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B2B Price Management using Price Waterfall Model and Business Intelligence solution

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Abstract—**The price setting and negotiation process in the B2B field is a complex process that requires a solid methodology and usually also advanced IT tools to make the process as efficient as possible. The Price Waterfall model is a flexible tool that allows for making the final price determination and revenue creation task much more manageable. In this paper, we introduce a software solution which integrates functionalities of a standard Business Intelligence system with a methodology given by the idea of the Price Waterfall model. The tool is designed as a dedicated decision-making support tool, with a complex internal workflow that should be applied within the price and revenue management process, to induce profitability of the whole business through informed decisions.**

I. Introduction

THE field of B2B interaction between companies puts more and more emphasis on the price negotiation processes because each company wishes to maximize profit margin from every business transaction. Therefore, the emphasis on building excellent decision-making support solutions, that use advanced data analysis methods as well, is getting stronger. The Digital Economy generates data as a basis for many solutions and models in the IT implementation area. For each organization equipped with the appropriate potential, the use of this data is an important factor for supporting decision-making processes.

The Digital Economy also changes the way the price is negotiated mainly in the B2B sector (but recently in the B2C as well). In this paper, we focus mainly on the B2B field, because the success in this field influences success factors of B2C interactions – fields are mutually beneficial [22]. Also, technically, the B2B can be viewed as a prerequisite regarding functional relationships between key players on the market.

The demand-and-supply law and the "invisible hand of the market" regulate the price. At the same time, however, as shown by Mc Kinsey's research, the 1% price increase generates 10-11% profit increase (*The power of 1%*) [1]. The success of the price negotiation process is, therefore, very important. However, as such, it is also very prone to a lack of accurate and timely information. Therefore, the execution of the price negotiation process is often backed by dedicated tools and computing capabilities within the enterprise information system, to minimize risk of possible economic losses.

The research on price management issues encompasses many research topics, e.g., from analysis of trends in pricing systems, to importance of exactness in the pricing process, relationships between price, revenue management, and business performance, dynamic pricing computations and approaches, use of price optimization in various use cases, competitive price information in the revenue management, and last but not least, pricing frameworks in competitive industries [29], [30], [31], [32], [33], [34], [35], [36], [37].

Concerning the information systems that support the business, and its success in terms of information delivery timeliness and relevancy, the relationship with the execution of related business processes is very important [2]. A precondition of the decision-making process efficiency is a smooth and seamless adaptation to changing business conditions, through the use of decision-making support tools. Such tools should offer innovative as well as added-value functionalities, combining well-known business analytics methods with business reporting capabilities, using innovative approaches (innovations are important change drivers within organizations [3]). An intuitive decision-making process is sometimes mentioned as an alternative approach in the management field, especially in ambiguous or uncertain situations [10]. However, in most business critical situations, the use of sophisticated computerized decision-making support, like the Business Intelligence (BI) system, is a complete necessity [15], especially when it comes to the issue of mining large data sets.

Usually, major BI system solutions offer standard functionalities, and in numerous companies around the world, these tools are still the most widely used ones within the decision-making support [4]. Specialized business processes, like the price setting and negotiation management in the B2B field, usually require specific back-room algorithms and functions to be executed seamlessly, and in full accordance with business users' expectation: consumption of ready-to-

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use outputs from the system, to make actual decisions more easily. Standard BI system functionalities are usually very broad, regarding their usage in specialized use cases, and certain calculations can be complex enough to employ different strategies.

Dedicated business-analytics and reporting-based solutions then come in mind to fill the functionality and output-interconnection gap, so that the whole decision-making system's environment moves closer to the idea of IT support of an intelligent enterprise. Such concept is mentioned in [5], and also in [19], in the context of real-time decision-making within an autonomous supply chain system. Cloud computing is commonly mentioned in connection with improvements of efficiency in the field of delivery of data analysis and reporting functions for business users. Cloud based BI systems, especially if the focus of the system is to interconnect various types of data source, offer many benefits, like cost efficiency, flexibility, and scalability, along with enhanced data sharing capabilities [21].

In this paper, we present an enterprise-grade solution that bears the characteristics of the above-mentioned system, and focuses on the fulfillment of requirements, that stem mainly in the B2B price management field. The solution leverages Price Waterfall model as a methodological background.

