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Role of Online Product Reviews and Text Mining in Development of New Generation Products

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ABSTRACT
In the era of Big Data, with the advances in e-commerce, users, rather than producers, tend to pioneer to express to-be-improved product features with online product reviews. Although there are many conventional methods for determining users' opinions about available products, these methods are costly, non-voluntary, applied with a limited group, and have the risk of including much bias. Reviewing user-generated product reviews has distinct advantages over traditional methods. On the other hand, extracting high-value data from online user reviews is challenging than interviews and market research. We introduce a framework that helps extract useful data from online customer feedback using accessible and handy tools to create pattern models in terms of clarification, comparability, and validity. This article provides a business case which allows the decision-makers to recognize the summarized and visualized review trends and their potential triggers that could be considered for future product decisions.
Keywords: big data; text mining; product design; ABSA.

INTRODUCTION
Defining the features to be improved in the product is a necessary but complicated process for the product redesign. Thus, various methods are used to obtain customer requests and opinions and determine new product needs. The initial product development process is the product of a need-based analysis and subsequent design processes. However, redesigning the product depending on new expectations or developing a new product to be included in existing products is different from the initial design process. Decisions made at this stage can be as healthy as fed by past experiences.

The tracking and evaluation of online opinions is also a significant and reliable source of information in this context (Pan, Lee-Yun, & Chiou, 2011). E-commerce has a massive economy, with many websites focused on online selling products. The vast majority of e-commerce sites provide customers with the opportunity to express their opinions about the products/services they have purchased. This feedback in the form of reviews provides excellent benefits for both the producer and the consumer (Güneş, 2020). The results provide a rich source of information about the users' experiences and satisfaction level used to develop more competitive products (Lee et al., 2014) to discover trends in consumer requirements (Jin et al., 2016) for the early stages of product design (Hu and Bing, 2004) and to develop more effective product design strategies and marketing plans (Lau et al., 2011).

It has been widely observed that this resource has been used in every area, from social services to internet applications. This resource is also used as a source for a variety of academic studies. Maiyar et al. (2019) focused on using social media content to examine customer-centric information that tracks consumers' evolving needs from textual social

media data obtained from fashion blogs in Germany. Using electronic data from Amazon.com, Chong et al. (2017) tried to predict whether online review variables such as valuation and review volume, the number of positive and negative reviews, and online promotion marketing variables such as discounts and free deliveries would affect electronic demand.

On the other hand, Bi et al. (2019) focus on handling the information within the network structure with the Kano model and analyzing customer satisfaction. Guo et al. (2017) focused directly on the new product development process. The study emphasizes the risk of failure in the new product development process and the importance of predicting product success. In this context, the method's efficiency was evaluated over the 4-burner gas cooker as a sample product. One of the areas where online feedback can be received most often is comments on physical products. Conventional methods such as the user's experience of the product and giving opinions are among the most useful and valuable sources of information (Focus Group, Contextual Inquiry, Interview, and Context mapping). However, accessing this resource with traditional practices is very costly and involves risks such as bias. Resources obtained from online evaluations feed a process similar to user experience-oriented applications invaluable as a traditional research method. However, the rate of benefiting from these data, especially in product design, is still minimal. The obtained comments also contain physical evaluations about the product and provide essential data on marketing and after-sales processes. From another point of view, these evaluations are based on different motivations such as the desire to express oneself and be useful, and may even include analysis and ideas at the technical detail level. However, while the importance of evaluating online feedback in its entirety is obvious, the method of this evaluation is also essential. Abdalraheem draws attention to the importance of determining whether the data obtained from the feedbacks are useful or not. This context defends the necessity of automating the work to be done and offers suggestions by comparing machine learning-based methods (2019).

Feedback about the product design differs somewhat from other examples as it is a physical object. The utilization process, which can be temporary for a service, is owning when the subject is a product and then becoming a user. An individual who can buy a service elsewhere when he needs it again does not have an equal chance to replace his product with a different product. This situation can be interpreted as expressing the products' comments more sharply or the expectations more clearly. On the other hand, there is a risk that the reviews may be manipulated in the comments made regarding online evaluations. Moriuchi draws attention to this gap in his study in 2018. The study cited that due to the increase of manipulated online reviews, giant e-sellers like Amazon.com are trying to deter false online reviews. On the other hand, the study includes recommendations for developing an understanding of social commerce and integrating social commerce as part of their marketing plans for online retailers (Moriuchi, 2018). However, it has been evaluated that comparative studies will be needed for clear statements about positive and negative inputs in terms of information that will provide input to product design. The study aimed to obtain information from online evaluations to product design, while the PlayStation (PS here and after) 4 Pro / Slim product was chosen as an example for this purpose. In this context, the validity of the data obtained was also focused on. The methods for freeing from manipulation were also discussed. The study includes an approach discussion and suggestions that can be the product design and redesign process source. In this study, a new approach is systematically established to extract useful data from online customer feedback using accessible and handy tools to create pattern models in terms of clarification, comparability, and validity.

The contribution of this analysis has several folds. First, the proposed approach allows the decision-makers to recognize the summarized and visualized review trends and their potential triggers that could be considered for future product decisions. Second, while the

importance of OPRs is increasingly recognized, decision-makers need different knowledge disciplines such as text processing, data mining, and information retrieval. Third, the approach proposed in this study does not only expose general product trends. This approach also lists the potential triggers behind patterns by assessing the internal dynamics of patterns. Forth, the proposed approach is close to QFD in terms of focusing on users and their needs in context but differs from the combination of OPR-based interactive and dynamic sources in context and generative tools such as pattern recognition for evaluation. Finally, if sufficient dictionaries are developed, the proposed approach may be generalized to other product categories.

The rest of this paper is organized as follows: This section provides a brief motivation and background. The following section presents the Sony PS 4 used in the research work. After that, the next section introduces the PS 4 Pro/Slim case study. Evaluation, discussion of the results, and concluding remarks are provided in section fine-tuning and discussion.

