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An Axiomatic Design approach for customer satisfaction through a Lean Start-Up framework

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Abstract

Value generation and customer satisfaction are the primary goals for those companies which want to be successful and profitable on the global market. Achieving these objectives is key for a middle-long term successful business model. Missing them may eventually lead to the company's failure, and also it might be a very difficult task to accomplish. Due to its strategic importance, the overall business model, along with the products and services to be delivered, should be assessed iteratively, defining their importance in respect with the customer needs and expectations. This control check is often experience-based rather than rationally guided, even in large and structured organizations. This paper proposes a novel approach to systemically build a customer development model, to verify the agreement between what is offered and the customer needs. The proposed customer model is built through the Axiomatic Design method, together with other tools that are properly tuned for this specific application.

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Keywords: Lean Start-Up Approach; Axiomatic Design, Customer Satisfaction; Product Innovation

1. Introduction

In the era of globalization, corporate strategies have been completely revolutionized. Global procurement of products, services and access to new international markets have become the reality for many firms; as a result, customers are demanding higher value for their money. Thus, higher customer satisfaction, reduction of development times and costs besides customer-focused engineering tools become many of the main success factors for a market-oriented product development [1].

The market is a medium that allows customers and vendors of a specific good or service to interact, in order to facilitate a trade in exchange for money –in other words, the place where demand and supply meet each other. The involved economical subjects can be divided into two macro-clusters of customers and vendors. Customers can be final consumers (vendors being Business to Consumer activities, or B2C) rather than companies (vendors being Business to Business activities, or B2B). On the other hand, vendors are those subjects (typically private companies) that enter the market aiming to collect profits by means of selling their goods.

Defining the goods to sell for a certain business is both a difficult and critical topic: commercializing a brand new product or service is a complex task with an uncertain outcome, and the survival of the company itself often depends on it [2]. The capability to be profitable and lead the market is given by the produced value that is recognized by the customers, both in B2B and B2C markets, and how much they are willing to pay for. Usually, it depends on the value the customers recognize, due to both tangible and intangible features of the product/service to be sold. It concerns to a trade-off between the benefits the business offers to the customer, and the sacrifices a customer has to make to obtain it [3-5].

Obtaining customers' favor is rarely easy, either because the real needs are usually not directly disclosed or the personal entrepreneur's business view is skewed from the actual situation.

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The onset of a new business model (or new products/ services) is traditionally based on forecasts about the market trends of demand and supply. These forecasts often do not come true as the firm enters the market, making the capital investments in new businesses very risky and uncertain until the highest amount of budget has already been spent. Many managerial, engineering and even psychological theories have been drawn out in order to make the whole process safer and more robust: collecting and analyzing customer needs (CNs) more accurately, thinking about how to reach them, doing benchmark on competitors, driving projects more rationally and functionally are just a few examples within the wide pool of already tested tools. Many other attempts try to investigate how a product or a process can be more innovative starting from design details [6-10].

The scope of this paper is to propose a novel approach for managing the onset of a new business model or launching a new product/service. The proposed approach merges the Lean Start-Up methodology with the Axiomatic Design theory for driving managers, as well as new entrepreneurs, through steps that nowadays are tied more to creativity and intuition rather than engineering practice. The proposed method aims to reduce new venture risks, stimulating the CNs analysis to generate the most innovative and appreciated solutions, furthermore introducing a stochastic approach to understand customer feedback and improve the original idea more effectively. The Axiomatic Design method particularly fits to accomplish these challenges, driving the identification of innovative and effective features, providing the tools to process customer feedback and converging to the final the solution.

Nomenclature

B2B	Business to business market
B2C	Business to customer market
MVP	Minimum viable product
VOC	Voice of customers
CNs	Customer needs
FRs	Functional requirements
DPs	Design parameters
p_i	probability of satisfying the customer
n	maximum number of satisfaction levels
i	number of satisfaction levels (from 1 to n)
I_i	information content of the i-th product feature
k	number of independent FRs (from 1 to m)
m	maximum number of independent FRs