The further presented system leverages analysis of large datasets, to facilitate its main purpose – the price management process execution. In the system, there is the knowledge from the field of computation performance optimization applied – (sales) data vectorization approach, which is a key feature of the Price Waterfall model implementation (data vectorization features and benefits were studied e.g., in [27] or [28]).

A game-theoretic approach is also a promising approach, since it enables the use of dynamic and competitive price modelling patterns (in [26], there are benefits of data-driven competitive analysis approach mentioned, in terms of creating price setting system architecture). Although the game-theoretic approach has important features, The Price Waterfall methodology allows to implement tools for a full scale pricing process execution (from analysis to price and contract configuration and further management).

The paper is structured as follows. First, the price management background of the software and the Price Waterfall model the software are described. Secondly, the software solution is introduced, as a complex, BI-based, price configuration and management toolset. Finally, the functionalities of the CPQ (Configure, Price, and Quote, [14]) software solution, focus on leveraging the Price Waterfall model, are presented in more detail, using a sample dataset.

II. Price Management Background and Theoretical Assumptions of Price Waterfall Model

In the world of digital economics, there will soon be no place for organizations that do not analyze their economic-activity and related data – it will simply lead to exclusion from the economic world. In contrast with that, and as quoted in [13, p. 14], the pricing is "a messy business" that varies greatly between industries and even different companies and as such, it is a subject of ongoing research.

There are other standards of customer behavior appearing in the B2B and B2C sectors. Within the B2B sector, the online shopping phenomenon is most visible, as research results in [6] confirm it – 93 % of B2B buyers prefer to buy on-line when they've already decided what to buy, and 93 % of B2B buyers prefer not to interact with Sales Rep. as their primary source of search for information. Other forecasts and behavior observations imply that, e.g., [7]:

- by 2018, more than half of large organizations globally will compete using advanced analytics and proprietary algorithms, disrupting entire industries;
- by 2018, 40 % of B2B digital commerce sites will use price optimization algorithms and configure/price/quote (CPQ) tools to dynamically calculate and deliver product pricing.

The most important decision-making process in the company's structure should be the process of determining the price. In the dynamic market situation era, where changes in prices and costs within enterprises happen continually, it is strategic to capture these change moments. It allows us to adjust and change prices to higher prices as late as possible and as soon as possible if such a possibility occurs.

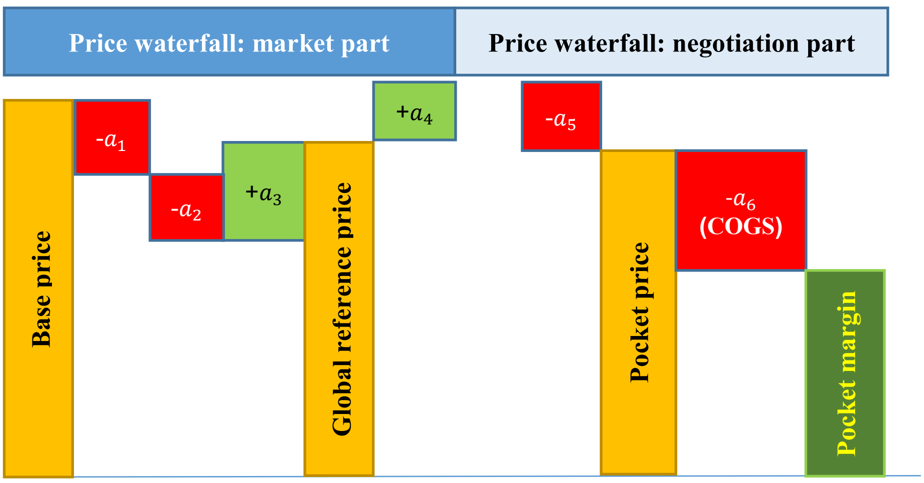

Fig. 1 Example of a Price Waterfall model visualization *(COGS = Cost of Goods Sold, i.e., standard product costs)*

Sometimes the fact of maintaining stable prices for a certain time is valuable and a highly desirable fact.

Market conditions press on the goods and services delivery so that the price is at the lowest possible level and the entire contract is more profitable for the customer. But on the other side, the whole transaction should be kept profitable also for the reseller. These two contrary motives push forward the necessity of implementing systems for an efficient determination of price in time, through a collection of historical data and by design of price trends, to be prepared for eventual price fluctuations and customer-side requests. The discussion on the use of the actual models and methodology, then comes to mind.