THE CASE OF PLAY STATION 4 PRO/SLIM

In the study, the well-known Sony PS4 Pro/Slim was selected as the sample product. There are specific reasons for choosing the PS4 Pro/Slim product in the study. First, the global gaming market was valued at USD 151.55 billion in 2019 and is expected to reach a value of USD 256.97 billion by 2025. Second, critical players in the market are Sony Corporation, Microsoft, Nintendo, and other small ones trying to keep innovating and releasing next-generation gaming consoles provides significant competition among the rivals. Third, in the wake of this COVID-19 outbreak, home entertainment seems to be the only option for gamers in lockdown; online gaming picks up its pace as one of the best options to stay at home entertainment. Moreover, last, both Sony Corporation and Microsoft's new generation consoles are released at the end of 2020.

A video game console is a specialized desktop computer powered by operating systems and CPUs to play video games. Video game consoles require a TV or monitor for display and controller, an input device used with video games to control an object or character in the game. Game consoles are capable of many of the typical desktop computer features such as Internet connectivity, file transfer and storage, and electronic communication through voice, video, and typed chat. Sony's first PS came out in 1995 and competed against Sega Saturn and Nintendo 64. The Sony PS game console family has sold more than 450 million parts since the day it was first launched, and the PS division now represents 78 percent of Sony's profits. However, Sony PS 5 is scheduled to launch in November 2020 with a base model with an Ultra HD Blu-ray compatible optical disc drive and a Digital Edition lacking this drive. This study was designed based on the PS 4, which was first released in 2013. The Pro version's user comments, the most potent version of PS 4, and the Slim series (2016), its smaller and lighter version, were used in the study. There are significant performance differences between the Pro and Slim models. The Pro series generally has about 30% more CPU and 100% more GPU. However, the Pro series has one extra USB 3.1, new version HDMI 2.0, and Optical Audio Output. HDMI 2.0 is required to support 4K, while the extra USB hard allows for VR and external drive. Despite these apparent differences from a visual perspective, the PS4 Slim is the standout of the three: it is thin, discrete, and very living room friendly.

CONSTRUCTING THE DATA SET AND FEATURE EXTRACTION

In the first stage of the experimental study, a data set to be used for advanced analysis was created. Since there was no PS 4 Pro/Slim related OPR dataset readily available, the data on verified purchase reviews between November 10, 2016- August 22, 2020, were gathered on August 24, 2020, from Amazon.com using a Web data crawler. A total of 6,202 verified purchase reviews with a 162,365-word count from the United States were separately recorded in the Excel file with their metadata.

First, to investigate whether there is a mismatch between the numerical responses and the written comments of the reviewers, a combination of sentiment analysis and correlation analysis is conducted by RapidMiner to analyse the (co)relationship between the reviewers' star rating and the qualitative measure of the reviewers' written comments. The link between the star ratings ([STAR]) and the overall calculated document-level sentiment scores (polarity [TEXT]) is investigated and evaluated using the Correlation Matrix operator in RapidMiner. This operator calculates the correlation between -1 and +1 that measures the degree of association between [STAR] and polarity [TEXT] attributes. A positive value for the correlation implies a positive association. The correlation value *r* (r=0,576), as shown in Table 1, was high, showing a significant relationship between the two variables, star rating and overall sentiment score. With this high correlation value obtained, it was determined that the existing data set has sufficient relevance, accuracy, and comprehensiveness for further analysis.

Table 1. The (co)relationship between the reviewers' star rating and the qualitative measure of the reviewers' written comments.

Attributes	Polarity (TEXT)	STAR	Confidence (TEXT)	Agreement (TEXT)	Subjectivity (TEXT)	Irony (TEXT)
Polarity (TEXT)	1	**0,576**	0,387	-0,355	0,04	-0,037
STAR	**0,576**	1	0,331	-0,321	0,104	-0,025
Confidence (TEXT)	0,387	0,331	1	-0,807	-0,129	-0,359
Agreement (TEXT)	-0,355	-0,321	-0,807	1	0,145	0,123
Subjectivity (TEXT)	0,04	0,104	-0,129	0,145	1	0,077
Irony (TEXT)	-0,037	-0,025	-0,359	0,123	0,077	1

After data collection, the feature extraction phase is applied to create a customized dictionary with more specific terms that are not included in basic dictionaries to carry out sentiment analysis over different aspects/features of the study's product. First, for the feature extraction phase, text pre-processing is applied to online text to remove noise and uninformative parts such as HTML tags, scripts, and advertisements before further processing to improve the classifier's performance. The pre-processing stage usually contains four common pre-processing steps: tokenization, stop-word removal, lowercase conversion, and stemming from reducing the dimensionality of features. For this purpose, the current data set is processed with the Process Documents operator in RapidMiner to generate word vectors from a text object. After applying transformation on the data, including HTML tags clean up, tokenizing, transforming cases, stopwords removal, filtering tokens by length, and stemming (Porter), POS tagging is performed by nouns/nouns phrases from the reviews that can be a candidate to product features. The study used the Stanford-POS tagger to parse each word (whether the word is a noun, adjective, verb, adverb, etc.) where the nouns and noun phrases are most likely to be product features. After the POS tagging is performed frequency of each noun and noun group was calculated. From the most frequent nouns (≥ %3), the selected nouns are collected into a separate list of candidate features to create a customized dictionary for MeaningCloud in RapidMiner. The user dictionary in MeaningCloud is composed of two elements: entities/concepts (what

you want to detect in texts) and the ontology (*MyParentNode>MyChildNode*) that is defined by the entries added to the dictionary. Two methods have been used to create a customized dictionary (*PS4_en*). In the first stage, the product user manual was examined from *https://manuals.PS.net*, and the terminology (hardware part names) of the product was classified ontologically as physical attributes of the product. This terminology list has been compared with the candidate product feature list, and the possible aliases have been added to the dictionary. The aliases of entry are the possible variants that will be considered as appearances of the entry in a text (*i.e., Entity: LAN port; Aliases: Ethernet, LAN Socket, Ethernet Port, Ethernet Socket, Ethernet connection; Ontology: Top>Product>Hardware>Console>LANPort*). In the second stage, the concepts are defined as quality attributes with their possible aliases such as design, performance to measure the fitness and suitability of the product and to analyse its quality characteristics (*i.e., Concept: Design; Aliases: Look, Aesthetics, Shape, Form; Ontology: Top>Product>Quality>Design*) (Figure 1).

