECU level, indicating that both the supply line and the manufacturing have overestimated the required materials and work for the cars. This means that the cars have been either more simple or less customized than originally anticipated. Therefore, ESU has invoiced the front line too much and ECU has done the same for ESU, but nevertheless, both ESU and ECU have made relatively high-level profits for the car. Initially, this may seem ideal as on the whole company level extensive profits are being made, but not in the long run as it indicates that the product is overpriced and will eventually drive away the customers who are paying higher price than what is set by the markets. Therefore, it would be beneficial to understand why these cases have been overpriced to bring the pricing error as low as possible.

5.5 Analysis Summary and Results

In this chapter, an analytical approach to the car module cost variation and profitability financials was taken to see how tendering phase car pricing is currently performing and which car characteristics could have an impact on the car price. A fair amount of pre-processing was required to combine the data extracts compiled from multiple sources to form a coherent and comparable data collection.

In the cost variation analysis, it was found that tendering phase car pricing performs in a rather sustainable matter, meaning that majority of the custom cars are priced accordingly and on average with a slight upside rather than a downside. Namely, in the long run costs do not exceed the corresponding revenue stream which is generated by the tenders delivered out from ESU. However, as already noted previously, based on the cost variation evaluation, the deviation in budgeting accuracy is not on a satisfactory level at this stage. Therefore, the initial analysis results and figures can be used as benchmark values in monitoring tendering quality and the successfulness of tendering process development actions in the future. Additionally, a discovery concerning pricing was made, that when the costs of a car in the tendering phase are undervalued, the deviation can be substantial and may have a great negative impact on the financial performance.

Later, it was found that some of these initially poorly performing cases could be in fact erroneous data and not completely valid to be included as part of KPI benchmarking values for performance measurement. When comparing ESU pricing performance to ECU's performance in equivalent cases, both entities perform relatively identically, except when ESU has moderately overbudgeted costs, ECU have been more consistent with their approximations. This could be a result of ECU having more hands-on knowledge of manufacturing conditions in terms of costs, which would give them better capabilities to forecast incurred costs in production.

Concerning cost variation, ESU car pricing generally performs consistently with an average cost deviation of 14 % and a standard deviation of 18 % (outliers excluded). It is possible that some of the excluded outliers are valid data points, which then would lower the profit margin percentage, but this is a good benchmarking point for future analysis. Another important factor in cost accumulation is the amount of engineering work required. If the car's structure is highly complex or has unusual number of custom elements, the required amount of engineering work grows substantially. Considerable causes to this fluctuation seem to be the size and mass of the car. The larger or heavier the car is, the more engineering work is required, and therefore, more costs are involved in manufacturing a car.

Finally, the emerging cars which stood out in the analysis were inspected more thoroughly. It was discovered that if car pricing is unprofitable or undervalued in the tendering phase, the cause is usually rooted in misestimation of the extent of required raw materials or amount of engineering work required. The same concerns also cars that have been highly profitable or the pricing has been overvalued. Therefore, promoting the understanding of car characteristics that cause challenges in car pricing is valuable in pursuing as accurate car pricing as possible in the future. With accurate car pricing, higher level of profitability can be reached when products are offered with a cost-based price that is accurately estimated.

6 Discussion & Conclusion

In this chapter the goal is to evaluate the successfulness of the project and the developed CCP-tool, and to give suggestions for further tool or process development activities. The intention is to review how well the new tool meets the expectations set for it, whether the goals set for the project were reached, and which aspects could be considered when developing the tool further in the future.

6.1 CCP-tool Review and Further Tool Development

The tool development project was a collaboration of multiple stakeholders, out of which the MSF Tendering team and the SOF Pricing teams were the main participants. The tool building process started with an in-depth review of existing tools and processes to detect the needs, issues, and conditions involved in the current operating environment. As the tool development progressed, continuous feedback was received from the tendering team representatives and other stakeholders to steer the tool design in the right direction, so that the tool would meet the expectations and requirements. The final, implemented version of the tool includes all necessary features and to some extent exceeded the expectations by allowing high level of customizability.