2. The Lean Start-Up approach for launching new business models or new products.

The traditional approach to create a new business expects the entrepreneur to write down the business plan. The business plan is a formal statement with a many-year forecast of the demand trend, the cash flow, the annual incomes and profits [11]. If the business plan is convincing enough, it will be able to collect investors' capitals, and this money will become the budget that will fund the man hours and the resources needed in order to design the product, start the production and finally reach the customer. Along the whole process, no feedback from customers is sought, making the entire process very risky since most of the budget has already been spent on the basis of a bet. This fact translates into 75% of new venture firms in the United States that do not return investors' capital [12,13]. Besides the definition of the whole business architecture (the type of customers, the number of suppliers, etc.), the existence of a business model firstly requires the idea of the product (or service) to be sold. This paper guides the passage from one phase of the Lean Start-Up approach to another, assuring that the generated idea is going to be the most innovative and appreciated by customers; for this purpose, dealing with a product or a whole business model does not make any difference, since the proposed ideas can be easily generalized.

Several techniques and approaches for reducing new venture risks have born recently [14-16]. The Lean Start-Up approach by Eric Ries [15] aims to reduce risk in new business models development, replacing the traditional business plan with a list of hypothesis to be verified and swapping the entrepreneur's intuition with the customer feedback. This method has been making more and more enthusiasts and it has been even defined as a turning point in management strategies [17]. In fact, although initially designed for fast-growing ventures of Silicon Valley, it has rapidly spread out through many other enterprises, including really large ones, like General Electric, Qualcomm and Intuit [17-20].

This approach to business development is simple, logical and economically sustainable, cutting down the risks to build something unsuccessful by means of fast learning cycles with customers [17,18]. The learning cycles' scope is to assess iteratively the market response in respect to the new product or service, suggesting how to modify it to get closer to customers' expectations.

In order to do this, the lean Start-Up defines the business plan not as a forecast, but rather a list of hypothesis to be validated rapidly through feedback from the markets. The lean Start-Up approach develops the final product essentially in three steps [15,21]. The first step is the new product idea generation (or, more in general, the new business model). In the larger case of new ventures, the idea generation covers the definition of the business plan in all its aspects through a board called business canvas. Unlike more traditional stand-alone volume of forecasts, the business canvas collects all the hypothesis about product definition, addressed customers, lists of suppliers, key factors, general costs and other details. As a second step, leveraging the proposed idea, a minimum viable product (MVP) is built and introduced to the market (B2B, rather than B2C) to test its value and the entrepreneur's growth conjectures [2]. The MVP is a prototype of the product that has to be evaluated by the customers, and represents the tool itself to validate the progress of the project until that moment.

Finally, there is the third step which is called pivoting: a structured course correction designed to test a new fundamental hypothesis about the product, strategy, and engine of growth [15]. During this step, the original idea is improved according to collected feedbacks [15,17]. In this way, the commercial proposal meets a better agreement with customer expectations, reducing risks with a minor amount of

resources. Nowadays the passage from a phase to another one depends mostly on intuition [17], and it is not aided by any kind of structured method or indication that would help managers and engineers to get to the optimal solution faster. Furthermore, both the CNs and feedback interpretation are often not easy. This aspect is twofold and, as far as regards the CNs, is related to the capability of including surprising and innovative features that customers do not expect, yet actually want within their products ("WoW features" or delighters [22]). On the other hand, understanding what to do in order to enhance the product may be difficult with traditional questionnaires. The Axiomatic Design method by Suh [23,24] is identified as a particularly suitable method to drive these aspects of new business development, from the customer needs taxonomy to the identification of those elements which build up the enterprises' competitive advantage and allow bringing added value to their products.

This paper proposes a novel approach for developing a new business model, or product, that merges the Axiomatic Design theory with the Lean Start-Up Approach. This merger is found beneficial into proposing innovative solutions and driving the product design, according to the pursuit of the customer satisfaction.

3. The merging between Axiomatic Design and Lean Start-Up approach

Both the Lean Start-Up and the Axiomatic Design methods are customer-oriented approaches: the former develops a product which satisfies customer expectations at its best, while the latter defines a new product (or service) once the CNs are settled. Notwithstanding this similarity, these techniques can be considered complementary. The Lean Start-Up sets a series of steps that lead towards a new business (new product) version which is the preferred one by the market, while the Axiomatic Design systematically defines each product parameter, from its functional requirements (FRs) to the process variables (PVs).

