



A Model for Augmented Reality Efficiency Analysis on E-Commerce Websites and its Feasibility Analysis for a Gold Jewelry Company

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Abstract

Nowadays, adding 3D (3-dimensional) photos of products to websites has become a necessity in terms of user loyalty and competitive advantage in the market. The fact that users can see the product through augmented reality technology during their online shopping allows them to get to know the product more closely. While innovative shopping offers 3D photography or augmented reality, this experience replaces traditional shopping, yet there are still many question marks in companies about whether this application will be successful and in case it is successful, in which products. For solving this question mark, a proper classification analyzing with deep learning is needed to identify product families to review performance of the implementations of 3D web design in the different product categories.

Research into the analysis of successful applications helps companies save time and money and support decision-making in their transition to 3D integration. There are many criteria that determine success. Deep Learning analysis and classification methods are one of the multi-input statistical analysis methods that helps to categorize products into groups. The fact that the 3D application has a comprehensive product range is one of the main reasons for using these methods. Classification products into groups has benefits, such as effective and fast results for companies to determine strategy. These analyzes also assist companies in making 3D plans of selected (predicted to be successful) products.

In this study, the classification of products and analyzing success rate of product families' effectiveness of implementations of 3D, the concept of e-commerce, augmented reality applications' success rate for product families' effectiveness are explained. In addition, changing customer behaviors and the manufacturer's view of 3D web design have been tried to be explained with previous researches. It is planned to conduct an evaluation with a jewelry company. 3D applications increase their value in the virtual world day by day. While witnessing the bases of

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the Meta age, the experience of augmented reality in shopping is one of the main steps of the future. The classification of products and analyzing product families' effectiveness of implementations of 3D web design allows to monitor the future e-commerce.

1. Introduction

In today's world, the concept of e-commerce has started to replace face-to-face shopping with the advancement of technology. People had more convenient way by variety of shops with only one click, ability to energy and time savings while shopping at any place and any time. These main factors made it easier for people to quickly adapt to e-commerce. E-commerce had changed the cultural way of shopping and so consumer behavior. Competition in today's market conditions force brands to find new solutions for differentiation. As a one most agile and high potential market, e-commerce market players look for new technologies to increase customer experience for gaining competitive advantages. 3D image technologies which are preferred by e-commerce companies for visualization of the products are stepping forward in this area since it has a potential to build a similar experience for share physical features of the products similar to retail stores. With the impact of the coronavirus, people got used to a more home-oriented life, and this has accelerated the increase of e-commerce in recent years. According to the data released by the Ministry of Trade of the Republic of Turkey, in 2020, Turkey's e-commerce volume climbed by 66% compared to 2019 and increased from 136 billion TL to 226 billion 220 million TL. This rise was about 18% in worldwide. Also, online orders, which were 1.36 billion units in 2019, increased by 68% and reached 2.29 billion units in 2020.

Technological progresses and changes are one of the major topics in today's not only Turkey but whole world's e-commerce operations since developing digitalized shopping experience is one of the key factors for success in e-commerce. There are several technologies that integrated on e-commerce systems in recent years such as Virtual Reality, Cheat bots and Augmented Reality. Despite all of the advancement in the technology, there are still some concerns and limitations on integration of this technologies on the web-sites such as setup costs and ease of use of the customers. Even though it comes with a high investment cost, being the 1st jewelry company in Turkey that has 3D applications brings prestige and more customer for Goldenline Jewellery as selected for gold jewelry company.

Boğaziçi company (Goldenline is its trademark) started its operations with the e-commerce site whose name is RUNDA as of February 2021, considering the coronavirus cases. It designs, produces and sells gold and silver gold-plated earrings, rings, pendants, necklaces and bracelets with press, casting, tube and hallow technologies and experienced personnel. Considering that working with a precious metal such as gold is also problematic for the marketing personnel in terms of security, the sales made through e-commerce sites by knowing the customers are important for the development of the company. In this regard, the use of sites integrated with AR, VR and 3D are among the subjects considered by

the company to invest in order to attract the attention of customers and to create an emotional bond between the product and the customer.