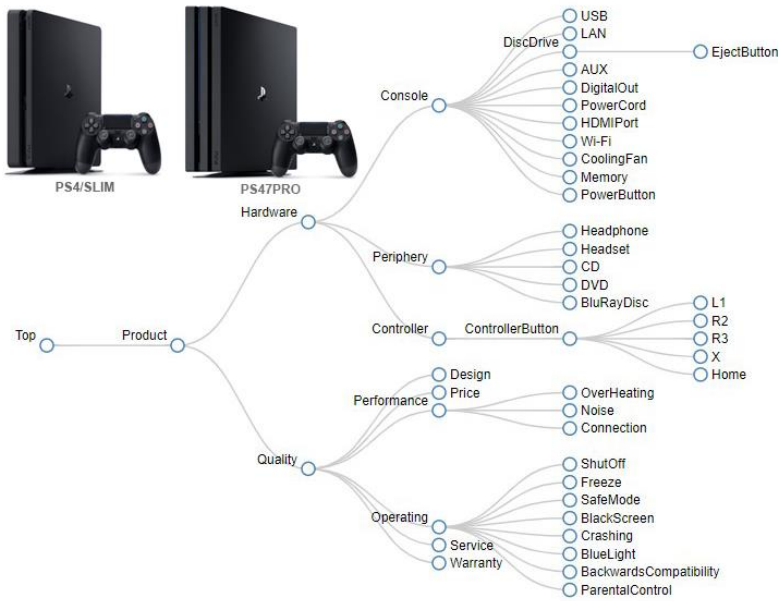

Figure 1. An example part of an ontology tree for PS4.

ASPECT-BASED SENTIMENT ANALYSIS (ABSA)

This stage will focus on ABSA to discover reviewers' attitudes and sentiment towards various features of the PS4. In this step, a mapping between extracted features (aspects) and sentiment scores is created where sentiment scores are used to classify the sentiment polarity (i.e., positive, negative, or neutral) of each aspect. The system enables us to see each product's strengths and weaknesses in consumers' minds in terms of various product features. In order to determine the sentiment intensity and polarity for each aspect of the PS4, a total of 6,202 verified purchase reviews in text form were submitted to ABSA by MeaningCloud in RapidMiner to break down the text into aspects and determine the corresponding sentiment for each of them. In the study, two lexicons, a domain-specific lexicon and a generic opinion lexicon, are used. The study used its domain-specific lexicon as a semantic resource (*PS4_en* dictionary) and as well as and the generic opinion lexicon of MeaningCloud to customize the operation. After calculating the contextual sentiment score for each aspect, the sentimental orientation (e.g., very positive [P+], positive [P], neutral [NEU], negative [N], and very negative [N+]) for each reviewed aspect is calculated (Table 2), and a contingency table has been formed by assigning a numeric value for each sentiment orientation (P+=2, P=1, NEU=0, N=-1, and N+=-2) as prior sentiment scores.

Table 2. Sample review row with ABSA polarity.

NAME	STAR	DATE	TEXT	Aspect: Sentiment (TEXT)
D**** A*********	3	May 17, 2018	Like the slim design and controller. The system has a great deal of difficulty streaming TV and movie content. Disappointing. Not what I was expecting from a 1 terabyte system...	Design: P | system: N | Controller: P | Streaming: N+

Then, to measure each aspect's central tendency, the arithmetic mean is calculated by dividing each sum of each aspect's total score by its count (occurrence), as seen in the sample row in Table 3.

Table 3. The sample row of an aspect with calculates mean.

Aspect	P+ =2	P=1	NEU= 0	N= -1	N+= -2	Σ Score	Count	Mean
Performance	20	20	3	5	1	53	49	**1,08 (P)**

After carefully analysing the aliases, each sentimental orientation of an aspect is categorized in flow chart format according to the ontology tree that is previously created (Figure 2). When this flow chart is examined, it is seen that the chart differs from the previously produced tree ontology in terms of certain features. First of all, it has been observed that users also commented and made evaluations about competing brands (XBOX and Nintendo) in the market. These evaluations are indicated on the far left of the flow chart. However, customers have not only evaluated the PS4 but also Sony and sub-brand PS brand images. In user reviews, it is seen that the PS sub-brand has a higher value than the Sony umbrella brand. However, when the products of the PS brand are evaluated within themselves, it has been found that the PS 3 version has a lower value for loyal customers compared to the PS 2. In comparison to the previously developed ontology tree, it was noted that customers also commented on new aspects (such as CPU, GPU, RAM, Package Design) that were not previously found in the feature extraction process. This interesting mismatch showed that the customers are wise, skilled, and experienced to evaluate even indirect technical details and have extensive knowledge than expected.

The current Flowchart presents interesting sentiment data about PS4. The level of detail increases towards the right to provide a visual representation of product aspects and their relationship. Each box in the diagram defines a product aspect that hits any sentiment. In each box's content, the name of the aspect, its' average sentiment score (between -2 and 2), and the number of sentiment scores for that aspect are specified in parentheses. Coloured arrows are pointing to different values in each box for ease of reading. When a general evaluation is made, some patterns in the flow depending on the ontological tree. In the first pattern structure, some aspects have consistently taken positive values. These stable positive aspect streams are presented in Table 4. When Table 4 is examined, it is seen that the sentiment values are consistently positive, starting from the top hierarchy. The possible reasons for this positive evaluation can be reached as we move to the right in the table. In the table, starting from the top hierarchy of sentiment values, it progresses steadily and positively.

