Journal of Computations & Modelling, vol.4, no.2, 2014, 1-40
ISSN: 1792-7625 (print), 1792-8850 (online)
Scienpress Ltd, 2014

Questionnaire Investigation on Jewelry / Accessory and its Sensitivity AnalysisUtilizing Bayesian Network

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Abstract

Recently, the numbers of jewelry/accessories buying via the Internet are increasing, especially for young people. They often have difficulty deciding what kinds of jewelry/accessories to choose, because there are many kinds of jewelry/accessories to choose from. Consulting service to support decisions is required for these matters. In this paper, a questionnaire investigation is executed for the purchasing on-line network, used for jewelry/accessory purchasing in order to get instructions for an on-line network consulting service. Nearly 500 sample data are collected. In this research, we construct the model utilizing Bayesian Network and causal relationship is sequentially chained by the characteristic of customer, the purchase budget and the accessory type. We analyzed them by sensitivity analysis and some useful results were obtained. These are utilized for constructing a much more effective and useful on-line network consulting service.

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Article Info: *Received* : October 25, 2013. *Revised* : December 12, 2013.
Published online : May 31, 2014.

To confirm the findings by utilizing the new consecutive purchasing records would be the future works to be investigated.

Keywords: jewelry; questionnaire investigation; Bayesian Network

1 Introduction

Owing to the prevailing Internet, new businesses such as jewelry selling via Internet with on-line consultation, what kind of jewelry/accessory for gift purchasers would be better to choose, is becoming a big trend. Purchasers via Internet have various purchasing patterns and they may have significant relationship with their characteristics and the circumstances they are in. Therefore, if we can make clear the relationship between these, we would be able to make a much more effective marketing plan and execute efficient sales promotion for each of them.

For these purposes, we created a questionnaire investigation of jewelry/accessory purchasing. In recent years, Bayesian Network is highlighted because it has the following good characteristics (Neapolitan, R.E., 2004).

・Structural Equation Modeling requires normal distribution to the data in the analysis. Therefore it has a limitation in making analysis. But Bayesian Network does not require specific distribution type to the data. It can handle any distribution type.

・It can handle the data which include partial data.

・Expert’s know-how can be reflected in building Bayesian Network model.

・Sensitivity analysis can be easily executed by setting evidence. We can estimate and predict the prospective purchaser by that analysis.

・It is a probability model having network structure. Related items are connected with directional link. Therefore understanding becomes easy by its visual chart.

In this research, it is suitable to utilize Bayesian Network to analyze jewelry / accessory purchasing because each variable does not necessarily have normal distribution. Reviewing past researches, there are some related researches as follows. Takahashi et al. (2008) made analysis for the future home energy utilizing Bayesian Network. Tsuji et al. (2008) made analysis concerning preference mining on future home energy consumption. There are some papers concerning purchase behavior in the shop (Tatsuoka et al.,2008-a, Tatsuoka et al., 2008-b). But we can hardly see the analysis concerning jewelry / accessory purchasing utilizing Bayesian Network.

In this paper, a questionnaire investigation is executed for on-line network jewelry/accessory purchasing in order to get instructions for an on-line network consulting service. These are analyzed by using Bayesian Network.

The analysis utilizing Bayesian Network enabled us to visualize the causal relationship among items. Furthermore, sensitivity analysis brought us estimating and predicting the prospective purchaser.

Some interesting and instructive results are obtained. These are utilized for constructing a much more effective and useful on-line network consulting service.

The rest of the paper is organized as follows. Outline of questionnaire research is stated in section 2. In section 3, an analysis by cross tabulation is executed. In section 4, Bayesian Network analysis is executed which is followed by the sensitivity analysis in section 5. Remarks is stated in section 6.

2 Outline of Questionnaire Research and Examinees

2.1 Outline of Questionnaire Research

Outline of questionnaire research is as follows.

Scope of investigation: Young Persons, Japan

Period : May 2008～June 2009

Method : Mail and self writing

Collection : Number of distribution 1,500, Number of collection 421 (Collection rate 28.1%)

Analysis methods are as follows.

Questionnaire results are analyzed by the following three methods. First, analysis by Cross Tabulation is executed in 3 in order to confirm the outline of the data. Second, analysis by Bayesian Network is executed in 4 in order to clarify and visualize the causal relationship among the items. Third, analysis by sensitivity analysis is executed in 5 in order to predict the prospective purchaser as is shown in Table 1.

Table 1: Analysis Procedure

Step	Aim of analysis	Used Method
1	Confirm the outline of the data	Cross Tabulation
2	Build Bayesian Network in order to clarify and visualize the causal relationship among items	Bayesian Network Analysis
3	Predict the prospective purchaser	Sensitivity Analysis

2.2. Outline of Examinees

1.Sex (Q45)

Male : 67%

Female : 33%

2.Age (Q46)

Under 18 : 1%

18～22 : 36%

23～27 : 15%

28～32 : 12%

33～37 : 14%

38～42 : 10%

43～47 : 4%

More than 48 : 8%

3.Occupation (Q47)

Student : 39%

Offic : 2%

Company Employee : 46%

Clerk of Organization : 1%

Independents : 6%

Miscellaneous : 6%

4.Address (Q48)

Osaka : 57%

Hyogo : 7%

Kagawa : 6%

Wakayama : 5%

Fukui : 5%

Nara : 4%

Others : 16%

3. Fundamental ideas for hypotheses

We set 10 Themes as follows. These are extracted from the experience of the professionals. We can consider many other themes, but we focus mainly upon monetary, frequency, character, and purchasing goods.