With the increasing e-commerce industry, more new online markets were born. The market volume increased but also competition is increased at the same time. This competitive environment has made customer obsession a priority for companies. Companies have started to invest in D2C channels with 3D and AR. Even online shopping was not common 20 years ago, now with 3D applications on websites, while doing online shopping people can see the furniture inside their homes wherever they want to locate or view it in their kitchens when they want buy a coffee machine. According to Suchith, Josh, Kurien, Yedukrishnan and Baby (2021, pp. 263-272) people still have uncertainty in online shopping about cashless transactions, product and dress size compatibility. Since AR defines reality without changing it, it is predicted that it can remove such drawbacks by implementations.

Therefore, this study aims to purpose a model for augmented reality efficiency analysis on e-commerce websites and a feasibility analysis for a gold jewelry company by clustering selected data. In order to get the necessary for data clustering, interviews were started with e-commerce companies that using AR on their website.

2. Literature Review

2.1. 3D in E-Commerce

E-commerce (electronic commerce) can be defined as practice of purchasing and selling online goods and services via the Internet or through online services. E-commerce getting popular within growing technical aspects and technological approaches through mobile or computer via internet. Digital marketing, supply and chain engineering, electronic money transfer systems and data analysis are main subjects of E-commerce. Bhatti et al. states that 52% of normal market consumers avoid physical shopping and get into the crowd; beside that, 36% of consumers stay away from physical shopping until vaccinated the coronavirus vaccine (2020, pp.1449-1452).

The network (i.e. internet) is a critical element of the system architecture, therefore fast-connection for internet is required to link the users point via internet or online services. For the reason that media material might take a long time to travel over an internet, e-commerce aims to the faster virtual reality (VR) purchasing for customer demands (Glazer et al., 2013; Jiang and Benbasat, 2005, pp. 111-147.).

2.2. Consumer Behavior

2.2.1. Changing Lifestyle

Consumer behavior is the set of strategies that include decisions and related activities in choosing, purchasing, using and disposing of products or services to meet the wants and needs of individuals or groups. It was defined as a sub-discipline of marketing that concerns with the behavior of target customers in the market after the 1940s.

While the World Health Organization (WHO) becomes more effective in managing Covid-19 by that the world economy revives itself with different normal it is obvious so say that Covid-19 have made enormous effect on consumer behavior. It can also say that new normal sped up the technologic trends. Since Coronavirus disease has made a place in life, developing and changing consumer behaviors cover every part of life; from the way do people work so the entertainment industry and the shopping behavior of users. Many of these changes will form the future lifestyle (Sheth, 2020, pp. 280-283).

According to Fabius et al. research for the McKinsey company (2020), new user behaviors appear fundamentally in 8 areas (e.g., rise in e-commerce, brand predilection factors, decreasing rates in employment). These areas can be split up as: “work”, “learning”, “communications and information”, “travel and mobility”, “shopping and consumption”, “life at home”, “play and entertainment” and the last area is “health and wellbeing”.

International Labor Organization (2020) stated that while the number of postings decreased in sectors such as food and beverage and retail, the needs of the industry about shipping, warehouse-logistics and e-commerce increased to a large extent.

2.2.2. Buying Intention towards Augmented Reality

The shopping ecosystem is shifting towards online channels day by day. Consumers place the orders from computers, phones or tablets instead of going to even the nearest store. People are abandoning old shopping habits and don't want to go back again.

For the Lixăndroiu, Cazan and Maican research (2021, p. 416) Zugara was chosen as software which is a virtual dressing room technology supported by augmented reality. This software instrument gave users free space with motion capture technology and the chance to choose whatever they want to wear. 121 students participated in surveys, their e-commerce intentions and characters were sent to analyze before trying the application. After students tested the virtual dressing technology, a second questionnaire was sent and compared with previous data. Second set of questions are about comparison of ordinary e-commerce and augmented reality implemented e-commerce.