A. Price Waterfall model, price adjustments and Pocket Margin

As mentioned in [8], the idea of the Price Waterfall model (PWm) is a mapping in the form of successive degrees as in the cascade of factors affecting the determination of the price of a given contract.

The process starts from Basepoint, in which the Base price (Base price point) is set, based on historical data (i.e., certain verification of the price by the market is already available). In the next steps, the price in consecutive price points changes according to **adjustments** that may be positive or negative (given the nature of the actual adjustment). Calculation of *k*-th price point value is carried out using equation 1:

$$\mathrm{PricePoint}_k = \mathrm{PricePoint}_{k-1} + \sum_{i=1}^{n} \pm a_i \,, \qquad (1)$$

where $\pm a_i$ represents *i*-th price adjustment out of total *n* adjustments set after the establishment of previous price point $\mathrm{PricePoint}_{k-1}$. Each price point refers to a certain point in the price setting and profitability assessment process (fig. 1 depicts a sample price waterfall and resulting pocket margin). If the sum of price corrections is negative (i.e., if there are mainly negative adjustments -a_i), the contract is discounted.

Each price adjustment between price points refers to different contexts, e.g., product attributes, bundling rules, regional pricing rules, channel adjustments, standard discounts, or negotiated discounts, service and shipping charges, rebates, service costs, and finally the standard product costs.

Market configuration leads to an Invoice after the Discount point where there is already a price established, which appears on the customer invoice. After this point, the cost part appears in the waterfall, where all costs related to a given transaction are included.

The last price point is called **Pocket Margin (PM)**. Through the computation of the Pocket Margin value, as the last element of the waterfall cascade, at the end of the transaction (i.e., the end of the entire price setting process), an estimation of the profit from this transaction is done. This feature of the PWm, i.e., a prompt estimation of the profit from the transaction at the moment the transaction is created, seems to be the most important in the whole process. Below-zero Pocket-margin value indicates profit (price margin) leakage, e.g., too high discounts were awarded, or adjustments at a given stage have not been done correctly, etc.

This phenomena should be identified as soon as possible to stop the profit leakage so that the whole price management process is efficient [25]. An example of a helpful analytic visualization of PM data is shown in Fig. 2 – a Tree Map visualization using transaction data (within the further presented CPQ solution). The red color squares show the area where PM < 0 , and it request a deeply analysis to get verify the reasons.

