Answer to Question 1:

The following are the alternatives for the first two decisions:

Decision 1: Games Athena should pursue

Action Alternatives

1) Warrior Guild
2) Seraph Guardians
3) Evercrest
4) No Acquisition

Action Standards

1. **Market Potential:** Choose the game that is preferred by a larger group of consumers, indicating potential for earning strong and constant revenue from the market.

2. **Estimated Profit:** Select the game that is expected to offer higher positive profit in the first year and has potential for long-term profitability. This criteria will include both the impact of the revenue and cost.

3. **Strategic Alignment:** Opt for a game that aligns with the strategic priorities of Athena, such as diversifying the game portfolio by adding a fantasy world game like Evercrest if it is missing from the current portfolio.

Decision 2: Pricing strategy for Athena

Action Alternatives

1) Premium Pricing
2) Competitive Pricing
3) Penetration Pricing

Action Standards

1. **Price Sensitivity:** If the market shows high price sensitivity, Athena should adopt competitive pricing to ensure it remains attractively priced and is not undercut by competitors**.** Conversely, if there is a significant market segment that values high-quality games and does not mind paying a premium, Athena could benefit from setting a premium price.

2. **Game Uniqueness:** It is better to opt for a higher price point if the game distinguishes itself with unique gameplay or innovative elements not found in competitor products.

However, the premium should match the additional value the consumers assign to the uniqueness of the game.

3. **Strategic Alignment:** If Athena aims to enter a new market segment or introduce an innovative game type, it should consider adopting lower prices than competitors. The penetration pricing can help to disrupt the market and win market share quickly.

Answer to Question 2:

a. Athena Softworks specializes in premium role play games for PC play. As per the Superdata report shared, the market size for premium pc play games stand at USD 5.2 Billion in 2019. This was directly mentioned in the bar graph showing Digital game revenue in Page 10 of the Superdata report.

b. While there was a decline in the premium game market in 2019, I expect the premium game for PC play to increase in 2020 to reach USD 5.3 Billion as per the Superdata report (pg 13). This comeback in growth is a fair expectation as there will be major releases in the first half of 2020 (Superdata report Pg 22).

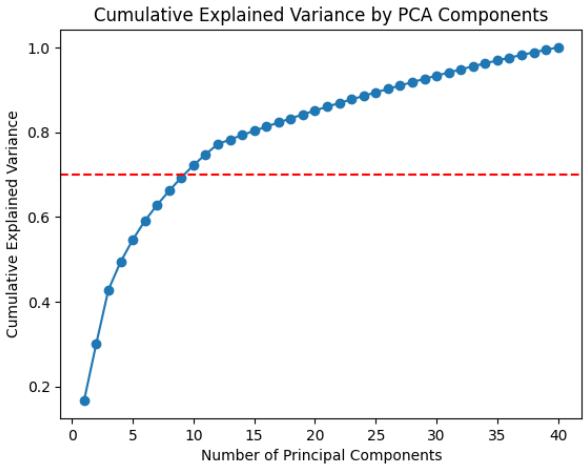
c. I expect COVID-19 to significantly boost the market size. People will indulge in video gaming more given they will be in quarantine with lack of activity options. This will increase the overall hours spent playing video games and in turn increase the demand for games. Moreover, the harsh uncertainty related to the future and desperation to get rid of boredom will likely push people to spend extra bucks on video games, leading to strong growth of the premium game for PC play market.

Answer to Question 3:

I first conducted a KMO-test to understand if the data is suitable for factor analysis. The results show that the **p-value is statistically significant and KMO value is close to 1**. This suggests that the relationships between items can likely be well-explained by a smaller number of underlying factors.

```
Bartlett's Test of Sphericity p-value: 0.0
KMO-test overall MSA: 0.8903064302758804
```

I then progressed with PCA analysis to understand the number of factors best suited for this data. The results show that **choosing 9 factors will be optimal as it explains 70% of the variance**.