Test results within usage of structural equation modeling (SEM) and partial least squares (PLS) regression showed an increase in purchase willingness of about 20%. Lixăndroiu et al. stated in research that augmented reality has a major impact on customer intention to online shopping and also introvert people should be in the target customer segmentation (2021, p. 416).

2.2.3. Consumer Behavior in the Jewellery Industry

Jewellery, which is one of the important export sectors for Turkey, is the process of making jewelry from precious such as gold and semi-precious metals. After 2000, the changes in the demands of the consumers and the high number of competitors in the sector made it necessary for gold jewelry manufacturers to work according to customer requests and needs (Tuncer & Cebeci, 2021).

It is an undeniable fact that generational differences affect consumers' perception of consumption and purchasing behavior in jewelry (Çıtır et al. 2021). According to the data published by De Beers Group in the Insight Report, 2/3 of global jewelry sales belong to the Y and Z generation. In 2017, approximately 60% of jewelry demand in the USA and 80% in China came from millennials. The Z generation has surpassed the Y generation in jewelry consumption. All these data show that young people will play a major role in jewelry consumption in the future (Jewellery Net, 2018).

Generation Z individuals, born in 2000 and later, also known as iGeneration, Gen Tech, Gen Wii, is a generation that grows up with access to the internet and portable digital technology from an early age. For this reason, the efforts of gold jewelry manufacturers to gain their customers through e-commerce will be important for the next generation.

2.3. Augmented Reality (AR)

Augmented Reality is a virtual 3D-object presentation method in a real-world environment which allows users to interact with objects. Augmented reality applications are distinguished from each other whether Augmented reality applications decide to locate and size the object. Marker based Augmented reality applications search the environment by the camera to find previously selected objects to define size of the environment and targeted location for the object. On the other hand, markerless augmented reality applications decide physical features of the environment with real time information from sensors without previous knowledge. According to Verhagen, Tibert, et al (2014, pp. 270-280), Augmented reality performs better for providing try on the experience customers according to Virtual Reality.

2.4. E-commerce Augmented Reality Application Customers Experience Review Methods

2.4.1. Clustering

Kannaiah and Shanthi (2015, pp. 64-73) suggest an evaluation model for efficiency of augmented reality applications on e-commerce. Researchers conducted a survey study that includes 222 subjects. All subjects are asked 30 qualitative questions which aims to understand what drives their consumer behaviors from the attributes that listed in the below:

- Information Oriented
- E-commerce Oriented
- Economic Benefits
- Interactivity
- Personal Feel
- Social Influences
- Brand Connections
- Shopping needs

All subjects rated their questions on a four-point scale. Researchers analyze these answers with clustering analysis which is one of the main methods for sorting customers. Clustering Analysis generates 6 clusters with 86.5% success rate. Researchers revealed that "Connection seekers" and "Conservatives" clusters have a negative attitude against Augmented reality while "Opinioners" support the Augmented reality applications. On the other hand, the rest of the clusters which are "Followers", "Respondents" and "Value seekers" are neutral positions at the time of study.

2.4.2. ANOVA Analysis in Scope of Interactivity and Vividness

Yim, Chu and Sauer (2017, pp. 89-103) reveal a study that Consumers preferences between Augmented reality, traditional 2D pictures are compared in scope of Interactivity and Vividness. Researchers proposed that media quality and high-level smoothness of response to interactions from users of the Augmented Reality application have a positive effect on users' willingness to use Applications while users' past experience reduces willingness to use Applications. Researchers developed 2D pictures, AR media of a watch and a sunglass to test their hypothesis about correlation between AR experience and willingness to use.