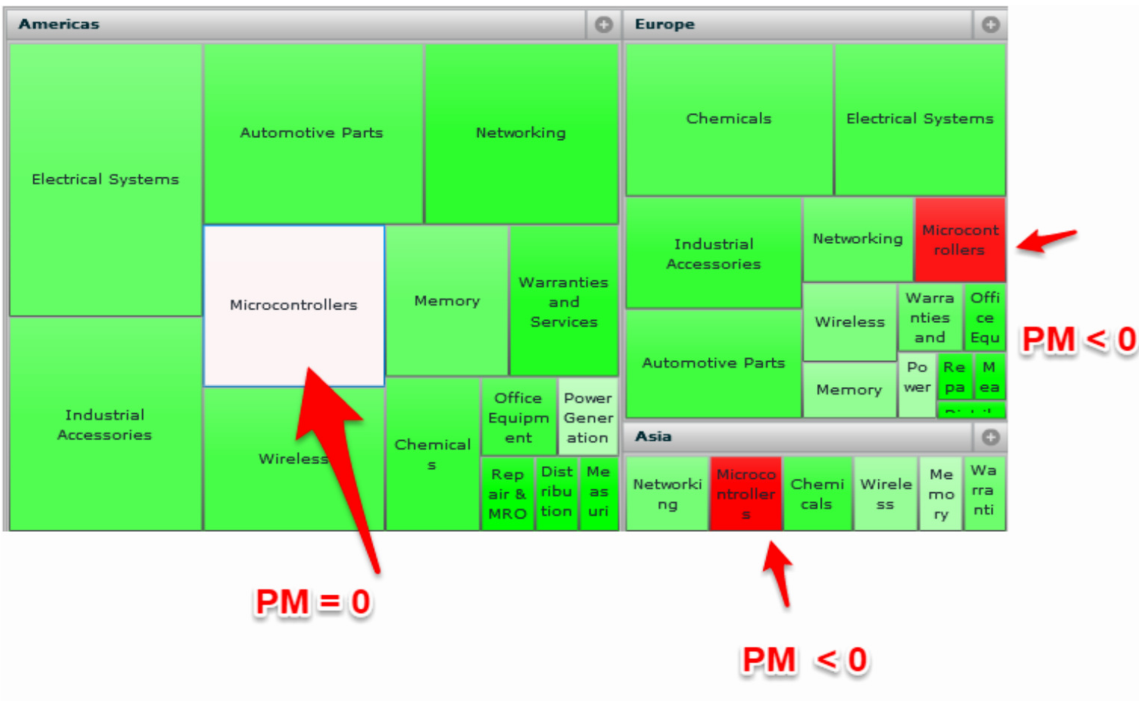

Fig. 2 Example of a Tree Map visualization used to analyze Pocket Margin values

Transaction data and the structure of the price waterfall cascade then allow for a calculation of the expected profit value. Depending on the defined pricing policies, the transaction will be prepared for the client after that, and they can then apply for additional discounts. Nevertheless, the limiting factor, i.e., the value of the Pocket margin is given for the transaction, and it should be kept greater than zero.

B. PWm and sales data vectorization

Implementation of the PWm-based price determination process (e.g., into a CPQ solution discussed in this work) ultimately makes possible the use of the strongest advantage of the PWm – **the data vectorization**[1].

For each transaction, data vectors **WF** of the price cascade is created. Anything in the sales process, i.e., the Customer, Sales Rep., Channel, etc. has its own defined **WF** vector for a given time range. In this way, it is possible to compare object's data by comparing the **WF** vectors of these objects, for example, $\mathbf{WF}_{\text{Channel (1,year 2017)}}$ vs $\mathbf{WF}_{\text{....Channel (2,year 2017)}}$, etc.

At any moment, the **WF** vector is specified, and this event enables tracking of changes for the entire company as it allows to compare relevant periods. Of course, the transaction data analysis without a pricing model can be done using tools like *QlikSense* or *PowerBI*. However, within the data analysis based on the PWm, the advantage in the form of data vectorization allows us to use of a more complex and multi-dimensional approach to the analysis of certain phenomena in sales activities.

The Big Data phenomenon [16], generally, and the analysis of very large data sets also plays an important role in the process of rich business insights creation [9]. Big Data is a source of many opportunities in multiple areas, like an increase in operational efficiency, creation of informed strategic decision, and also better customer service, etc. [17], [18], [20]. It is reported that in the commerce field, the use of Big Data analytics can lead to a 60% increase in operating margin [11]. So the use of Big Data sources within the price management process should be viewed as a valuable source of insights as well. Certain external data, like data from users' interaction within social media, can contain information that may lead e.g., to definition of additional types of price adjustments.

Other modern and mostly unstructured data sources, like customer expectations expressed as opinions within social media posts and comments, or video blogs and voice recordings may contain such information[2]. Through application of well-known unstructured data analysis methods, like sentiment analysis and natural language recognition and processing in general, the way to the overall improvement of the price and revenue management is already open.

III. Presentation of the CPQ price management solution

The further presented CPQ solution leverages the PWm methodology and enables interconnection of data from various enterprise sales processing systems, to analyze data and presents outputs that allow for automatic price adjustments and very quick decisions. However, only the use of structured data sources is currently implemented in the system (fluent processing and analysis of unstructured data is one of future milestones). The system includes standard as well as more advanced BI-system based functions (among other), which are a necessity today. The software solution is primarily intended to be used by standard as well as power users within the pricing process. User interface and back-room functions of the solution are programmed mainly using the Java programming language.

A. Main modules of the CPQ solution

The full scope of data processing includes three key modules: the module for the data analysis and visualization (Analyze), the pricing policy configuration module (Optimizer), and the contract creation module (Execute). The results obtained from the contract creation module are returned to the Analyze module, thus closing the data flow cycle (fig. 3). The trend of decision-support systems integration, in the field of complex Management Information Systems deployment, rather than creating isolated systems (as mentioned in [12]), is fully respected in case of the presented software solution (modules cooperate with each other).