I then conducted the factor analysis using 9 factors. The loadings were as follows:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
imp.challenge	-0.09694	-0.01564	0.638451	0.138388	0.130095	-0.00273	0.057807	-0.02503	0.036411
imp.unlocks	-0.00137	-0.32837	-0.10165	0.133967	-0.06267	0.171701	0.096227	-0.73824	0.002315
imp.customize	0.220113	0.06251	-0.0152	0.098218	0.113647	-0.0125	-0.09679	-0.01483	-0.7636
imp.difficulty	-0.09183	-0.0098	0.634461	0.127036	0.123726	0.007559	0.084476	-0.03616	0.038476
imp.characters	0.306823	-0.03698	-0.05202	-0.04125	0.081259	-0.03396	-0.77438	0.073796	-0.10385
imp.storyline	0.32413	-0.04333	-0.03352	-0.05584	0.088642	-0.03947	-0.76358	0.084874	-0.13312
imp.mastery	-0.02479	0.012193	0.795893	0.088991	0.128514	-0.01393	0.024142	0.013526	0.005716
imp.backstory	0.304582	-0.0368	-0.06246	-0.03961	0.082464	-0.00518	-0.78401	0.072106	-0.11631
imp.dominate	-0.00695	0.469696	-0.01982	-0.04812	0.090709	-0.28804	0.117565	0.095927	-0.07812
imp.completion	-0.02384	-0.298	-0.10163	0.122845	-0.06189	0.148391	0.058628	-0.78148	-0.00645
imp.wealth	0.207419	-0.2406	0.054304	0.043452	0.133271	-0.09014	-0.04343	-0.06408	-0.15324
imp.fantasy	0.780089	-0.01503	-0.03752	0.077796	0.106562	0.010323	-0.13952	0.009282	-0.13838
imp.items	0.712093	-0.01085	-0.01541	0.069592	0.084508	0.011275	-0.29639	0.010514	-0.11337
imp.power	0.769558	-0.00327	-0.0225	0.051809	0.111504	0.015952	-0.14729	-0.00882	-0.11733
imp.offbeat	0.160548	0.035064	0.242592	0.056226	0.779252	-0.01699	-0.05719	0.037478	-0.10639
imp.collect	0.001012	-0.32556	-0.1219	0.120129	-0.04766	0.153126	0.095319	-0.77576	-0.01359
enj.excitement	-0.00025	0.11296	0.02562	-0.16532	0.016128	-0.73032	-0.03989	0.096959	-0.00167
enj.destruction	-0.10145	0.052116	-0.15923	-0.78318	-0.06173	-0.11327	-0.00986	0.093629	0.097674
enj.others	-0.00877	0.792456	0.012705	-0.01361	0.037092	-0.04224	-0.05692	0.123617	-0.02282
enj.react	0.001526	0.090772	0.006893	-0.11011	0.036666	-0.72012	-0.03407	0.10563	-0.05431
enj.duels	-0.0266	0.534942	-0.01555	-0.09102	0.076038	-0.27979	0.116093	0.110914	-0.05574
enj.strategy	0.039098	0.004839	0.759695	0.080155	0.106095	-0.01557	-0.02974	0.08431	-0.03376
enj.roleplay	0.78085	-0.00901	-0.03638	0.052392	0.106035	-0.00161	-0.13063	0.016931	-0.12746
enj.competition	-0.0239	0.532185	-0.02756	-0.09533	0.050695	-0.28168	0.131253	0.125658	-0.06169
enj.decisions	0.05963	0.019652	0.765243	0.073169	0.099579	-0.03432	-0.01292	0.089351	-0.03076
enj.common.goal	0.026318	0.756436	0.039364	-0.00803	0.041226	0.025107	-0.05475	0.146221	-0.03437
enj.planning	0.023693	-0.00926	0.766108	0.058739	0.113459	-0.02367	-0.02223	0.112727	-0.02621
enj.immersion	0.781281	-0.01979	-0.02711	0.099837	0.09787	0.022551	-0.13457	0.018718	-0.12598
enj.helping	0.002734	0.767385	0.028182	0.001021	0.01415	0.030522	-0.05937	0.132204	-0.02662
enj.fast	-0.00487	0.11433	0.033492	-0.12183	0.023383	-0.74389	-0.01995	0.099831	-0.04177
enj.guns	-0.09383	0.055135	-0.18773	-0.78987	-0.04638	-0.09649	-0.04435	0.085096	0.082374
enj.gore	-0.08715	0.05735	-0.15448	-0.78483	-0.08013	-0.15669	-0.02587	0.070855	0.086779
enj.blow.up	-0.07411	0.082015	-0.17062	-0.79103	-0.07432	-0.12907	-0.03176	0.072577	0.107174
freq.explore	0.142135	0.053466	0.228956	0.074566	0.757805	-0.0207	-0.05286	0.029368	-0.07517
freq.experiment	0.129014	0.057353	0.223107	0.07061	0.765496	-0.02665	-0.05686	0.028566	-0.09836
freq.study	-0.02019	0.007354	0.777915	0.085011	0.144966	0.010688	0.028397	0.03675	0.008543
freq.char.creation	0.179645	0.052244	-0.01766	0.131562	0.110414	-0.07507	-0.10903	0.007448	-0.72542
freq.stats	0.209556	-0.22714	0.043491	0.06364	0.147411	-0.12092	-0.03466	-0.07062	-0.14998
freq.customize	0.201786	0.060229	0.01041	0.106706	0.092704	-0.0328	-0.0924	0.007808	-0.74023
freq.test.world	0.130545	0.070567	0.227382	0.060808	0.761488	-0.05878	-0.07867	0.074433	-0.09216

I then defined the factors using the loadings.

Factor Analysis

Factor 1: Love for Fantasy and Power

High loadings on elements like imp.fantasy, enj.roleplay, and enj.immersion, which indicates a preference for immersive, fantasy-based experiences. While high loadings for imp.items and imp.power highlights preference for increasing power in games.

Factor 2: Group Play

High positive loadings for enj.others, enj.duels, enj.competition, enj.common.goal, and enj.helping, indicate preference for group play with interest in competing with others.

Factor 3: Strategy

Prominent loadings on imp.challenge, imp.difficulty, imp.mastery, enj.strategy, enj.decisions, enj.planning and freq.study indicate a focus on skill mastery, strategic planning, and intellectual challenge.

Factor 4: Aversion to Destruction

Strong negative loadings on enj.destruction, enj.guns, enj.gore, and enj.blow.up, emphasizing dislike for destructive elements.

Factor 5: Unconventional Gameplay

Significant positive loading on imp.offbeat, freq.explore, freq.experiment and freq.test.world indicates a preference for unconventional or quirky game elements, and offbeat gameplay.

Factor 6: Aversion to Exciting and Fast

High negative loadings for enj.excitrement, enj.react, and enj.fast indicate preference for slower gameplays with less action and excitement.

Factor 7: Narrative Disengagement

Negative loadings on narrative aspects like imp.characters, imp.storyline and imp.backstory, indicating less interest in the story-driven elements of games.

Factor 8: Aversion to Collection and Completion

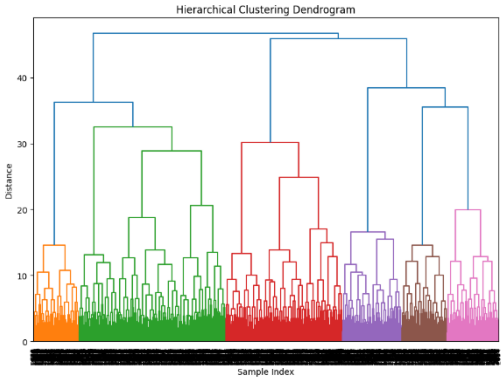
Strong negative loadings on imp.unlocks, imp.completion and imp.collect suggest an aversion to game elements focused on collecting items or completing every aspect, which might indicate a preference for more relaxed gameplay.

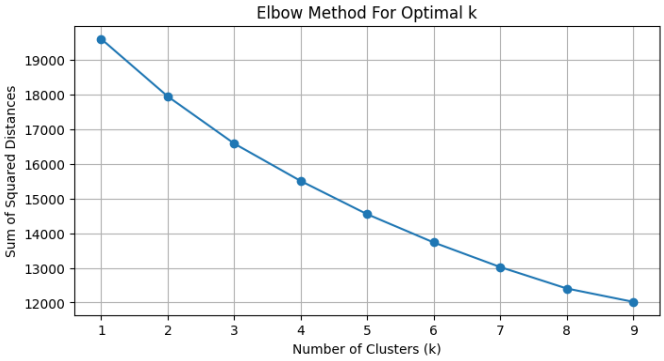
Factor 9: Aversion to Customization

Notable negative loadings for customization-related items like freq.char.creation, freq.customize and imp.customize, pointing to a preference for personalizing gameplay and characters.