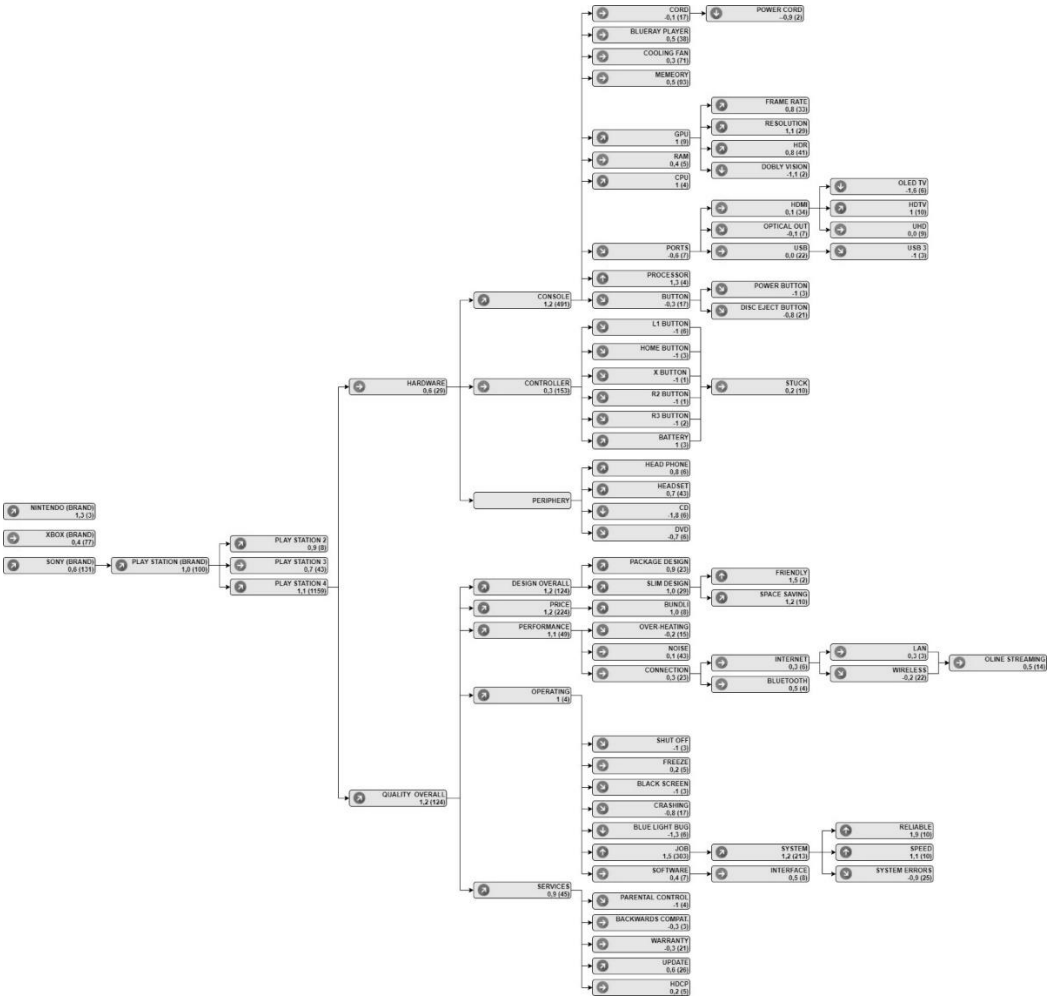

Figure 2. The flowchart of product features based on their score.

The possible reasons for this positive evaluation can be reached as we go to the right in the table. For example, the design (*NN*) aspect was independently rated positively by users. The package design (*NN* + *NN*) and the slim design (*JJ* + *NN*), which are other aspects of this aspect, also have a positive independent sentiment score. Thus, while the design statement alone has an unjustifiably favourable value, the other two independent aspects have a potential explanation for why the design aspect is highly valued. Likewise, since the friendly and space-saving expressions in the lower hierarchy appear simultaneously and together in the text, they are declared justifications were indicating why the slim design expression gets a higher score.

In addition to the issues mentioned above, the product's price and the product's sale as product bundles (package deals) are welcomed by the customers (Table 4). Product bundles can be immensely popular with customers who appreciate the bundle's discount. For this reason, Black Friday, Christmas (Xmas), and gift prices are frequently mentioned in customer comments.

Table 4. The first pattern structure with stable positive aspect streams.

ROW	ASPECT	SUB#1	SUB#2	SUB#3	SUB#4	SUB#5
1	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	DESIGN OVERALL 1,2 (124)	PACKAGE DESIGN 0,9 (23)		
				SLIM DESIGN 1,0 (29)	FRIENDLY 1,5 (2)	
					SPACE SAVING 1,2 (10)	
2	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	PRICE 1,2 (224)	BUNDLE 1,0 (8)		
3	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	OPERATING 1 (4)	JOB 1,5 (303)	SYSTEM 1,2 (213)	RELIABLE 1,9 (10)
						SPEED 1,1 (109)
4	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	SERVICES 0,9 (45)	UPDATE 0,6 (26)		

The PS 4 Pro / Slim is seen by commenting customers as a high-performance fast product that does its job. This situation is already supported with a 4.48 / 5-star average score of 6202 reviews of the product. On the other hand, the product has qualified update support. It is seen that some problems, such as Blu-ray support, were corrected over time.

Although an aspect higher in the hierarchy got high scores in the second pattern structure, it scored lower than expected in terms of its subcomponents (Table 5). Building a perfect product is always a work in progress situation; there is no such thing as a perfect product. Therefore, even if a product has a high score, each customer experience can point out a new problematic area. When the number of complaints on the same problem increases, that problem appears as a serious product defect or deficiency. These defects or deficiencies can be classified into three categories: minor, major, and critical. The nature and severity of a defect determine in which of the three categories it belongs. When it comes to major defects, *shut off, freeze, crashing, black screen, blue-light bug, and system errors* are aspects that can fall into this category. Because these aspects render PS 4 Pro/Slim completely unusable or malfunction and rework software or hardware may be needed to correct the issue. When the comments containing these expressions are examined, a 1/5-star score is generally given. Users who cannot operate the product due to system malfunctions are seen as the customer group with the worst product experience.