In their study, Researchers conducted a survey that included 258 participants (138 for sunglasses and 120 for watch). They developed web-sites 4 websites which scored same level results for media quality and smoothness of response to interactions from users:

- Interactivity (sunglasses: MAR = 5.03, Mweb = 4.84, $t(136) = .93$; watch: MAR = 5.06, Mweb = 4.87, $t(118) = 1.03$)
- Vividness (sunglasses: MAR = 5.04, Mweb = 4.89, $t(136) = .77$; watch: MAR = 5.08, Mweb = 4.80, $t(118) = 1.25$)

After that test, researchers split their data based on experience to 3 groups and subtract the mediocre reacted group to see the effect of the AR experience more clearly. They conduct an ANOVA analysis to test their data's independence and they find significant results that show that data is independent. In conclusion, the experiment's final regression results show that for both objects, there is a superior difference of willingness to use. AR visualization integrated web-site gives customers more willingness than 2D pictured web-site.

2.4.3. Comparison AR with VR and 2D within Different Environments

Lu and Smith (2008) states an experiment model that aim to indicate differentiation of the performance of the visualization methods such as VR, AR or traditional 2D images for E-commerce. Researchers pointed out that usage of the same objects for testing each visualization method resolves a risk of error variance that could be caused by differentiation of objects. 4 different places which are open office, cubic office, single user room and crowded room; is also selected to test every visualization method. Experiment conducted with 24 participants, each of them asked to select an object for each place with every method and evaluate their experience 1 to 5. Researchers tested their data using Factorial ANOVA. Results show that p-values of effect of the area is 0.7913 which is considerably over of the

experiment's critical value for p-value (0.05). As a result, researchers claimed that environment does not have an effect for selection of visualization methods for e-commerce. On the other hand, 2D image gets overall score of 2.167, VR gets 3.75 while AR gets 4.583 at the ANOVA analysis. P-values for this analysis are less than the critical point of p-value so results are reliable. In conclusion, AR systems show significantly higher success than other visualization methods for e-commerce systems regardless of environment according to the study.

2.4.4. Comparison of AR with 2D Images Ecommerce Experience of Different Social Groups and Different Operating Systems

Alves and Reis (2020, (pp. 114-123) state a study of reviewing the influence of several factors such as socioeconomic status, age and operating system on effectiveness of Augmented Reality integrated e-commerce applications on consumer behaviors. Researchers chose IKEA Place application since it could be accessed by either android or IOS devices. Participants asked to simulate their purchasing routine on previously determined object by using Augmented Reality features. Researchers observed participants' gestures and comments. After the experiment, each participant was asked to answer a survey to evaluate given qualitative questions between 1-7. Researchers prefer to use descriptive analysis on data and results based on subject could be seen on the table-1.

Table 1. Descriptive analysis of the data obtained (Alves and Reis, 2020), (pp. 114-123)

	N	Minimum	Maximum	Average	Standard deviation
Ease of use	82	2,48	7,00	6,21	1,11
Perceived utility	82	2,77	7,00	5,73	1,05
Intent to use	82	2,58	7,00	5,55	1,17
Purchase attractiveness	82	2,50	7,00	6,38	0,72
Purchase convenience	82	4,08	7,07	6,59	0,57
Ease of purchase	82	2,00	7,00	6,29	0,78
Purchase confidence	82	3,68	6,93	6,19	0,56

Based on their detailed analysis, researchers stated that IKEA Place's Augmented Reality features have a positive effect on consumers' purchase attractiveness, purchase convenience, ease of purchase and purchase confidence. Besides that, Researchers could not find enough proof to claim that there is correlation between socioeconomic status, age, operation system and effectiveness of Augmented Reality integrated e-commerce applications on consumer behaviors.