Clustering

I then focused on K-means analysis to identify segments within the respondents. I first came up with a hierarchical clustering dendrogram and used the elbow method to try and find the optimal number of clusters.





Although the Elbow method did not provide a clear indication, I utilized the Dendrogram to investigate the potential for both 3 and 4 clusters.

3 Clusters

I first tried using 3 clusters and found that the factor loadings for different clusters were different enough to identify unique characteristics. The following are the 3 clusters I identified.

	Love for Fantasy and Power	Group Play	Strategy	Aversion to Destruction	Unconvetional Gameplay	Aversion to Exciting and Fast	Narrative Disengagement	Aversion to Collection and Completion	Customization Focus
Fantasy and Power Lovers	1.084609549	-0.21934072	-0.292778852	0.031823006	0.04634004	0.043247854	-0.109425192	-0.067585286	0.031053201
Tactical Masterminds	-0.59162917	-0.48781276	0.683148812	0.314949598	-0.103840122	-0.0031905	0.115676425	-0.009338223	-0.126920019
Group Destructors	-0.603354535	0.911413603	-0.517352052	-0.449540367	0.076314577	-0.050568468	-0.011884465	0.097639893	0.125647088

Fantasy and Power Lover: This cluster has significant positive loading on Lover for Fantasy and Power (1.08), indicating a strong preference for games that offer immersive fantasy worlds and focuses on powering up. The negative loadings on aspects like Strategy (-0.29) and

Narrative disengagement (-0.11) suggest that these gamers are less interested in strategic complexity and instead prefers fantasy based stories.

Tactical Mastermind: This cluster shows a substantial positive loading for Strategy (0.68), signifying a strong inclination towards strategic thinking and planning. The negative loading for Group Play (-0.48) and Love for Fantasy and Power (-0.59) implies a preference for engaging with complex strategies alone.

Group Destructors: This cluster has high positive loading for Group Play (0.91) indicating a preference for playing in groups, coupled with a low aversion for destruction (-0.45). Moreover, this group also does not prefer games focused on strategic thinking. This suggests that gamers in this cluster prefer playing destructive games in groups that does not require serious mental engagement.

4 Clusters

I also then tried to create 4 clusters to see if more nuanced characteristics can be brought up.

	Love for Fantasy and Power	Group Play	Strategy	Aversion to Destruction	Unconvetional Gameplay	Aversion Exciting and Fast	Narrative Disengagement	Aversion to Collection and Completion	Customization Focus
Fantasy and Power Lover	1.213338218	0.252765133	-0.061553688	0.220896213	0.126108217	0.309294035	-0.185431338	-0.237435144	-0.026825256
Tactical Masterminds	-0.29615309	-0.131009643	1.320802508	-0.091679722	-0.337814116	0.054481745	0.254195075	0.066935481	-0.097259989
Group Destructors	-0.619730538	0.970907667	-0.537419459	-0.441695737	0.132246219	-0.112422757	-0.019964025	0.128439056	0.141097296
New Cluster	-0.308827106	-1.087744529	-0.6075185	0.302818468	0.052318364	-0.241658493	-0.029157984	0.045206393	-0.024778805

As the result shows, the first 3 clusters for this cluster analysis are same as that of 3 clusters with Fantasy and Power Lovers having high positive loadings for ‘Love for Fantasy and Power’, Tactical Masterminds having high positive loadings for ‘Strategy’ and Group Destructors having high positive loadings for ‘Group Play’ and high negative loading for ‘Aversion to Destruction’. The new cluster that was generated seems to be the exact opposite of Group Destructor with high negative loadings for ‘Group Play’ and positive loading for ‘Aversion to Destruction’. While this might represent a distinct gaming style, it does not introduce new insights significant enough to warrant a separate cluster for practical applications such as pricing or marketing. Therefore, the **3-cluster model is preferred** as it offers a more simple, distinct and manageable segmentation.

I then focused on understanding the demographic patterns of these 3 segments through cross-tabulation, regression and mean value analysis.

Cross-Tabulation

I conducted the cross-tabulation exercise for all 4 demographic factors in the dataset. The results of such are explained below.

Age: We created 3 buckets for age: 18- 34, 35 - 55 and 55+. We initially also created a bucket “under 18” but realized there are no values below 18 and so that bucket was empty.

```
Observed Frequencies:
 Age_Group                18-34  35-55  55+
Cluster_Label
Fantasy and Power Lovers    619    104   49
Group Destructors           545     60    7
Tactical Masterminds        631    144   19

Expected Frequencies:
 Age_Group                      18-34       35-55        55+
Cluster_Label
Fantasy and Power Lovers  636.244261  109.171717  26.584022
Group Destructors         504.380165   86.545455  21.074380
Tactical Masterminds      654.375574  112.282828  27.341598

Chi-square Contributions:
 Age_Group                    18-34     35-55        55+
Cluster_Label
Fantasy and Power Lovers  0.467375  0.244996  18.901431
Group Destructors         3.271284  8.142093   9.399478
Tactical Masterminds      0.835021  8.959331   2.544923

Chi-squared Statistic:  52.7659327225794
P-value:  9.539020584375138e-11
```

The statistically significant p-value indicates that there is a relationship between the age and clusters. The chi-square values are higher than 3.84 for the 35-55 and 55+ buckets of Group Destructors. Looking at the expected and observed values it is evident that these players are less likely to be in the 35 and above age groups. Fantasy and Power Lovers also has a chi-square above 3.84 for the 55+ age bucket and higher observed value vis-a-vis expected indicates that older gamers are more likely to be drawn to immersive fantasy experiences. Finally, tactical masterminds are more likely to be in the 35-55 age group (chi-square 8.9> 3.84), showing the preference of players in this age group for strategic gameplay.