From this point of view, the Lean Start-Up method represents a useful framework an entrepreneur should act within, encouraging a change in his/her mindset to make the business less uncertain. On the other hand, the Axiomatic Design developed by Suh [23,24], with its extensions [25], represents a tool to systematically implement features which are able to surprise customers and lead markets. Furthermore, the use of Axiomatic Design in this context represents a useful guide for switching from a step to another of the Lean Start-Up framework.

Every new business starts from an idea of a product, or a service, which should meet the customer needs. Surrounding this idea, all the other aspects which typically define the traditional business plan, or the less-traditional business canvas, are defined [2].

This paper focuses on the implementation of the Axiomatic Design theory in the Lean Start-Up framework to enable the implementation of product features that are tied to deeper and hidden CNs, recognized as the ones that are able to create competitive advantage, surprise customers, and defeat competition. Furthermore, Axiomatic Design can help managing customer feedback, regrouping them depending on the probability to satisfy customer expectations. From this point of view, the onset of a new business matches with the definition of a new product: without the latter, the former itself could not exist. On the other hand, the proposed remarks are extensible from the product design to other areas of the business canvas.

Fig. 1 shows the proposed framework to drive the definition and launch of a brand new product, according to the Lean Start-Up principles. Each new idea of business arises from the perception and collection of existing and unsatisfied CNs.

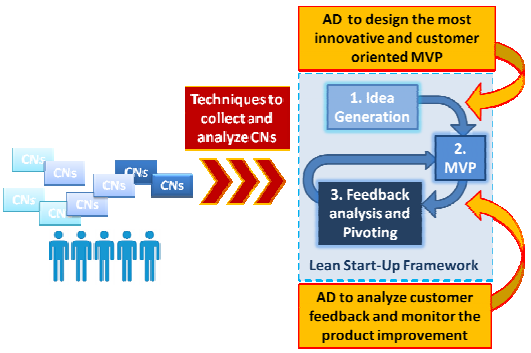

Fig. 1. The merging between the lean Start-Up framework and the Axiomatic Design, together with other techniques for launching a new business model

There are many different ways to elicit customer needs [26]. These methods facilitate eliciting and structuring customer needs by the definition of the Voice of Customer (VOC) [4] as customers' specifics, thus applying popular tools like series of Quality Function Deployment [27] or Conjoint Analysis [28] to analyze it. Other techniques, like Kansei Engineering [29,30], employ even psychological tools to interpret CNs or exploit Web-based consumer elicitation methods. Eventually, some authors have set guidelines for designing product development processes [31].

Once the collection and analysis of CNs have spotted a lack of market proposals, the idea for a new product (business) is born and the first step of the Lean Start-Up framework is achieved. The Idea Generation phase shall bring to the creation of the MVP and its iterative improvement, according to the lean Start-Up principles and the market response. The Axiomatic Design plays a twofold key role between the first and the second step of lean practice, as well as between the third and the second one. Moreover, the iterative improvement of the MVP, due to the analysis of the market response, makes easier for the system range to overlap the design one, reducing the product information content and real complexity, according to Suh [32]. This process has the double advantage of maximizing the MVP capability to achieve the FRs [32] and adjusting them to satisfy the real CNs.

3.1. The idea generation and the technological bet

More and more often, the life of a product in advanced markets is quite short; huge efforts are made to generate ideas for filling needs and continuously satisfying growing

expectations coming from the market. Thus, spotting and properly interpreting the demand (or, in other words, the CNs) is crucial to collect customers' preferences and beat competitors.

The Axiomatic Design rigorously deals with the whole product development through four domains, from customer needs to production parameters (PVs); other methods tend to translate the VOC into design parameters (DPs) directly, neglecting the definition and the analysis of functional requirements (FRs).

The FRs are the features that the product/service shall satisfy, i.e. the way it is meant to reach the customer needs. Obviously, it may not be a unique FR to satisfy a customer need, thus, a better agreement with customer expectations may be found, if required. In other situations, the VOC might be a DP as well. Especially in the latter case, the complete analysis, as suggested by Suh, is fundamental to drive the detection of hidden CNs and spot those requirements which could lead to the opening of a new market, or win in the already existing marketplace. The proposed approach, if the VOC is expressed by DPs, expects to pass through the zigzagging conversely to find out the supposed FRs, and the hidden CNs beneath them.