2.5. Deep Learning Product Categorization

2.5.1. Multi-Model Product Categorization on E-commerce-with Text and Image Classification Methods

Zahavy, Krishnan, Krishnan and Mannor (2016) suggest a multi-model classification for e-commerce product categories. Since texts and images are only known features of a product, researchers firstly develop separate models for each information type with their data. After that, they develop an algorithm that chooses either one of the model's classification as an to find the true category of the product. Researchers use Walmart's website products and categories as an input which consist of 1,200,000 products and 2890 categories. For text data

classification, researchers choose convolutional neural networks (CNN) which receive text as a first layer and transform into a vector. Afterwards, 128 filter embedded layers are performed convolution operations. All of the results obtained from the layers are pooled in the next stage. Finally, adding a drop-out regularization layer pursued by a softmax layer classifies the results. In order to classify image inputs which have are 224x224 rgb images, researchers preferred VGG network algorithm. Text classifiers resulted with 70.1 % correct classification while image classification performed 56.9 % success rate. Even though text classification model outperforms the image-based model, there are 7.8 % products that are classified successfully only with image-based model. As a conclusion, a multimodal decision technique has a theoretically 77.8 % success change.

Additionally, Researchers preferred 2-phased multimodal learning technique to unify its classifications that coming CNN and VGG algorithms for their multimodal decision technique. First part of researchers' decision model, decision level fusion approach preferred. In this approach, the aim is to find the best decision rule which is predefined in a pool, for each class. In the second stage, feature level fusion approach which begins with input specific deep neural networks learning, In the second part, a multi-modal representation vector developed from data exclusive feature vectors. An extra layer that classifies these multimodal representation vectors terminates the decision process. Results of the experiment displays %71.8 success rate which is a significant achievement for the model.

2.5.2. Multi-Model Product Categorization with Several Text Classification Methods

Yu et al. (2018) state a study that analyzes the efficiency of several deep learning methodologies for classification of the products into categories according to their titles. Experiment contains combining usage of the methods as well as separate application of the methods. Researchers choose models Fasttext, TextCNN, VDCNN, TextRNN, AbLSTM and directory tree. Data is divided into training sets, with size 720.000 validation set with size 80.000 and test set with size 200.000 by the researchers. The Fasttext model is chosen by researchers to be a benchmark for the experiment and a model trained and validated with sets. Results are reviewed with tags named as interval which means predicted probability interval and Inconsistent and Consistent which respectively represent true classed and false classed according to the real category of the product. Detailed results could be seen at table-2.

Table 2. Probability distribution of predict results (Yu et al. 2018)

Interval	Inconsistent	Consistent	total
0~0.1	152	11	163
0.1~0.2	496	52	548
.....
0.92~0.93	209	259	468
0.93~1	4804	60570	65374

Feature selection which includes text processing and Feature extraction ant text extraction executed as an next part of the study since text based classification's performance determined by this processes. Different text processing methods are

tried such as excluding numbers or nouns to modify data into less noise. However, Fasstext algorithm models showed that original data performed better than modified versions of the data. To continue Feature selection, researchers reviewed text conversion method vector space model preferred and word vectors are calculated with Fasstext algorithm from the data. Results could be seen at the table-3.

Table 3. Probability distribution of forecast results (Yu et al. 2018)

Text Preprocessing Methods	Precision	Recall	F1 score
Origin	0.823	0.823	0.823
Exclude numbers	0.816	0.816	0.816
Stopwords	0.806	0.806	0.806
Stopwords +Stemming	0.797	0.797	0.797
Stopwords +Stemming +Extract nouns	0.807	0.807	0.807

After the feature engineering process, researchers begin with a test stage with single label models. Results could be seen at table-3. Single label prediction indicates that all of the classification features considered as an one group for each combination such as “25-14-17” represents one label, however multiple layered models say that this representation consists of 3 labels “25”, “14”, “17”. Researchers formed their multiple layered via SP-tree algorithm. This algorithm analyzes a product’s name’s word vector and calculates the probability of frequency of each label. Most common labels are considered as a higher-level hierarchical node of the tree model. Model generated 8 levels of labels. SP-tree algorithm considers each of this level as a separated label as an explained before. SP-tree algorithms applied each of the methods that are used in a single model. Finally, researchers combined multiple labeled methods as a last experiment with a simple voting method and the weighted voting method. Simple voting method considers each labeling instance separately and each method gives a vote in the selection of the label. Labels with higher vote generates the class. For weighted voting methods, each of the votes multiple with precision value before results are reviewed. Methods performance could be seen at table-4.