Income: We created 3 bins for income: Under 50k, 50-100k, and 100k+.

```
Income Group Analysis
Observed Frequencies:
 Income_Group              Under 50K  50K-100K  Over 100K
Cluster_Label
Fantasy and Power Lovers        431       276         65
Group Destructors               374       196         42
Tactical Masterminds            397       311         86

Expected Frequencies:
 Income_Group               Under 50K    50K-100K  Over 100K
Cluster_Label
Fantasy and Power Lovers  426.053260  277.537190  68.409550
Group Destructors         337.752066  220.016529  54.231405
Tactical Masterminds      438.194674  285.446281  70.359045

Chi-square Contributions:
 Income_Group              Under 50K  50K-100K  Over 100K
Cluster_Label
Fantasy and Power Lovers   0.057435  0.008514   0.169933
Group Destructors          3.890169  2.621592   2.758683
Tactical Masterminds       3.872711  2.287620   3.477015

Chi-squared Statistic:  19.143672136403627
P-value:  0.0007364696157726211
```

The chi-square test results for the relationship between income groups and player clusters indicate a statistically significant association, with a p-value well below the threshold for significance. For under 50K bucket of Group Destructors (chi-square 3.89> 3.84), the observed

value is higher than expected, meaning Group Destructors are more likely to be in the under 50K income group. Conversely, for Tactical Masterminds the observed value is lower than expected for the under 50K group (chi-square 3.87> 3.84), indicating that these players are usually more solvent.

Gender: The dataset had 3 gender categories: male, female and non-binary.

```
Gender Analysis
Observed Frequencies:
 gender                    female  male  nonbinary
Cluster_Label
Fantasy and Power Lovers     401   367          4
Group Destructors            233   375          4
Tactical Masterminds         367   420          7

Expected Frequencies:
 gender                       female        male  nonbinary
Cluster_Label
Fantasy and Power Lovers  354.808081  411.875115   5.316804
Group Destructors         281.272727  326.512397   4.214876
Tactical Masterminds      364.919192  423.612489   5.468320

Chi-square Contributions:
 gender                       female      male  nonbinary
Cluster_Label
Fantasy and Power Lovers  6.013655  4.889288   0.326131
Group Destructors         8.284686  7.200485   0.010954
Tactical Masterminds      0.011865  0.030807   0.429025

Chi-squared Statistic:  27.19689556298809
P-value:  1.813743407005719e-05
```

The statistically significant p-value evidences a relationship between clusters and genders. For Group Destructors, the observed and expected values for males and females (chi-square> 3.84 for both) indicates that these players are more likely to be males. Conversely, for Fantasy and Power Lovers, the observed and expected values for male and females indicate that these players are more likely to be females.

Location: The dataset had a record of states for each respondent. However, I clubbed the states into 4 regions to ensure ease in analysis and interpretation of trends.

```
Region Analysis
Observed Frequencies:
 region                   Midwest  Northeast  South  West
Cluster_Label
Fantasy and Power Lovers      186        109    297   180
Group Destructors             117        116    230   149
Tactical Masterminds          169        135    302   188

Expected Frequencies:
 region                      Midwest   Northeast       South        West
Cluster_Label
Fantasy and Power Lovers  167.302112  127.603306  293.842057  183.252525
Group Destructors         132.628099  101.157025  232.942149  145.272727
Tactical Masterminds      172.069789  131.239669  302.215794  188.474747

Chi-square Contributions:
 region                     Midwest  Northeast     South      West
Cluster_Label
Fantasy and Power Lovers  2.089699   2.712179  0.033939  0.057729
Group Destructors         1.841521   2.177940  0.037160  0.095631
Tactical Masterminds      0.054766   0.107742  0.000154  0.001196

Chi-squared Statistic:  9.209656062781415
P-value:  0.16212594895716467
```

The p-value of 0.16 is not statistically significant and none of the chi-square values are above 3.84. Therefore, there is no distinguishable relationship between region and players from the identified segments.

Regression

I further conducted regression analysis for age and income to deep dive into the demographic trends.

Age: I conducted linear regression with the Group Destructors segment as the baseline.

OLS Regression Results

Dep. Variable:	age	R-squared:	0.023
Model:	OLS	Adj. R-squared:	0.022
Method:	Least Squares	F-statistic:	25.84
Date:	Sat, 01 Mar 2025	Prob (F-statistic):	8.15e-12
Time:	01:38:50	Log-Likelihood:	-8073.6
No. Observations:	2178	AIC:	1.615e+04
Df Residuals:	2175	BIC:	1.617e+04
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	25.3807	0.399	63.671	0.000	24.599	26.162
Cluster_Fantasy_and_Power_Lovers	3.4146	0.534	6.398	0.000	2.368	4.461
Cluster_Tactical_Masterminds	3.3435	0.530	6.303	0.000	2.303	4.384

Omnibus:	657.665	Durbin-Watson:	1.934
Prob(Omnibus):	0.000	Jarque-Bera (JB):	1612.077
Skew:	1.660	Prob(JB):	0.00
Kurtosis:	5.597	Cond. No.	4.03

The p-value is statistically significant for all co-efficient. The intercept of 25.34 indicates the mean age of the Group Destructors segment while the positive coefficients of Fantasy and Power Lovers and Tactical Masterminds indicate that these segments are, on average, 3.4 years older than the Group Destructors segment.

Income: I conducted linear regression with the Group Destructors segment as the baseline.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                 income   R-squared:                       0.013
Model:                            OLS   Adj. R-squared:                  0.012
Method:                 Least Squares   F-statistic:                     13.99
Date:                Sat, 01 Mar 2025   Prob (F-statistic):           9.22e-07
Time:                        01:40:51   Log-Likelihood:                -25725.
No. Observations:                2178   AIC:                         5.146e+04
Df Residuals:                    2175   BIC:                         5.147e+04
Df Model:                           2
Covariance Type:            nonrobust
================================================================================================
                                   coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------------
const                         4.588e+04   1319.194     34.778      0.000    4.33e+04    4.85e+04
Cluster_Fantasy_and_Power_Lovers  5031.5368   1766.315      2.849      0.004    1567.695    8495.378
Cluster_Tactical_Masterminds      9280.8647   1755.461      5.287      0.000    5838.308    1.27e+04
==============================================================================
Omnibus:                      386.634   Durbin-Watson:                   1.914
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              706.881
Skew:                           1.099   Prob(JB):                    3.18e-154
Kurtosis:                       4.720   Cond. No.                         4.03
==============================================================================
```

The p-value is statistically significant for all co-efficient. The intercept of 45,880 dollars indicates the mean income of the Group Destructors segment while the positive coefficients of Fantasy and Power Lovers and Tactical Masterminds indicate that these segments are wealthier. In fact, Tactical Masterminds have the highest average income.

Other Statistical Analysis

While the regression was able highlight the different mean values, I wanted to have a more simplistic view and so I calculated the means for each group along with the % of females for each group. The results are as follows:

```
Average Age and Income per Cluster:
                                 age        income
Cluster_Label
Fantasy and Power Lovers   28.795337  50910.621762
Group Destructors          25.380719  45879.084967
Tactical Masterminds       28.724181  55159.949622
```

The age and income mean values validate our previous findings from the regression analysis.