Interestingly, this group of customers has negative reviews for the product itself and the Sony brand for reasons such as disappointment and inadequate after-sales service. The second group of significant defects could adversely affect the function, performance, or appearance of a product. In this group of defects, the product works but is not at the desired performance or satisfaction level. For example, although the product operates, it generates higher heat than expected, it works louder, and there are problems in connection, especially in the wireless one. Although it is normal for every electronic product to generate heat, overheating indicates a chronic problem. The causes and consequences of product overheating are different. Overheating may cause the product to shut down or the cooling fan to run continuously. A continuous running fan can create noise. Therefore, the defects mentioned here may be cause or effect in a series to each other. For this

reason, aspects with low scores should be examined in detail, and possible cause and effect relationships should be looked at each other.

In this category, other defects are related to the services offered by the product. Warranty conditions, parental control (features that allow parents to restrict the access of content to their children), backward compatibility (features that allow for interoperability with an older legacy system), and HDCP (a copy protection scheme to eliminate the possibility of intercepting digital data midstream between the source to the display) are the primary complaint issues.

Table 5. The second pattern of flow chart with low scores than expected.

ROW	ASPECT	SUB#1	SUB#2	SUB#3	SUB#4	SUB#5	SUB#6
1	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	PERFORMANCE 1,1 (49)	OVER-HEATING -0,2 (15)			
				NOISE 0,1 (43)			
				CONNECTION 0,3 (23)	INTERNET 0,3 (6)	LAN 0,3 (3)	ONLINE STREAMING 0,5 (14)
						WIRELESS -0,2 (22)	
					BLUETOOTH 0,5 (4)		
2	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	OPERATING 1 (4)	SHUT OFF -1 (3)			
				FREEZE 0,2 (5)			
				BLACK SCREEN -1 (3)			
				CRASHING -0,8 (17)			
				BLUE LIGHT BUG -1,3 (6)			
				SOFTWARE 0,4 (7)	INTERFACE 0,5 (8)		
3	PLAYSTATION 4 1,1 (1159)	QUALITY OVERALL 1,2 (124)	SERVICES 0,9 (45)	PARENTAL CONTROL -1 (4)			
				BACKWARDS COMP. -0,3 (3)			
				WARRANTY -0,3 (21)			
				HDCP 0,2 (5)			

In the third structure, consistently low scores are seen throughout the hierarchy (Table 6). As the customers are the purest form of quality control, these low scores should be taken as positive attributes that highlight a problem, and their potentials should be welcomed for further improvements. From this point of view, it is seen that opposing opinions are generally formed within the scope of hardware, and most of them can be eliminated by adding extra hardware, more qualified design, and appropriate software update. For example, the product received a low score in Blu-ray Player and extra external HDD (Memory). However, this problem was solved with the update published by Sony in 2017. The update adds support for 3D Blu-ray discs to PS VR, letting users see 3D in full stereoscopic glory when watching movies using a headset and enables 8TB of additional space via external drives. On the other hand, some problematic areas are not solvable over the current product. Considering the reviews, it is seen, for example, that optical out and extra third USB ports are requested in all models. The optical out port is in the PRO model but not in the Slim model.

Similarly, the Pro model has 1 TB of Memory, while the Slim model has 500 GB of Memory. The critical point here is that while consumers were making a purchasing decision, they did not analyse the differences between Pro and Slim models and did not adequately examine the differentiating features of segment products. In many user reviews, this is particularly evident for customers who bought the Slim model. Many users purchased the Slim model, assuming that it has 1 TB of Memory, but they negatively commented on the Memory when they saw that it had 500 GB of Memory. Another downside to Memory is the size of the system files. The Pro model, which is introduced with 1 TB of Memory, actually has 800-850 GB of free space due to the space taken up by system files. In this context, consumers made negative comments as they encountered a free space less than the declared memory space. The negative evaluations about the cooling fan are caused by the fact that the fan is insufficient, especially in cases requiring high processing power, causing overheating and the system shuts down against this critical threat. Another downside is related to the noisy operation of the cooling fan. The fan's continuous upper performance has often been stated to prevent overheating that affects the gaming experience. In the PS, the most intensive interaction of users is the controller. The controller's main complaints have been declared as the stuck of the keypad buttons over time.

Table 6. The third pattern of flow chart with consistently low scores.

ROW	ASPECT	SUB#1	SUB#2	SUB#3	SUB#4	SUB#5
1	PLAYSTATION 4 1,1 (1159)	HARDWARE 0,6 (29)	CONSOLE 1,2 (491)	CORD 0,1 (7)	POWER CORD -0,9 (2)	
				BLUERAY PLAYER 0,5 (38)		
				COOLING FAN 0,3 (71)		
				MEMORY 0,5 (93)		
				RAM 0,4 (5)		
				PORTS -0,6 (7)	HDMI 0,1 (34)	OLED TV -1,6 (6)
						UHD 0,0 (9)
					OPTICAL OUT -0,1 (7)	
					USB 0,0 (22)	USB 3 -1 (3)
				BUTTON -0,3 (17)	POWER BUTTON -1 (3)	
					DISC EJECT BUTTON -0,8 (21)	
			CONTROLLER 0,3 (153)	L1 BUTTON -1 (6)	STUCK 0,2 (10)	
				HOME BUTTON -1 (3)		
				X BUTTON -1 (1)		
				R2 BUTTON -1 (1)		
				R3 BUTTON -1 (2)		
			PERIPHERY	CD -1,8 (6)		
				DVD -0,7 (6)		