This approach deals with the ordinary passages among the axiomatic customer, functional and physical domains, but in the opposite order, forcing to self-question whether the problem has been completely dissected or something better and more connected with real customer needs could be found. This axiomatic practice may stimulate managers to think about what the not-revealed hidden CNs could be. Obviously, the knowledge of such hidden CNs is just supposed at first but, according to the Lean Start-Up framework, it could be assessed and validated by the customers later.

Knowing the hidden CNs is extremely important since it allows finding out the "WoW features" that the product shall have to maximize customer satisfaction and make a solution winning [22,33,34]. These new features bring value for the customers, since they surprise them, determining market leadership, establishing the benchmark reference and defeating competitors.

These are the reasons why the technological bet, which defines the success or the failure of a business proposal, is mainly determined by the WoW features.

The proposed analysis method is meant to help managers spotting what the upper FRs – and the underlying CNs – might be, also leading to unexpected results which might go beyond the apparent CNs and eventually open new markets or push the demand by implementing new features.

A simple example is shown in Fig. 2, regarding the hypothetical carrying out of a brand new car by a car manufacturer. The VOC could deal with several requirements which have to be collected, filtered and analyzed according to one or more of other existing techniques [26]. From an axiomatic design standpoint, CNs may be expressed as attributes (which shall be translated into technical specifications) or nouns, even apparently matching DPs.

Referring to the scheme of Fig. 2, the VOC asks for the red body paint for a brand new car. The customer will be apparently satisfied if he will get access to a red painted car, but this could be just a partial insight of the real customer desire, and may not be enough to push the customers' preference for the product. Customer segmentation (i.e. splitting the customer base into groups depending on age, gender, interests and spending habits) helps to draft hypothesis about the overlying FRs and the upper hidden CNs. In the given example the supposed FR is "to provide classic Italian racing colors", while the upper hidden CN could be "sporty feeling".

To collect the customers' preference, the brand new product should have new innovative and astonishing WoW features to accomplish the hidden CNs. From an Axiomatic Design point of view, the WoW features are DP/FR couples, thus, new supposed FRs (and their corresponding DPs) shall be derived from the previously-found hidden CNs.

Once the supposed FRs and their corresponding hidden CNs are spotted, it should be asked if there is any other way to push further the fulfillment of the hypothesized couples CN/FR, by listing new supposed FRs and their corresponding DPs, according to the Axiomatic Design theory. The design matrix that was previously found may even contain FR/DP couples that are not uniquely referred to the analyzed product (or business) model, but also to new collateral businesses. Referring to Fig. 2, an example of collateral-WoW DP to satisfy the couple "sporty feeling/to provide classic Italian racing colors" could even be an alternative business, focused on sporty items' trade.

An example of new supposed FR, derived by the hidden CN "sporty feeling" and contained in the design matrix, could be "to provide a racing experience". A DP that is able to satisfy the new supposed FR could be "placing of the start/stop engine button on the steering wheel". In order to maximize the impact on customers, and assess whether the spotted WoW features are really innovative or not, a benchmark research on similar proposals from competitors is required at this stage.

In this context, the benchmark database acts like a first filter to skim the list of WoW features (both intended as new FRs and corresponding DPs). On the other hand, the customer segmentation further skims and redefines the found WoW features, since it provides those criteria to assess their feasibility.

The customer segmentation defines what customers are disposed to pay for, and provides the reference to measure the perceived value. From an Axiomatic Design standpoint, the customer segmentation can provide constraints about the economic feasibility of the FR/DP couples, while benchmark analysis provides the guidelines for selecting innovative solutions for the product or the whole business model.

The skimming of WoW FR/DP couples through benchmark analysis, together with the economic constraints derived from customer segmentation, generates an innovative customer-oriented design to be implemented in the MVP [24].