```
Cross-Tabulation of Cluster Labels and Gender:
gender                       female      male  nonbinary
Cluster_Label
Fantasy and Power Lovers   0.519430  0.475389   0.005181
Group Destructors          0.380719  0.612745   0.006536
Tactical Masterminds       0.462217  0.528967   0.008816
```

The gender distribution also matches with our analysis from cross-tabulation with a high percentage of males seen in the Group Destructors group. The % of females is slightly higher in the Fantasy and Power Lovers segment and % of males is slightly higher in the Tactical Masterminds segment. % of non-binary is significantly low across all segments.

Overall, I believe that Group Destructors are young players, mostly males, who do not have a very strong financial position. On the other hand, Fantasy and Power Lovers and Tactical Masterminds are likely to be above 35 with a higher income, indicating more mature and established segments.

Answer to Question 4

Handling missing data

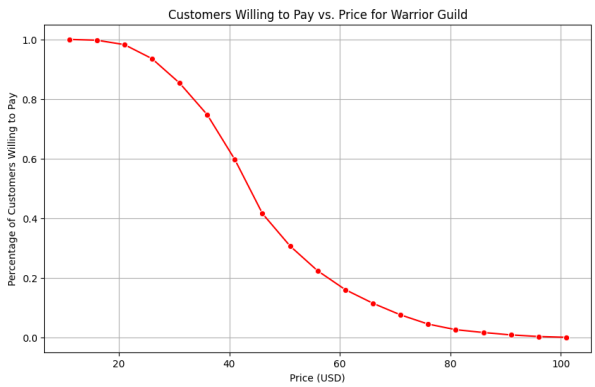
I noticed that 138 records are missing in the gg.pricemax column across different games. To deal with the missing data, I adopted the **multiple imputation** approach with IterativeImputer utilizing a RandomForestRegressor after grouping the data by 'gg.game.presented' to maintain game-specific accuracy.

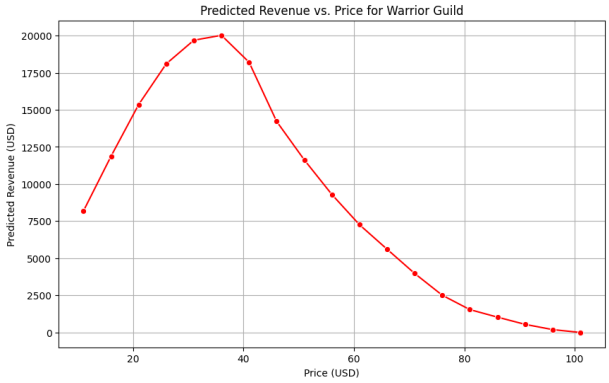
```
from sklearn.experimental import enable_iterative_imputer
from sklearn.impute import IterativeImputer
from sklearn.ensemble import RandomForestRegressor

print(data['gg.maxprice'].isnull().sum())

imputer = IterativeImputer(estimator=RandomForestRegressor(), initial_strategy='median', random_state=0)

grouped = data.groupby('gg.game.presented')
imputed_data = pd.DataFrame()

for name, group in grouped:
    group_imputed = group.copy()
    group_imputed[['gg.maxprice']] = imputer.fit_transform(group[['gg.maxprice']])
    imputed_data = pd.concat([imputed_data, group_imputed], ignore_index=True)

print(imputed_data['gg.maxprice'].isnull().sum())
```

I opted for multiple imputations because it offers a more nuanced treatment of missing data by creating several plausible imputations, enabling a better assessment of uncertainty compared to other methods such as mean imputation and regression imputation.

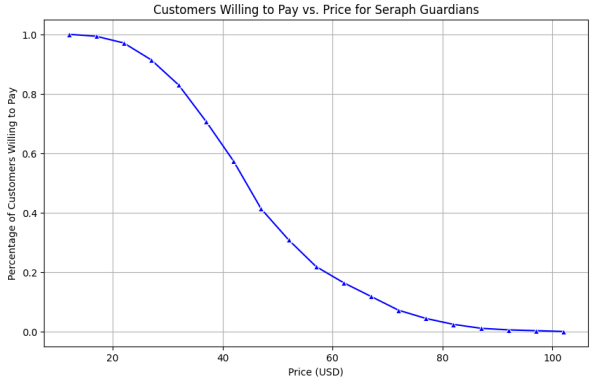
Gabor Granger

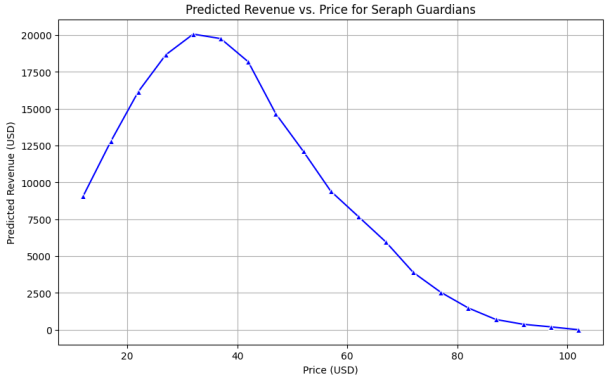
After managing the missing values, I ran a Gabor Granger analysis for each game. Let's analyze them one by one.



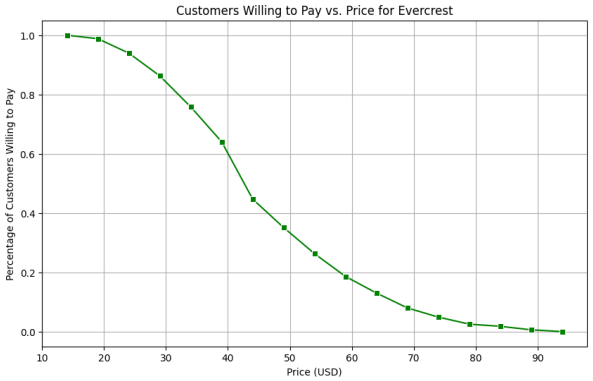


For Warrior Guild, the highest willingness to pay is around 15 dollars. However, we want to ensure that our revenue gets boosted, even if that means a smaller number of people paying for our game. Therefore, the **optimal price for Warrior Guild will be 36 dollars**, where revenue is predicted to be the highest.





Following the same approach of Warrior Guild, we see that the highest predicted revenue is **32 dollars for Seraph Guardians**. Therefore, that will be considered as the optimal price



Similarly, for Evercrest, the highest predicted revenue is at 34 dollars. Therefore, that will be considered as the optimal price.

Regression Analysis

We then conducted linear regression analysis to understand which are the most and least interested segments for each game with Group Destructors as the reference segment.