However, it has been declared that the power button and the disc eject button on the console are tiny and invisible. Detailed evaluations on this subject will be made in the following sections. Given an overall assessment of this pattern, specific improvements must be made by Sony. First of all, the company should reflect on the features and differences of the consumer's models transparently and eliminate improper communication. It is seen that the inexperienced buyers who experienced the PS for the first time could not analyse these differences well at the time of purchase and stated them as complaints due to disappointment after the purchase. Another consumer expectation is that some low-cost features (longer power cable, optical port, third USB port, etc.) are included in all company models. There is a fierce price war between competitors in this sector. Therefore, companies act like nit-picking bean counters to offer the most competitive price to the consumer, sacrificing many possible product features to give the consumer advantage in practice. From this perspective, the firm may trade-off between price and the most desirable minor features and the challenges customers face to build better competitive products. Some physical product features that are the subject of complaints can be resolved with appropriate software updates. Software updates are important because they often include critical patches to security holes and improve the software's stability and remove outdated features to make the user experience better. As far as it can be observed in product evaluations, there is a big decrease in complaints after updates. For this reason, companies should follow product complaints closely and provide appropriate updates in a way that even the most inexperienced user can install the update. Because, when examining the user comments, it is seen that many inexperienced users who are unaware of the updates have taken their complaints, and other experienced users direct these complaints towards a solution.

THE DESIGN ISSUES

In this section, variable-length word phrases containing the design aspect are searched in user comments. The main reason for attention to the design aspect is that it has the relatively highest user score. The design expression is defined in the source dictionary (*PS4_en*) with different aliases (*looks, aesthetics*). In NLP, unique expressions in the text and word phrases containing that word can be searched using N-gram modelling. By keeping the design-related expression constant (*c*) thanks to rule-based text search, word phrases created with this aspect were produced. The type of a word or, in other words, the class to which it belongs; can be Noun, Verb, Pronoun, Adjective, Adverb, Preposition, Conjunction. Some words belong to only one of these classes, while some may belong to more than one. The word type can be determined by examining a word's position in a sentence and determining the Part-of-Speech (*POS*) for that word. While the method based on the number of observations of two or more words together in statistical NLP, the frequency of observation of (*n-gram*) words placed side by side in the collections is also measured. For N-grams containing the design aspect, two basic patterns and possible combinations were evaluated. The first of these is *ADJ + NOUN (design, aesthetics, look).* The other is the combination *VERB (looks, feels, designed) + ADJ*. Thus, 30-word phrases were reached over the entire data set. The frequency of occurrence of each, the sentiment value (Polarity), as well as other n-grams (*neighbour n-grams*) in the same sentence with the word phrase are presented in the table below as possible reasons for the evaluation (Table 7).

Table 7. User reviews about design aspect and aliases

Row	Word Phrases	POS	Occur.	Pol.	Neighbour n-grams
1	Looks great	*VERB |ADJ*	13	P+	
2	looks good	*VERB |ADJ*	8	P	
3	looks amazing	*VERB |ADJ*	6	P	
4	slim design	*ADJ |NOUN*	4	P	space saving

5	looks nice	*VERB |ADJ*	4	P	
6	great design	*ADJ |NOUN*	3	P+	
7	good design	*ADJ |NOUN*	3	P	space saving
8	love design	*VERB |NOUN*	3	P+	
9	nice slim design	*ADJ |ADJ |NOUN*	2	P	
10	love slim/sleek design	*VERB |ADJ |ADJ |NOUN*	2	P	
11	looks cool	*VERB |ADJ*	2	P	
12	like slim design	*VERB |ADJ |NOUN*	2	P	
13	love the slim design	*VERB |DET |ADJ |NOUN*	2	P	
14	looks beatiful	*VERB |ADJ*	2	P	
15	sleek design	*ADJ |NOUN*	2	P	space saving
16	looks well	*VERB |ADJ*	2	P	
17	small design	*ADJ |NOUN*	2	P	slim fit
18	aesthetic design	*ADJ |NOUN*	2	P	
19	ugly design	*ADJ |NOUN*	2	N	triple layer big mac design
20	useful design	*ADJ |NOUN*	1	P	
21	Functional/aesthetic design	*ADJ |ADJ |NOUN*	1	P	
22	sleek / thin design	*ADJ |ADJ |NOUN*	1	P	space saving
23	smaller design	*ADJ |NOUN*	1	P	convenient
24	slick design	*ADJ |NOUN*	1	P	
25	beautiful design	*ADJ |NOUN*	1	P	
26	feels and looks well-constructed	*VERB |CONJ |VERB |ADV |VERB*	1	P	easy to install cables
27	looks better	*VERB |ADJ*	1	P	
28	short sided design	*ADJ |ADJ|NOUN*	1	P	
29	minimal design	*ADJ |NOUN*	1	P	
30	looks perfect	*VERB |ADJ*	1	P+	

According to Table 7, all users generally like the design of the PS 4 with an average score of 1.2 (P). When the basic N-grams and the neighbouring N-grams are examined, the taste's general justification is determined from two angles. The first of these is the product's aesthetic value, and the product's visual values are satisfactory for the users. Moreover, adjectives such as slim, small, thin, which generally have relative polarity, were seen as positive features for this product. In short, being small and thin appears as a desirable and appreciated design feature in game consoles. It has also been observed that the small size of the product creates functional advantages such as space-saving.

Table 8. Negative and positive comment sets of focused sample features.