3.2. The measurement of customer feedback and pivoting strategies

According to the Lean Start-Up approach, the MVP, which contains the allegedly found WoW features, has to be market-tested through the collection of customer feedback for being

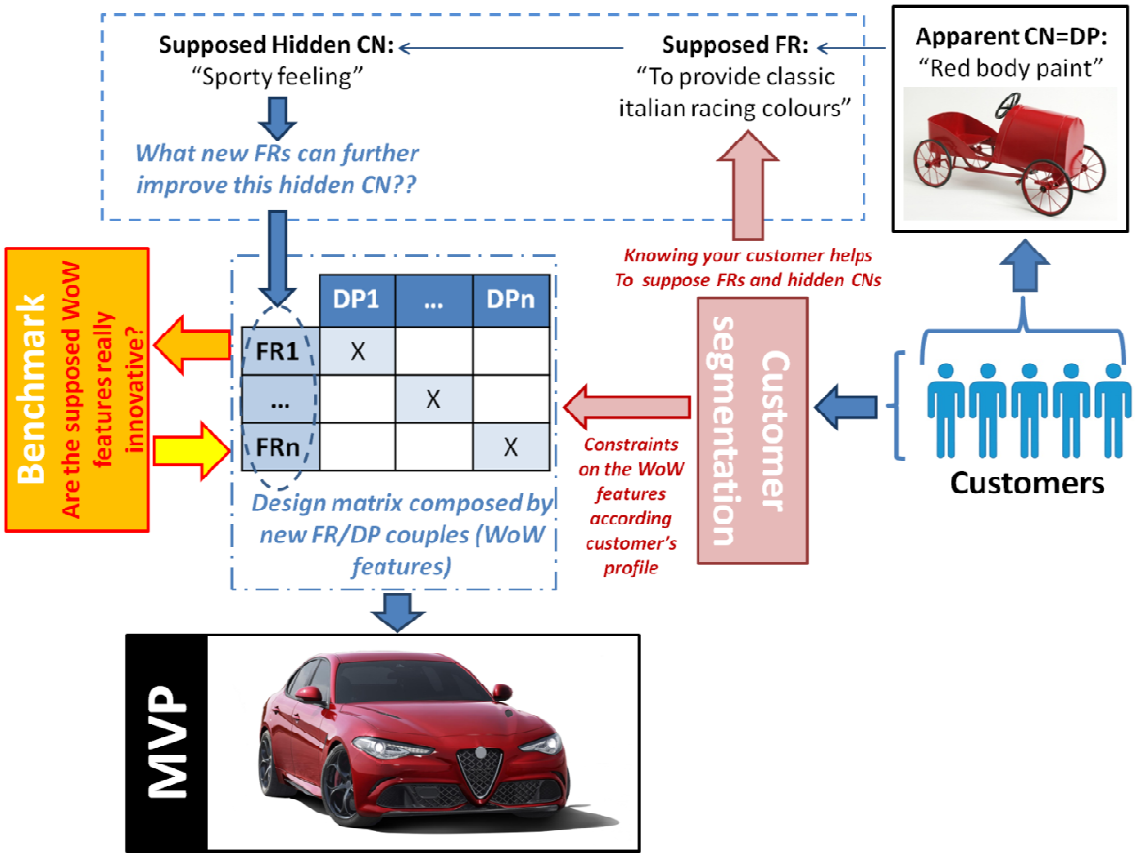

Fig. 2. The Axiomatic Design framework to drive managers from the business/product model to the MVP.

further refined [2,15]. The Axiomatic Design approach can be used again within the Lean Start-Up framework to assess stochastically the overall MVP capability to satisfy customer expectations.

The traditional customer satisfaction questionnaires are redacted with open questions to briefly have customer suggestions, and multiple-choice questions whenever the satisfaction about a specific characteristic is needed to be accounted according to a number (usually five) of satisfaction levels – spanning from "completely satisfied" to "completely unsatisfied".

This kind of questionnaires assesses the customer satisfaction classifying it within discrete levels, while their interpretation is carried out through calculated indexes and matrices. The Axiomatic Design allows one to evaluate the probability to satisfy the customer requirements for the whole MVP, starting from the calculated probability for each FR. Such a way to assess the agreement of the product to customer expectations is more accurate and realistic than the use of *n* or more discrete levels since each function is an event whose execution may satisfy customer requirements in different percentages. Each event may or may not depend on other events, according to the relationships of the design matrix.