```
Analyzing game: Warrior Guild
                            OLS Regression Results
==============================================================================
Dep. Variable:            gg.maxprice   R-squared:                       0.017
Model:                            OLS   Adj. R-squared:                  0.014
Method:                 Least Squares   F-statistic:                     6.306
Date:                Sat, 01 Mar 2025   Prob (F-statistic):            0.00193
Time:                        01:49:09   Log-Likelihood:                -3064.0
No. Observations:                 744   AIC:                             6134.
Df Residuals:                     741   BIC:                             6148.
Df Model:                           2
Covariance Type:            nonrobust
=================================================================================================================
                                    coef    std err          t      P>|t|      [0.025      0.975]
-----------------------------------------------------------------------------------------------------------------
const                            43.4882      1.026     42.396      0.000      41.474      45.502
Cluster_Fantasy_and_Power_Lovers     4.6118      1.393      3.311      0.001       1.877       7.346
Cluster_Tactical_Masterminds         1.0560      1.355      0.779      0.436      -1.605       3.717
==============================================================================
Omnibus:                       62.170   Durbin-Watson:                   1.877
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               76.234
Skew:                           0.736   Prob(JB):                     2.79e-17
Kurtosis:                       3.543   Cond. No.                         4.02
==============================================================================
```

For Warrior Guild, the average maximum price Group Destructors are willing to pay is 43.5 dollars (the intercept) while the same value for Fantasy and Power Lovers is 43.5+4.6= 48.1 dollars. The p-value is not statistically significant for all co-efficient of Tactical Masterminds. Therefore, for **Warrior Guild the least interested segment is Group Destructors and the most interested segment is Fantasy and Power Lovers.**

```
Analyzing game: Seraph Guardians
                            OLS Regression Results
==============================================================================
Dep. Variable:            gg.maxprice   R-squared:                       0.035
Model:                            OLS   Adj. R-squared:                  0.032
Method:                 Least Squares   F-statistic:                     13.65
Date:                Sat, 01 Mar 2025   Prob (F-statistic):           1.51e-06
Time:                        01:49:09   Log-Likelihood:                -3135.3
No. Observations:                 756   AIC:                             6277.
Df Residuals:                     753   BIC:                             6291.
Df Model:                           2
Covariance Type:            nonrobust
=========================================================================================================
                                    coef    std err          t      P>|t|      [0.025      0.975]
---------------------------------------------------------------------------------------------------------
const                           41.0833      1.044     39.368      0.000      39.035      43.132
Cluster_Fantasy_and_Power_Lovers     6.9396      1.410      4.923      0.000       4.172       9.707
Cluster_Tactical_Masterminds         5.8267      1.391      4.189      0.000       3.096       8.558
==============================================================================
Omnibus:                       50.949   Durbin-Watson:                   1.991
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               59.626
Skew:                           0.678   Prob(JB):                     1.13e-13
Kurtosis:                       3.238   Cond. No.                         4.00
==============================================================================
```

The p-value is statistically significant for all co-efficient. For Seraph Guardians, the average maximum price Group Destructors are willing to pay is 41.08 dollars (the intercept) while the same value for Fantasy and Power Lovers is 41.08+6.94= 48.02 dollars. Therefore, for **Seraph Guardians the least interested segment is Group Destructors and the most interested segment is Fantasy and Power Lovers. However, it is important to highlight that Tactical Masterminds are willing to pay 46.9 dollars, which is very close to Fantasy and Power Lovers.**

```
Analyzing game: Evercrest
                            OLS Regression Results
==============================================================================
Dep. Variable:            gg.maxprice   R-squared:                       0.064
Model:                            OLS   Adj. R-squared:                  0.061
Method:                 Least Squares   F-statistic:                     22.99
Date:                Sat, 01 Mar 2025   Prob (F-statistic):           2.19e-10
Time:                        01:49:09   Log-Likelihood:                -2782.1
No. Observations:                 678   AIC:                             5570.
Df Residuals:                     675   BIC:                             5584.
Df Model:                           2
Covariance Type:            nonrobust
=========================================================================================================
                                    coef    std err          t      P>|t|      [0.025      0.975]
---------------------------------------------------------------------------------------------------------
const                           39.0108      1.080     36.137      0.000      36.891      41.130
Cluster_Fantasy_and_Power_Lovers     9.5430      1.412      6.757      0.000       6.770      12.316
Cluster_Tactical_Masterminds         6.2467      1.446      4.320      0.000       3.408       9.086
==============================================================================
Omnibus:                       40.400   Durbin-Watson:                   2.054
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               46.433
Skew:                           0.639   Prob(JB):                     8.26e-11
Kurtosis:                       3.096   Cond. No.                         4.09
==============================================================================
```

For Evercrest, the average maximum price Group Destructors are willing to pay is 39.01 dollars (the intercept) while the same value for Fantasy and Power Lovers is 39.01+9.54= 48.55 dollars. Therefore, for **Evercrest the least interested segment is Group Destructors and the most interested segment is Fantasy and Power Lovers.**

From the analyses, it is evident that **Fantasy and Power Lovers are the most interested segment in all games while Group Destructors are the least interested in all of them**. This indicates that whatever game we choose, it will be a good fit for Fantasy and Power Lovers while the opposite is true for Group Destructors. However, it is important to highlight that **Group Destructors may be willing to pay less since they are less solvent and so using willingness to pay as a predictor of interest may not be accurate**.

Among all the games, Fantasy and Power Lovers are willing to pay the most for Evercrest which makes sense given the fantasy world-based components of that game. Moreover, Group Destructors are willing to pay the most for Warrior Guild, which also makes sense given it is a multiplayer battle arena game. Furthermore, Tactical Masterminds are willing to pay the most for Seraph Guardians which aligns with their need for strategic elements in a game.

Gross and Net Revenue Calculation

I then wanted to calculate the gross and net revenue using the optimal price and costs mentioned in the case. The results for gross revenue are as follows:

```
predicted_gross_revenues = {}

for game, data in all_games_wtp.items():
    optimal_price_info = data.loc[data['pred_revenue'].idxmax()]
    optimal_price = optimal_price_info['price']
    num_respondents_at_optimal = sum(imputed_data[imputed_data['gg.game.presented'] == game]['gg.maxprice'] >= optimal_price)
    percentage_conversion = num_respondents_at_optimal / len(imputed_data[imputed_data['gg.game.presented'] == game])
    estimated_buyers = percentage_conversion * 0.3 * 10000000  # 30% conversion of interested players
    gross_revenue = estimated_buyers * optimal_price
    predicted_gross_revenues[game] = gross_revenue

    print(f'Game: {game}, Optimal Price: ${optimal_price}, Estimated Gross Revenue: ${gross_revenue:,.2f}')
```

```
Game: Warrior Guild, Optimal Price: $36.0, Estimated Gross Revenue: $80,709,677.42
Game: Seraph Guardians, Optimal Price: $32.0, Estimated Gross Revenue: $79,619,047.62
Game: Evercrest, Optimal Price: $34.0, Estimated Gross Revenue: $77,327,433.63
```

I noticed that Warrior Guild achieves the highest gross revenue, with Seraph Guardians trailing very closely behind. I then looked into the net revenue to understand how incorporating costs can change the financial position.

```python
def calculate_net_revenue(predicted_gross_revenue, development_cost):
    fixed_costs = 7e6  # $7 million for acquisition and marketing
    royalties = 0.05 * predicted_gross_revenue  # 5% royalties to the developer

    # Calculating Valve's cut based on the tiered structure
    if predicted_gross_revenue <= 10e6:
        valve_cut = 0.30 * predicted_gross_revenue
    elif predicted_gross_revenue <= 50e6:
        valve_cut = 0.30 * 10e6 + 0.25 * (predicted_gross_revenue - 10e6)
    else:
        valve_cut = 0.30 * 10e6 + 0.25 * 40e6 + 0.20 * (predicted_gross_revenue - 50e6)

    # Net revenue after all deductions
    net_revenue = predicted_gross_revenue - (royalties + valve_cut + development_cost + fixed_costs)
    return net_revenue

# Including development costs for each game
development_costs = {
    'Warrior Guild': 5e6,
    'Seraph Guardians': 5.5e6,
    'Evercrest': 6e6
}

net_revenues = {}

for game, gross_revenue in predicted_gross_revenues.items():
    net_revenue = calculate_net_revenue(gross_revenue, development_costs[game])
    net_revenues[game] = net_revenue
    print(f"Net revenue for {game}: ${net_revenue:,.2f}")
```

```
Net revenue for Warrior Guild: $45,532,258.06
Net revenue for Seraph Guardians: $44,214,285.71
Net revenue for Evercrest: $41,995,575.22
```

Similar to gross revenue results, Warrior Guild comes out as the game with the highest net revenue, followed by Seraph Guardians. However, given the differences are not significant as per this analysis, Athena should not drop any particular games from consideration.

Answer to Question 5:

Since here the assumption is each customer would only buy one game, I considered that they will **purchase only the game that they have ranked 1**. Therefore, by counting the number of times a game have been ranked 1 and dividing it by the total number of respondents we can determine the market share as follows:

```
Market share for WarriorGuild: 13.18%
Market share for SeraphGuardians: 50.05%
Market share for Evercrest: 9.78%
Market share for DevilsGate: 18.60%
Market share for Marksman: 2.30%
Market share for QuestoftheTitan: 6.11%
```

Interestingly, Seraph Guardians is by far the winner among the competitors with more than half of the respondents marking it as their most preferred game. This indicates that Seraph Guardians will be a strong choice when deciding on the game to acquire.

However, there are quite a few assumptions in the previous calculation that might not be representative of the real world. The following are the assumptions I want to change:

Assumption 1 - Uniform Pricing: Assuming all games are priced equally might not accurately mirror real-world market conditions where pricing strategies significantly influence consumer decisions.

Modification: I will introduce a dynamic pricing strategy where each game takes up a price within a range for different rounds of the simulation. I will also incorporate price elasticity of demand to reflect how price changes affect consumer purchasing behavior.

Assumption 2 - Single Purchase Per Customer: It may not be realistic to assume that each customer will purchase only one game, especially in a diverse market with multiple appealing options.

Modification: I will include the possibility that respondents might purchase multiple games. I will introduce probabilities for purchasing based on game rankings to consider the likelihood of purchasing even lower-ranked games.

Assumption 3 - Static Competitor Strategies: Assuming competitors will not alter their strategies in response to Athena’s pricing and marketing might overlook potential market dynamics.

Modification: I will simulate potential competitor reactions, such as price adjustments efforts in response to Athena's pricing strategies to better predict shifts in market share.

Assumption 4- Market Representation: Assuming that the survey respondents perfectly represent the broader market might overlook nuances such as geographical, demographic, and psychographic variations that could significantly affect game popularity.

Modification: Conducting multiple surveys across different segments to enrich the dataset or increasing the sample size to capture a wider range of consumer profiles may help in catching nuances better. A relatively cost-friendly way to better capture nuances can be running

simulations with varying characteristics of respondents to understand how different distributions of market segments might impact revenue from game releases.

I wanted to apply the modifications related to **pricing and multiple purchase opportunities** to **simulate the market share**. It is important to note that during the simulations the prices of different games will vary and so this exercise will somewhat capture the impact of competitors lowering prices to dominate. The code and results for simulation are as follows:

```
def run_simulation(data, game_prices, price_elasticity_factor, rank_probabilities):
    # Considering price elasticity
    price_elasticities = {game: max(0, 1.0 - price_elasticity_factor * price) for game, price in game_prices.items()}

    # Initializing market shares
    market_shares = {game: 0 for game in game_prices.keys()}

    # Simulating market shares
    for index, row in data.iterrows():
        for game, price in game_prices.items():
            rank_column = f'rank.{game}'
            if rank_column in data.columns:
                rank = row[rank_column]
                if rank in rank_probabilities:
                    adjusted_probability = rank_probabilities[rank] * price_elasticities[game]
                    market_shares[game] += adjusted_probability