Table 4. Test performance of combined strategy category prediction models (Yu, Sun, Li, Li and Zheng, 2018)

Methods	Fusion Strategy	P	R	F1
Baseline (Fasttext)	--	0.83	0.82	0.82
Baseline+ FT+AblSTM	Simple voting	0.83	0.81	0.82
Baseline + FT+AblSTM+ AT	Simple voting	0.86	0.80	0.82
Baseline+ FT+AblSTM	Weighted voting	0.86	0.82	0.83
Baseline + FT+AblSTM+ AT	Weighted voting	0.85	0.83	0.84
Baseline + FT+AblSTM+ AT+FST+AST (STAGE 1)	Weighted voting	0.8552	0.8389	0.8404
Baseline + FT+AblSTM+ AT+FST+AST (STAGE 2)	Weighted voting	0.8397	0.8428	0.8379

3. Proposed Methodology

As it mentioned before, this study is aimed to purpose model for feasibility analysis of 3D models' efficiency for a gold jewelry company (Goldenline). Purposed model consists of 3 stages. First stage intets to class products into accurate classes. In our to achieve this, multi-level deep learning model is suggested. Model uses Product definitions and RGB images as an input for its classification process. VGG network algorithm is suggested to classify RGB images while TextCNN, VDCNN, TextRNN, AblSTM, Fasttext algorithms are recommended for text classification. Since SPtree algorithm is one of the optimal strategies to obtain reliable multi-level deep learning algorithm, This study suggests to use the SPtree algorithm for the building of the multi-leveling by combaning 2 of the algorithms that mentioned before. Since data characteristics are varying for each dataset, it is recommended to try several variations. Optimal categories are determined based on optimific combinitaion of the algorithms. Samples from each catogery are randomly selected to be input for the second stage.

In the second stage, A customer Survey is planned to observe customers' reactions for 3d visuals of the products in e-commerce website of the goldenline. Firstly, at least 10 minutes of usage of Augmented Reality visual of the sample product is recommended to acquirment of significant experience by the volunteer. In this Occation, it is recommended to provide each of the volenteer the same test device and same samples from the each categories could be help the achieve to decrease the possibilty of error since variety of the test plartfrom and test object could effect the judgement of the customers. Survey is recommended to be constituted with w quantitative queations where volinteers are expected to be given rating to this questions between 1 to 10. A list of topics of the questionnaire and Hypothesis are given respectively below:

- Ease of use: to determine the level of ease on usage.
- Perceived utility: to determine if consumer got an utility on 3D implementation.
- Intent to use: to determine the consumers intention to use 3D implementation on online shopping.
- Purchase confidence: to determine measure how much 3D implementation increased the trust in the brand.
- Purchase attractiveness: to determine the level of attractiveness for product.

Image 1. Survey Questions

I would like to take advantage of the opportunity to view the product in 3D in online shopping. *

1 2 3 4 5 6 7 8 9 10

I don't agree at all. I agree totally.

My intention to buy the product in online shopping increases with the 3D application. *

1 2 3 4 5 6 7 8 9 10

I don't agree at all. I agree totally.