FEATURE	Negatives				Positives			
	Status	O	Judgment	O	Status	O	Judgment	O
Power (ON/OFF) Button Disc Eject Button	super tiny/tiny	1	hard-to-see	1	Physical button	4	eliminate accidental eject/rest mode	2
	small	3	frustrating	1				
			hard-to see	1				
	thin	1	not accessible	1				
			hard-to find	3				

			impossible-to find	1				
	no touch screen	1						
Controller Buttons	difficult to remember	1			looking better	1		
	difficult to learn	2	20 buttons	1	feeling better	2	plastic feel	1
	sticking buttons	6					texture on the control sticks	1
					easier access	1		
					works great	1		

On the other hand, being slim, small, and thin also brings some product complaints. When detailed examinations are made based on physical properties, some troublesome points in terms of design are criticized by users. For example, the on / off and disc eject button, which is in direct physical contact with the user, is at the centre of the criticism (Table 8). Both keys resulted in low scores in the overall assessment. The main reason for this is that they are small and, therefore, inaccessible and invisible. Therefore, while being small and thin is a useful feature in general design, it is subject to criticism when it comes to details. Similarly, fitting many control keys in a narrow space makes it challenging to use the controller, especially for inexperienced users. The analysis made within the scope of the study also allows some surprising inferences to be made. For example, many users focused on the subject positively commented that the buttons on the product are physical buttons. Although there are more advanced possibilities in terms of technology, there is the thought of preventing accidental presses behind the demand for physical keys. From this point of view, it is seen that user comments give valuable data in the context of context in use.

THE WISH LIST

Experience-based user preference plays an important factor in developing next-generation products and marketing to fulfil consumer perceptions and preferences. Many quantitative and subjective methods have been proposed, such as QFD, HOQ, Kano, MOSCOW, discrete choice analysis, and others to capture the voice of the customer to map consumer requirements to technical specifications, and to improve next-generation products by considering the past user–product experiences and preferences of a population.

This section has tried to identify the users' needs by analysing and filtering the modal verbs through the source review texts, establishing the target characteristics, and determining the possible feature and presentation suggestions. In English, the modal verbs include *can, must, may, might, will, would, should*. They are used with other verbs to express ability, obligation, a possibility. There are apparent differences between modal verbs. The modal verb "must" and the phrase "have to" are used to express obligation and necessity, and both express submission to various general and minimum requirements; that is, something needs to be fulfilled by the product. The modal verbs "may" and "might" are used to express that something is possible. "Should" is used to show obligation, give a recommendation or even an opinion, and to express something probably. "Should" indicates a requirement if possible, but overall product success does not rely on it. Similarly, "could" is used to suggest a possibility or even a polite request about a requirement if it does not affect anything else on the product as the time and resources permit. Similarly, "would and wish" is used to make a polite request and indicates hypothetical situations of a requirement later, but delivery will not be this time or not appropriate at that time.

In this section, sentences containing modal (MD) were investigated. A simple modal expression in English is PRP + MD + VB + NN (*e.g., It must have storage*). Individual wishes appear as a combination of PRP + VPB + TO + VB + NN (*e.g., I wish to have a*

controller) acting as a modal. CDs with JJ, JJR, and JJS added in front of the depicted names indicate requested improvements (*e.g., I wish to have longer battery life or I want to have 1 TB storage.*) For this purpose, all user comments were subjected to the POS tagging application on a sentence basis, and the sentences that comply with the above-mentioned modal usage rules were accepted as a pattern and recorded as a separate file. As a result, it was seen that there were 93 modal usages in 12055 sentences that create a sample wish list (Table 9).

Table 9. The wish list with modal verb usage.

MODAL	WISH	#O	MODAL	WISH	#O
must have	1TB memory	3	wish to have	better headphones	2
should have	2TB Memory	2	wish to	connect Air pods	1
should have	an exact 500GB or 1TB Memory	2	must have	2.0 HDMI port	1
should have	SSD Drive	2	should have	a few more USB ports	2
should have	extra 4GB Memory for 2K	1	should have	optical digital audio output	1
could	format hard drive without laptop	1	should to have	its own remote controller	1
wish to have	2TB Memory	3	must have	to work with OLED TVs	1
would have	1 TB SSD	1	should have	to work with VIZIO TV	1
wish to have	more storage	1	would have	more TV support	3
should have	4K UHD Blu-ray	1	should have	4K/30FPS option	1
could to have	4K UHD Blu-ray drive	1	wish to have	better graphic level	1
would have	4K Blu-ray	1	wish to have	ability to run 1440p @ 60 fps	1
wish to have	4K Blu-ray drive/support/player/upgrade	7	wish to have	HDR support	1
could have	backwards compatibility	1	wish to have	longer HDMI cable	1
would have	backwards compatibility	1	wish to have	more games	2
wish to have	backwards compatibility	4	wish to have	physical CD/DVD games	1
could to have	cheaper price	1	must have	individual set up option	1
wish to have	cheaper price	3	could have	simpler menu design	1
must have	two controller	2	would have	different interface	2
should have	two controller	2	must to have	physical buttons	2
wish to have	second controller	2	wish to have	polished surface finish	1
want to have	longer battery life	1	would have	the Pro in other colours at launch	1
should have	ability to turn off the controller light bar	2	should have	ability to change profile picture	1
could have	technical support on phone	1	should have	major streaming services with an app	1
would have	better consumer service	2	should have	no ads	1
should have	full manual to download	1	should have	Parental Control	1
wish to have	2 year warranty	1	should have	shorter load time	2
must have	silent fan	1	wish to have	larger mod download limit	1
should have	silent fan	1	wish to have	ability to link Xbox	1

should have	better cooling fan	2	wish to have	ability to play music CDs	1
wish to have	silent fan	1			
wish to have	an extra cooling fan dock	1			