    # Checking for zero total before division
    total_shares = sum(market_shares.values())
    if total_shares > 0:
    # Normalizing market shares to sum to 100%
        market_shares = {game: (share / total_shares) * 100 for game, share in market_shares.items()}
    else:
        print("Total market shares sum to zero, can't normalize.")
    return market_shares
```

```
# Probabilities for each rank allowing multiple purchases
rank_probabilities = {
    1: 0.90,
    2: 0.75,
    3: 0.60,
    4: 0.30,
    5: 0.15,
    6: 0.05
}

# Defining number of simulations
n_simulations = 200
aggregate_results = {game: [] for game in ['WarriorGuild', 'SeraphGuardians', 'Evercrest', 'DevilsGate', 'Marksman', 'QuestoftheTitan']}

# Runing multiple simulations with varying price sensitivity
for _ in range(n_simulations):
    # Assigning a random price sensitivity for this simulation
    price_elasticity_factor = np.random.uniform(0.01, 0.03)

    # Assigning random prices within the range of $10 to $50 for each game
    game_prices = {game: np.random.randint(10, 50) for game in aggregate_results.keys()}

    results = run_simulation(imputed_data, game_prices, price_elasticity_factor, rank_probabilities)
    for game, share in results.items():
        aggregate_results[game].append(share)

# Computing average market shares
average_market_shares = {game: np.mean(shares) for game, shares in aggregate_results.items()}
```

I ran 200 simulations with **probabilities assigned to different games based on ranking, varying prices ranging from 10 to 50 dollars and varying price sensitivit**y. The results are as follows:

```
Average adjusted market share for WarriorGuild: 16.98%
Average adjusted market share for SeraphGuardians: 25.18%
Average adjusted market share for Evercrest: 14.08%
Average adjusted market share for DevilsGate: 16.69%
Average adjusted market share for Marksman: 12.26%
Average adjusted market share for QuestoftheTitan: 14.81%
```

As per my observation, the simulation results demonstrate how market share projections can vary significantly when key assumptions about pricing and purchase behavior are altered. The initial results, with static pricing and single-game purchases, showed Seraph Guardians dominating market share. However, after introducing varying prices and price sensitivities and allowing for the possibility of multiple purchases, the simulation results displayed a more balanced distribution of market share among the games. In fact, Warrior Guild and Devil's Gate are now significantly closer to Seraph Guardians in terms of market share. This variability underscores the importance of considering multiple market conditions and customer behaviors in forecasting as it provides a more comprehensive view of potential outcomes.

Answer to Question 6:

The following are my final recommendations:

Game: Acquire Seraph Guardians

I recommend Athena to acquire Seraph Guardians because it has gained high preference from a significantly higher number of customers (question 5). In fact, it is expected to capture the highest market share of 25.18% even when variable pricing and multiple game purchase for one gamer is simulated. If we consider the market size to be USD 5.3 billion in 2020 (question 2), the revenue from Seraph Guardians is estimated to be 5.3x0.2518 = 1.33 Billion dollars.

While the Warrior Guild seems to have outperformed Seraph Guardians in the net revenue calculation exercise in question 4, the difference is very marginal. Moreover, question 4 assumes a uniform 30% deflator for all games when considering the number of people who will purchase the game. However, more people may be willing to purchase Seraph Guardians at that price than 30% since it has outranked other games in case of customer preference.

Pricing: Premium Pricing

As per the Gabor Granger analysis, Seraph Guardians has an optimal price of 32 dollars and optimal price of the three games ranged from 32 to 36 dollars and so this can be considered the range for competitive pricing. Prices below 32 can be considered penetration pricing as these prices essentially target to undercut pricing of competitors, while prices above 36 dollars may be

considered as premium pricing for Seraph Guardians. Here's the data frame of Gabor Granger analysis for Seraph Guardians for quick reference.

	price	per_customers_wtp	pred_revenue
0	12.0	1.000000	9072.0
1	17.0	0.993386	12767.0
2	22.0	0.970899	16148.0
3	27.0	0.914021	18657.0
4	32.0	0.829365	20064.0
5	37.0	0.706349	19758.0
6	42.0	0.572751	18186.0
7	47.0	0.412698	14664.0
8	52.0	0.308201	12116.0
9	57.0	0.218254	9405.0
10	62.0	0.164021	7688.0

Seraph Guardians, anticipated as the most preferred game, is likely to attract customers even without under cutting price of competitors. Moreover, analysis from the Gabor Granger data suggests minimal revenue difference between the 37 and 32 dollar price points. Considering the strong preference for Seraph Guardians, which is not fully captured in the Gabor Granger analysis, it is reasonable to set a premium price of 40 dollars. The assumption is customers' willingness to purchase will remain robust even at this higher price point.

Targeting Strategy: Target Tactical Masterminds

Rationale:

- Tactical Masterminds has the highest average income among the groups, as indicated in question 3. This financial capability positions them as ideal candidates for premium-priced offerings like Seraph Guardians.
- Their strong alignment with the strategic and problem-solving elements and single-player mode of Seraph Guardians makes this product a natural fit for their gaming preferences.
- Although Fantasy and Power Lovers are willing to pay the most for Seraph Guardians, averaging $48.02, Tactical Masterminds are a close second at $46.90. This underscores their readiness to invest in high-quality gaming experiences and their interest in Seraph Guardians.
- I also noticed that a greater portion of Tactical Masterminds have ranked Seraph Guardians as number 1 compared to Fantasy and Power Lovers, indicating higher preference of Seraph Guardians among Tactical Masterminds.

```
Percentage of Tactical Masterminds who ranked Seraph Guardians as 1: 0.6020151133501259
Percentage of Fantasy Lovers who ranked Seraph Guardians as 1: 0.5699481865284974
```

- Tactical Masterminds represent the largest share of our survey respondents with 794 participants. If these figures emanate broader market trends, this group could potentially be the most substantial customer segment.

Positioning: A Premium Strategic Game for Solo Play

- I recommend emphasizing the game's deep strategic elements that appeal to the analytical strengths of Tactical Masterminds.
- I think it is also beneficial to promote immersive single-player RPG experience since mature gamers, such as those over 35, may be more willing to play games which they can play on their own schedule instead of spending time forming groups.
- Finally, Seraph Guardians should be positioned as a premium product with emphasis on high quality graphics and unique gameplay elements to justify a higher price point.