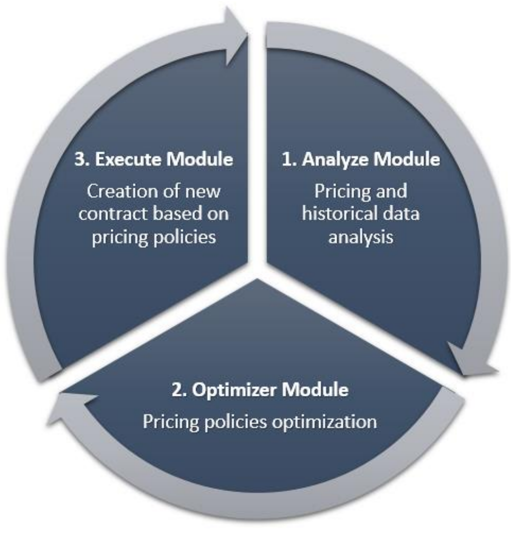

Fig. 3 Data flow within the CPQ solution's environment

Main tasks of the Analyze module:

- Identify price, margin and profit opportunities for any part of the company's business, utilizing transaction data;

[1] Fluid use of data vectorization within the data analysis process is a computationally non-trivial task, but may lead to richer insights.

[2] Some of these may be, or already are included within certain proprietary price setting rules, but without proper tools, they can be used as rather vaguely defined indirect effects.

- analysis of a number of business metrics;
- identification of specific areas of margin leakage (i.e., with PM < 0);
- visualization of profit opportunities and contributing factors with a possibility of sharing the results with team members for higher productivity;
- explanation of how revenue or margin changed from one period to the next regarding the price, volume, mix, win/loss, cost, and exchange rate effects.

Main tasks of the Optimize module:

- Combination of all relevant internal and external data needed for setting the price (various product costs, competitive and market information, past pricing process performance, etc.), and setting the prices in a single rule-based system combining both data classes;
- generation of massive amounts of prices using configurable rules and strategies, and easy management of price lists, thus enabling efficient mass price changes;
- tracking of price changes (workflow is recorded);
- integration with downstream systems for pushing and publishing prices.

Main tasks of the Execute module:

- Evaluation and enforcement of pricing strategy on every deal;
- modelling each deal (quote, contract, etc.) for profitability estimation, with adherence to pricing strategy, etc.;
- automatic routing of deal to appropriate approvers based on each deal's characteristics (workflow enabled), thus enabling both simple and very complex deal management, including mass price changes.

Fig. 4 shows standard reporting and visualization charts within the CPQ solution's Analyze module.

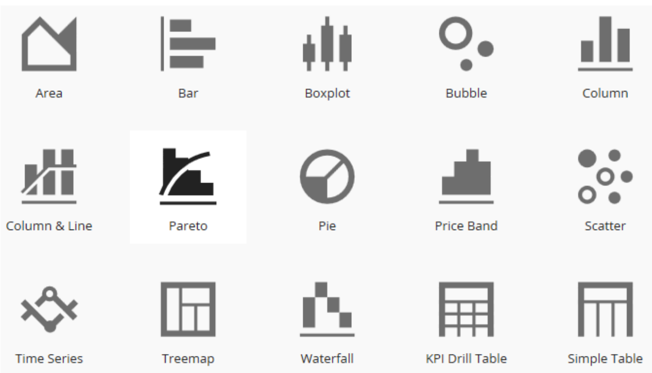

Fig. 4 Standard charts within the Analyze module in the CPQ solution.

Some functions are also available in BI tools available on the market (e.g., the bar chart, box plot visualization, scatter plot, etc.), as well as visualization functions that are strictly related to the PWm concept – Waterfall and Price Band. Each function supports the idea of decision-making automation, within the price configuration and management process, i.e., each one can be used to visualize certain aspects within the process, with the possibility of viewing special features of the process using both special functions mentioned above.

B. Example of Price Waterfall visualization using sample dataset

In fig. 5, there is a sample of the Price Waterfall visualization (using the "Waterfall" function) presented, generated using a sample dataset. The test dataset was used due to security reasons because it was not possible to showcase live company's data in the paper. The dataset is a standard multidimensional dataset for OLAP-based data analysis, with dimensions like Products, Country, and a fact table, with columns containing values of actual price points and adjustments for a given transaction time.

The use of vectorized sales data for data analysis also allows us to use 3-D charts. This way of data visualization is possible because each transaction has its price data vector **WF** set. 3-D visualization of the price waterfall is one of possible future enrichments that could be implemented within the presented CPQ solution. Principally, the 3-D visualization of the price waterfall allows for a deeper analysis of the price establishment and profitability management process (output combines benefits of popular charts like tree map and bubble chart). Currently, the tool's UI lacks such functionality, so an example of such visualization was elaborated using Microsoft Excel's charting functions – result can be seen in fig. 6.