3D integration makes it easier for me to buy the product. *

1 2 3 4 5 6 7 8 9 10

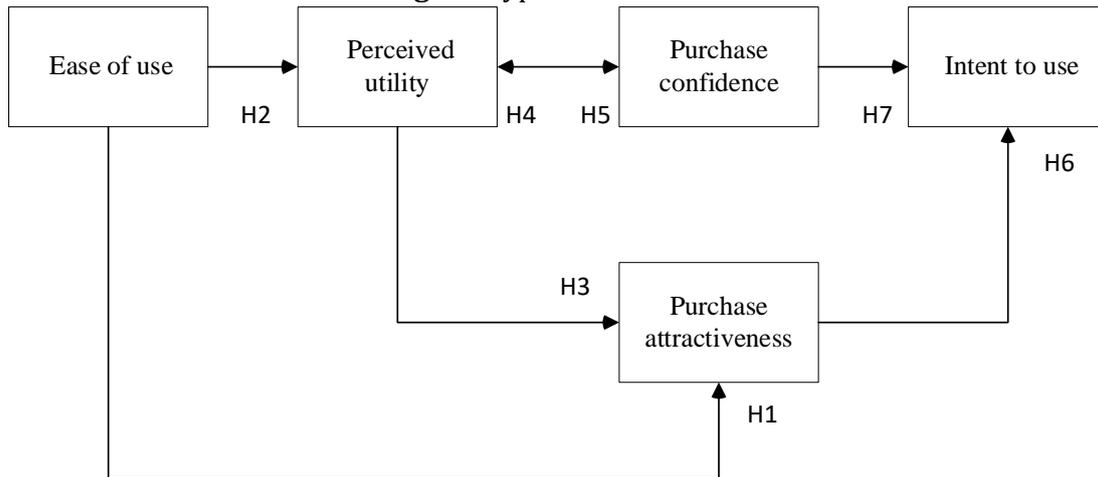
I don't agree at all. I agree totally.

Viewing the product in 3D increases my confidence in shopping from the brand. *

1 2 3 4 5 6 7 8 9 10

I don't agree at all. I agree totally.

Image 2. Hypotehsis Relations



- H1. Purchase attractiveness is positively related to Ease of use
- H2. Perceived utility is positively related to Ease of use
- H3. Purchase attractiveness is positively related to Perceived utility
- H4. Purchase confidence is positively related to Perceived utility
- H5. Purchasing confidence is positively related to perceived utility
- H6. Intent to use is positively related to Purchase attractiveness
- H7. Intent to use is positively related to Purchasing confidence

In the 3rd and the last stage of the methodology, an ANOVA analysis is recommended review Hypothesis based on Survey Results. Firstly, it is suggested to check data's internal consistency evaluated with Cronbach's Alpha method for whether that survey results shows reliable scores or not. One of the other critical reviewing methods for regression analysis such as variance extracted percentages and inter-construct correlations should be checked to see if they have p-values scores 0.01 which demonstrate that regression analysis is significant. Before forming analysis work with A series ANOVA, separation of the qualitative result of the participants into 3 groups based on their regression scores and subtracted to the medium group to acquire significant results. It has been aimed to prioritize the categories to applying AR transformation for the categories that given the best outcome for H4 from the customer survey to achieve effective use of the limited sources in the company.

4. Conclusion

Aim of this study was to propose a model for feasibility analysis of 3D models' efficiency for a gold jewelry company (Goldenline). Literature Reviews show that 3D model has positive effects for e-commerce side of the company. Efficiency of the 3D model adaptation processes is one of the key factors for gaining competitive advantage in today's market conditions and the proposed methodology of this study aims to increase this efficiency with combining several scientific methods such as Survey study, deep learning algorithms and ANOVA analysis.

5. Further Research

Adaptation of the products in upcoming technological innovations like 3d visualization methods has a potential to increase companies growth in several other aspects which could be reviewed in further researchers are discussed at the this stage study. Google is expected to open its new research category as a 3d image searches. Potential increase of a companies revenue with early adaptation to the 3d image visibility that coming from Google's search without need of advertisement could be studied in further researchs

On the other hand, it has been seen that, Data that expected to be collected from the customers could be used in several other aspects to increase the companies market share with minor modifications. With additional profiling questions to the questionnaire, Clustering analysis could be applied to the dataset to determine customer profiles and their preferences. This customer profile allows the company to offer to the customer goods based on their cluster's preferences that obtained from the market basket analysis. This adaptation's potential advantages to the company's revenue is also could be also reviewed in a in further researchs.

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