Wish lists are collections of desired product specifications commented by customers, signifying next-generation product interest without immediate purchase. These wish lists are usually formed due to a specific product experience and guide decision-makers for new generation products. When the obtained wish list is examined, three different types of demand patterns emerge. The first of these consists of the demands of the Slim version users. Interestingly, these users demand features that are usually in the Pro version. Because, during the purchase, many consumers do not necessarily read specs to learn about features. Moreover, many customers may not be aware of features that will meet a critical need in the future. Most of them may not be aware of some technical nuances and differences that will require almost expertise today. For example, 500 GB may seem a sufficient storage space for many users. However, during use, this area may be exhausted in line with the usage characteristics. Many users may complain about the insufficiency of the storage space they have received due to this experience. Some aspects of the products may not be known or predicted at the purchasing stage. For example, many users may not be aware that the product is not playing a music CD. Moreover, in perception, a drive with 4K playback capacity is expected to play CD. Complaints on this issue point to a particular disappointment and a lower performance than expected. Issues such as the product's incompatibility with OLED TVs or Air pods, fan with higher noise than expected, and slow loading times are complaints resulting from experience. On the other hand, understanding the value of some missing features known at the time of purchase may be subject to the wish list. Although the product has been sold with a single controller, many users have requested the second one. Because many users have to buy the second controller and think they are paying more than the likely bundle price. Similarly, the Slim version does not have an optical out port. Although this port's actual cost is meager compared to the product's total price, the fact that it is not included in Slim is the subject of criticism, and many users are trying to solve the Optical Output problem eclectically with the HDMI Splitter by bearing relative costs.

The second type of wish list stems from the expected improved performance on the existing features. The basic logic here is that the next one should be somewhat better than the current one. Moreover, technology develops and becomes cheaper from consumer perception. However, many companies, also Sony, choose either the sequential naming approach such as PS 1, 2, 3, 4, and 5. The launch of a new generation such as PS5 comes with the risk of disappointing enthusiastic consumers who expect more from the product than they otherwise would have. Consumers in this pattern expect superior features such as higher storage capacity, graphics processing capacity, quieter fan, longer battery life, and faster loading time than existing ones from the next generation product. Therefore, an improved version of the product always brings with it the demands for improved product features.

The third type of wish list is relatively minor, but it is aimed at each user's desired characteristics. This is perhaps the most critical part of the lists. Because this area may contain potential topics that may be overlooked for companies, although there are minor requests, it can include potential innovation suggestions. It should be regarded as an area capable of exceeding customer expectations rather than specifying general customer requirements. The majority of them are features that customers are indifferent to and that are rarely or never needed. Such needs are neither explicitly stated nor expected by customers. However, if it is satisfactory, they positively affect how much the customer will be satisfied with a particular product. Because these will be the features that will differentiate the product if found. In the evaluation made within the study's scope, no

feature proposal to accommodate this potential was encountered. However, it should be kept in mind that some demands, although at very low frequencies, will be noticed by general customers as a surprise if they are satisfied. For example, Parental Control requested by only a few users, ad-free interface, longer HDMI cable, downloadable user manual are features that general users are not aware of but will benefit practically all users.

Another example is much more interesting. Two users state that the buttons on the product should be physical. When these comments of the users examine, it is seen that this request is requested to prevent accidental pressing of these keys and the product from going into rest mode.

CONCLUSION

With a series of analyzes carried out so far, it has been possible to obtain meaningful results, which may be a valuable input for decision-makers. It is difficult to read and interpret all these opinions on millions of product reviews. However, these difficulties do not mean that these user-generated comments cannot be used to aid a series of targeted analyses.

Significant satisfactory results were obtained in the analyzes made within the scope of the study. The first and the most general conclusion reached is consumers' awareness of some critical dissatisfaction issues about the product they use. Indeed, thanks to the developing interaction environments, consumers are assertive and willing to express their experiences about the product. Therefore, producers must take great care in analyzing user-generated content. Without their approval, the business does not grow and succeed in improving the customer experience and preventing potential churn rate.

Thanks to the analysis made within this scope and presented in detail in the content, it was possible to reach the problematic issues of the PS4 product first. Thanks to the analysis carried out based on ABSA, each feature of the product was automatically determined through user comments, and these features were created in a hierarchical order in the form of an ontology tree. In the Flow Chart, the superior and sub-concepts related to each feature are defined, as well as the frequency of each feature's occurrence, and its average sentiment value can be defined. Even this descriptive Flow chart alone summarizes the overall user experience of the product, and with its rich content, it offers decision-makers a large set of information and a general panorama. With this chart, decision-makers can read problematic issues in their products and observe improvement areas. Moreover, if this chart structure can be prepared for other competitor products, it can provide an excellent comparison for decision-makers. User-defined product reviews have two basic and excellent features. The first of these is that they have a dynamic structure. Every content produced by the user allows the charts to be changed instantly. Another feature is that if the user comments are classified over the comment dates, the change over time in the time series can be detected. Decision-makers may have the opportunity to read the results of their interventions, such as product updates.

In the study conducted on PS4, it was possible to reach some product-specific results. Although the product has a high rate of appreciation by users, it still needs improvements in some aspects. General complaints about the product are usually hardware-based. Relatively insufficient storage capacity and overheating, noisy cooling system, backwards compatibility, Blu-ray player, and stuck controller buttons are the main complaints. Most of these criticisms are also included in the wish list created. Therefore, it has been observed that the criticisms create a demand for new generation products. Enabling backwards compatibility with the company statement of storage capacity and Blu-ray improvements in the new generation PS5 shows that the company's criticisms are considered and confirm the current study's high analysis quality.

With the current study, it has also been possible to make detailed analyzes of focal features. Within this study's scope, the "design" aspect, one of these features, was presented as an example and subjected to detailed examination. When the subject was the focal features, the proposed analysis structure focused on the feature's sentiment values and tried to reveal the reasons that constitute the sentiment. When the subject is handled in this respect, it is possible to analyze problem areas. The positive and negative reasons for that feature are why each feature scores positively or negatively. For example, the on / off and disc eject buttons on the PS4 are generally evaluated negatively. The reason for this in the backward neighbor n-gram analysis is that the buttons are small and weak. Their small size makes them difficult to find and use. However, their physicality prevents them from being accidentally pressed. This analysis allows defining a specification on this feature of the next product. So, in the new generation PS5, these buttons should be physical, large, and visible. The proposed approach is effective to identify the target to-be-improved product features from all candidate features as well as capable to create a design brief for each focused feature.

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