As seen in the fig. 6, in the upper right corner, there are companies grouped for which the Pocket margin value is high – i.e., these are very profitable customers. The situation in the bottom left corner should be analyzed because the Pocket margin value is low and even less than zero. There is possibly a transaction in this area, for which the Base price is high, and yet Pocket margin is close to zero or negative (Invoice price value is also shown there). So losses have been incurred and detected with a possibility of obtaining more precise insights (the reason for these decisions should be analyzed as soon as possible). After including the third viewpoint (Base Price in this case), the visualization of the Price Waterfall shows more promise than the standard 2-D variant, especially if there will be more such outputs included in a complex dashboard (i.e., more business performance aspects could be studied at once).

C. Known limits of the solution and future outlook

Known limitations of the software are that it focuses mainly on the CPQ problem, i.e., the process of ad-hoc setting and price management within the B2B relationship. Currently, there are no functions that would possibly allow for a prediction of future prices (or price adjustments) as well as the revenue of the company, or even relationships on the B2C (C2B) level. The inclusion of B2C-related capabilities are, however, more important in the case of relationships with non-enterprise customers (which is actually not the case of the presented solution). In this field, however, the analysis of customer-based knowledge about our products' aspects would be essential [23].

Capability of predicting future states of important business aspects, using machine learning or even deep learning methods, to understand text, emotions and, generally, the unstructured data, are becoming a crucial functionality [18] (one instance of a smart quotation system is presented in [24]). The fact that not only large companies recently started to recognize the importance of Big Data sources implies that the vast amounts of multi-purpose data are very tempting. As it was mentioned above, it is important and also highly relevant to the price and also revenue management process E.g., events' features and descriptions that may contain hints for future events, people's interests and their development that may induce future changes in demand, etc. Mining also such data source is in the future plans of the presented CPQ solution's development.

IV. Conclusion

The CPQ tools market will grow significantly in the future. It will be driven by the need for advanced price management solutions, with powerful predictive data analysis capabilities that, among others, will help to optimize such a crucial decision-making process, as is the optimal price creation process. The integration of such functionalities and capabilities in an integrated BI system environment will also be a necessity, given the amount of and data interdependencies and necessary visualization options, for the presentation of results in a way that allows for a continual improvement of the company's business.

Next steps in the development of the presented CPQ solution will be the expansion of capabilities with the utilization of AI and machine (deep) learning algorithms as well as interconnection with insight-richer data sources (Big Data sources). It would lead to the creation of more advanced system that would allow for price optimization within the revenue management process (by the PWm methodology).

Future research on this topic will focus on the revenue optimization and related approaches, with a study of its possible efficient inclusion into novel functions. These new functions might allow for an optimized execution also of the revenue management process, within the interface of the software solution.

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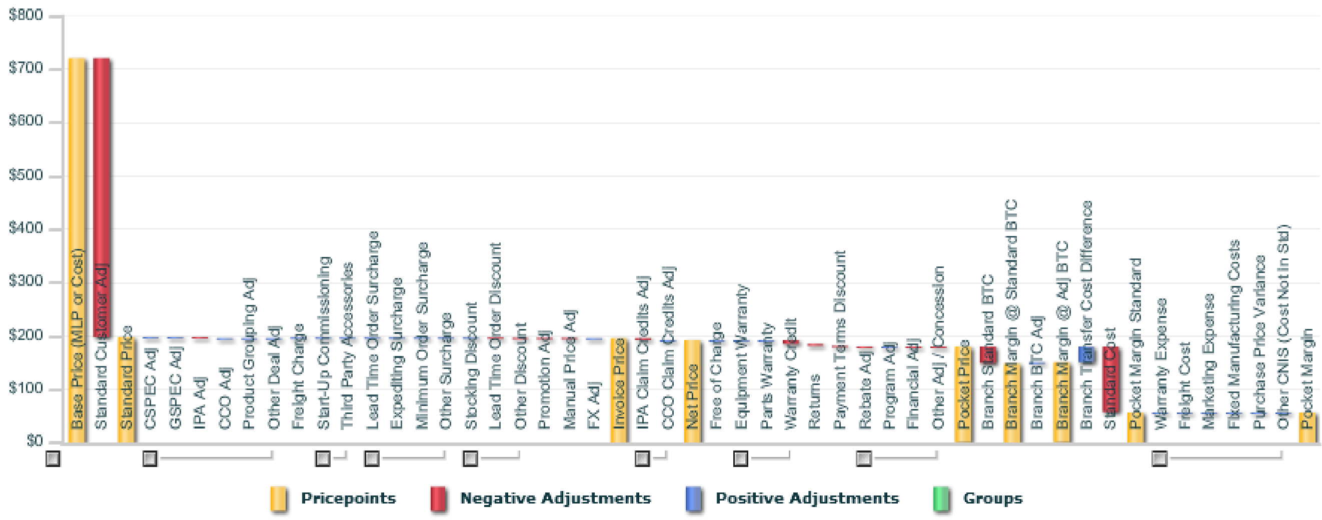