The tool contains functionalities to cover all tendering phase car pricing activities, which were previously scattered in multiple separate tools. Therefore, user competence is now required only for one comprehensive car pricing tool, which makes the daily work in the tendering team a lot easier and less complicated. The use of the tool also does not require any kind of maintenance competence, as the tool is managed and updated separately by the SOF Pricing Team. Also, advanced understanding of the tool fundamentals is not needed for price list updating actions. Hence, the stakeholder roles and responsibilities are now clearly coordinated: users in the tendering department can focus on the usage of the tool, whereas the Pricing Team has an administrational role and is responsible of maintaining the tool and the background prices and cost data.

Although the CCP-tool enables a lot more flexibility and customizability compared to previous solutions, it is bound by the limitations of the Microsoft Excel software. Therefore, some desirable optional features were not implemented in the creation of the first version of the tool. These features include a database that would automatically collect the details of manually added custom materials and items, the possibility to tender multiple different car types in a single file and having a more optimized and appropriate graphical user interface designed specifically for the intended use. Implementation of these features would require a separate native desktop app or custom software created specifically for the tool.

The most prominent disadvantage of the first version of the tool is that as it only covers the car module, although the project scope was narrowed down to the car module and the tool succeeds in that task. However, other elevator modules are being priced through other kind of processes and tools, meaning that there is still room for improvement in creating a totally comprehensive system where cross-integrated tools over module boundaries would work seamlessly together in elevator pricing. This is one of the biggest challenges in the future development to create a solution where all modules would be included and could be configured collectively. An instant future development need related to the project, but outside of the actual project scope, is to expand and maintain the price data in the database to provide up to date pricing information available for the users of the tool.

6.2 Project Successfulness

The main project goals were to build a custom car pricing tool for tendering purposes, to collect all relevant C-process knowledge and price data in one location and to perform a cost variation dynamic and main price driver analysis for car profitability insights. The first two goals are tightly knit together as all C-process knowledge and pricing data is compiled in the tool and its data sources. From KONE's point of view, the main interests from a business perspective were to have a new, flexible tool for any car type implemented, combined with a centralized master price data, while also receiving crucial performance insights through the data analysis. The project successfulness is evaluated from this viewpoint.

The tool development part of the project can be considered as a success as it meets all the requirements and allows more flexibility than previous solutions. The tool was taken into operative production use already during the thesis project as the need for a new solution was significant. The initial reception from the users has been positive, which is crucial as usability and user experience were one of the main requirements, and to have that without compromising the essential features. The graphical interface could be more optimized for this specific use but is limited by the software it is applied in.

In the analysis part, there was moderate amount of confidential data included which created restrictions in presenting calculations, results, and monetary profitability values in the scope of the thesis. However, as actual values were used in the analysis, the findings are documented in monetary values, which allows to report findings for KONE to be used for further process development actions or as a basis for more supplementary analysis. These findings and values, especially the one's from the cost variation section, will be used as reference KPIs when new performance monitoring processes are initialized in the future. This initial work done in the scope of the thesis project works as a great basis for further and more sophisticated KPI metrics, so that cost variation performance could be reviewed better and more extensively in the future.

6.3 Conclusion

In this study, a review of transfer pricing concepts and optimal bidding-strategy was conducted to support the business case, which acts as the practical side of the thesis. After a general business case review, a centralized pricing tool for custom elevator cars was developed with the intention to reduce the number of car tendering pricing tools to one. The tool was built in Excel and offers more flexibility than previous tools as it can be used for any elevator car, regardless of its type. Aside from tool development, a data analysis on historical car pricing data was conducted to gain an understanding of the cost variation dynamics and car profitability in the current state. These discoveries and performance indicators are projected to be used as benchmark values for future process enhancement implementations and car module tendering performance reference values.

A logical and organic continuum in the field the project would be to take the learnings and useful features produced in the thesis project and expand those to also cover the other elevator modules. By doing so, even more flexibility could be achieved in tendering processes as a universal and streamlined approach would establish even more clarity in the whole company's pricing and tendering field.

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