Assuming the range of customer satisfaction spanning from 0% (very unsatisfied) to 100% (completely satisfied) and, taking into account "*n*" levels to describe the agreement between customer expectations and product features, the associated probability to satisfy the specific range is calculated according to Eq. (1):

$$p_i = i \cdot \frac{100}{n} \tag{1}$$

Where *i* is the number which represents the i-th level of satisfaction, *n* is the number of satisfaction levels. The definition of information content associated with the specific feature is given in Eq. (2):

$$I_i = \log_2 \cdot \frac{1}{p_i} \tag{2}$$

Where "p_i" is the probability the i-th feature satisfies the customer expectations. The probability that the MVP and all its characteristics satisfy the customer is given by the intersection among the occurrence of the events, which correspond to proposed features. The associated probability to the MVP is given by Eq. (3) or Eq. (4), depending on whether the FRs accomplishments are independent or dependent

events. In the latter case, the probability $P(FR_1 \cap FR_2)$ is calculated for each couple of dependent FRs.

$$P(FR_1 \bigcap FR_2 \bigcap ... \bigcap FR_m) = \prod_{k=1}^{m} FR_k \quad (3)$$

$$P(FR_1 \bigcap FR_2) = P(FR_2) \cdot P(FR_1 \mid FR_2) \quad (4)$$

Each function of the product (and the whole product itself) can be associated with a probability to satisfy customers. These probabilities allow quantifying the acceptance of the customers for the MVP and monitor the evolution of the prototype after it has pivoted several times. Monitoring the probability variation as a function of time, pivoting after pivoting or model after model (after the first product commercialization), can help understanding how the market evolves and the customer preferences' change. In fact, when a market is mature, finding a way to attract customers turns out to be more difficult than in a new one since customers tend to become sceptics [14]. Thus, the surprising effect of the WoW factor in a mature market might be less meaningful and effective. From the standpoint of the proposed model, reduced probability values could be expected when collecting feedback in mature markets. The plot of probability to meet customer expectations as a function of time can be used as an index of market maturity due to its shape. The graph has a characteristic s-shape: the probability is zero before the new market is opened, grows fast with the market development when introducing more and more WoW features and finally becomes almost horizontal when the market is mature and the customers become more demanding. The asymptotic behaviour of the curve on the right-hand side of the chart shows how the effect of WoW features decreases over time, until they become "Satisfiers" and "Must be", according to Fig. 3. Finally, the introduction of a quantitative criterion for characterizing the preference towards a specific FR or the entire MVP can help establishing a hierarchy of the most appreciated FRs/DPs, and also spot those features which the tested market is not interested in.

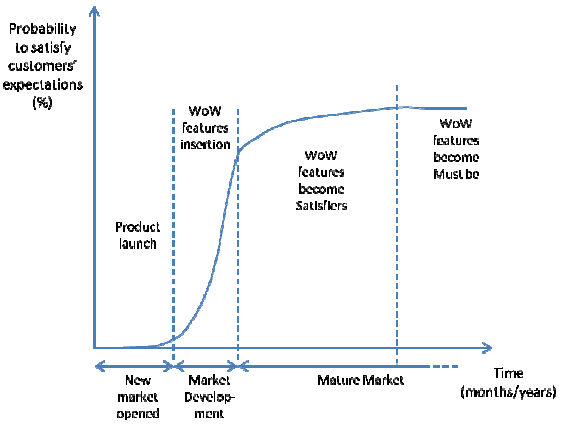

Fig. 3. The probability of satisfying customer expectations vs. time and market evolution.

4. Conclusions

The lean Start-Up approach is revolutionizing the idea of a business that shall be less and less managed by means of lucky intuitions [17], and more based on the iterative improvement of the customer satisfaction through the continuous search for feedback. The Lean Start-Up approach proves itself as a useful framework to greatly reduce the risk in starting a new business and launching a product; yet, what this approach does not cover is how to walk along its stages. The Axiomatic Design method provides a pattern to do this, driving the passage from the idea generation to the MVP creation, easing and encouraging the spotting of innovative contents that take the form of new FRs and DPs to be skimmed through feasibility constraints, customer profiling and the benchmarking on similar proposals by competitors.

Once the MVP is ready to be shown to the potential customers, a key issue for managers and entrepreneurs becomes interpreting their feedbacks. Again, the Axiomatic Design allows quantifying stochastically the agreement between what is offered and what is expected, introducing a criterion to prioritize the modifications to be implemented in the original project (or idea) and keep a record of the variation of customer tastes regarding the offered product.

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