Fig. 5 A Price Waterfall generated within the CPQ solution from a sample dataset

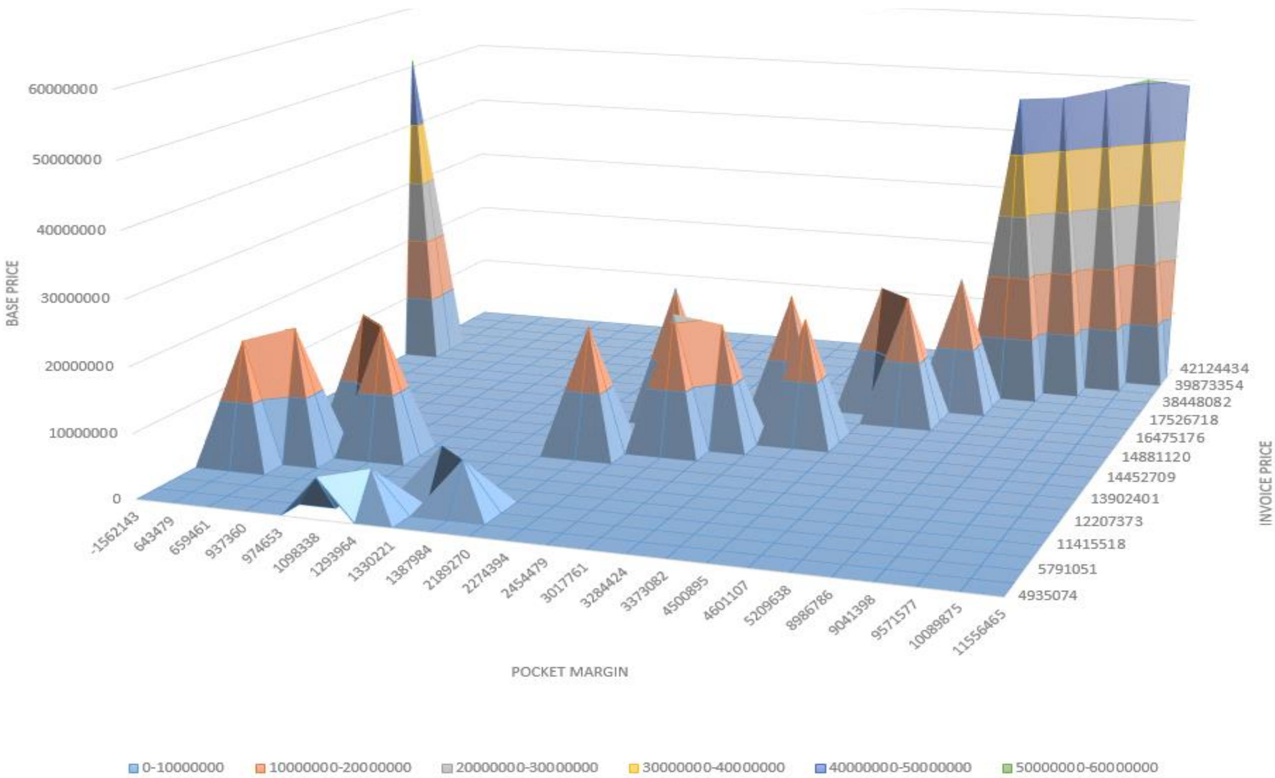

Fig. 6 3-D visualization of a sample Price Waterfall using sample dataset (presentation of a future functionality)