Theme 1	:	Female would esteem coupon much better than male does.
Theme 2	:	Those who make stress upon material or quality have rather high budget amount.
Theme 3	:	There are not so much utilization of Internet shopping for the people who like sports and shopping.
Theme 4	:	Those who like indoor lifestyle use Internet frequently.
Theme 5	:	Company employee uses Internet Shopping much more frequently than student or housewife.
Theme 6	:	Those who like shopping esteem brand, trend and design.
Theme 7	:	Budget amount is large when he / she has someone to consult with in making present.
Theme 8	:	Those who like shopping do not hesitate to consult with sales clerk.
Theme 9	:	Those who often use Internet shopping live far from urban.
Theme 10	:	Those who like shopping also like Internet shopping.

The results of statistical hypothesis testing are as follow.

Theme 1. Female esteems coupon much better than male does.

Null hypothesis: Female esteems coupon as male does.

Table 2: Cross Tabulation result 1

		Q35 (%)					
		Very important	Slightly important	Ordinary level	Not so important	Not important	Total
Q45	Male	0.208	0.384	0.220	0.107	0.082	1.000
	Female	0.321	0.346	0.233	0.057	0.044	1.000
Sum		0.245	0.371	0.224	0.090	0.069	1.000

Real number	Important	Not important	Sum
Male	188	60	248
Female	106	16	122
Sum	294	76	370

Expectation	Important	Not important	Sum
Male	197.0594595	50.94054	248
Female	96.94054054	25.05946	122
Sum	294	76	370

Statistic	6.149465
Rejection region	3.84146

The hypothesis is rejected with 5% significance level.

Therefore it can be said that “Female esteems coupon much better than male does”.

Shop owner has an impression that many women respond to the promotion or campaign of coupon.

It is only women to inquire about campaign of coupon. Women seek the best timing to buy, while men often buy the goods when they need, whether the campaign is held or not.

Theme 2. Those who do not make stress upon material or quality have rather low budget amount.

Null hypothesis: There is not so much difference in esteeming material or quality whether the budget is high or not.

Table 3: Cross Tabulation result 2

		Q12 (%)							
		～5000	～10000	～15000	～20000	～25000	～30000	more	Total
Q5	Very important	0.123	0.262	0.139	0.197	0.033	0.172	0.074	1.000
	Slightly important	0.145	0.271	0.187	0.182	0.019	0.131	0.065	1.000
	Ordinary level	0.149	0.175	0.193	0.228	0.009	0.123	0.123	1.000
	Not so important	0.214	0.143	0.143	0.286	0.107	0.071	0.036	1.000
	Not important	0.000	0.333	0.000	0.167	0.000	0.333	0.167	1.000
Sum		0.143	0.240	0.171	0.202	0.025	0.138	0.081	1.000

Real number	0～20,000（Cheap）	20,000～（High）	Sum
Important	256	80	336
Not Important	25	9	34
Sum	281	89	370

Expectation	0～20,000（Cheap）	20,000～（High）	Sum
Important	255.18	80.8216	336
Not Important	25.822	8.17838	34
Sum	281	89	370

Statistic	0.1197
Rejection region	3.8415

The hypothesis is not rejected.

It cannot be said that budget is not necessarily high even though consumers esteem material or quality. In particular, consumers can not confirm the goods holding at their hands, therefore they confirm the explanation of material or quality at the site.

We often hear from many shop owners that they have experience of what consumers who buy only price deducted goods are severe in selecting goods. It can be said that those who are severe for price are also severe for quality.

Theme 3. There are not so much utilization of Internet shopping for the people who like sports and shopping.
Null hypothesis: There is little difference in the frequency of utilization of Internet shopping among those who like sports/shopping and those who do not.

Table 4.1: Cross Tabulation result 3

		Q38 (Internet Shopping) (%)				
		Very often	Sometimes	Rarely	Never	Total
Q21 (Sports)	Very important	0.139	0.376	0.171	0.314	1.000
	Slightly important	0.071	0.473	0.161	0.295	1.000
	Ordinary level	0.125	0.458	0.139	0.278	1.000
	Not so important	0.250	0.438	0.094	0.219	1.000
	Not important	0.286	0.286	0.000	0.429	1.000
Sum		0.130	0.415	0.156	0.299	1.000

Real number	use	Not use	Sum
Like	187	170	357
Dislike	26	13	39
Sum	213	183	396

Expectation	use	Not use	Sum
Like	192.023	164.9773	357
Dislike	20.977	18.02273	39
Sum	213	183	396

Statistic	2.886697
Rejection region	2.874374

The hypothesis is rejected with 1% significance level.

Table 4.2: Cross Tabulation result 3

		Q38 (Internet Shopping) (%)				
		Very often	Sometimes	Rarely	Never	Total
Q23 (Shopping)	Very important	0.167	0.395	0.111	0.327	1.000
	Slightly important	0.124	0.513	0.133	0.23	1.000
	Ordinary level	0.119	0.396	0.208	0.277	1.000
	Not so important	0.081	0.243	0.27	0.405	1.000
	Not important	0	0	0	1.000	1.000
Sum		0.133	0.41	0.161	0.296	1.000

Real number	use	Not use	Sum
Like	163	112	275
Dislike	12	27	39
Sum	175	139	314

Expectation	use	Not use	Sum
Like	153.264	121.7357	275
Dislike	21.736	17.26433	39
Sum	175	139	314

Statistic	11.24787
Rejection region	6.634897

The hypothesis is rejected with 9% significance level.

It can be said that there are not so much utilization of Internet shopping for the people who like sports and shopping.

There who like sports and shopping would easily go out and search goods at real shop. It may be considered that they do not think highly of net shop.

Theme 4. Those who like indoor lifestyle use Internet frequently.

Null hypothesis: There is not so much difference in the frequency of using Internet whether those who like indoor lifestyle or not.

Table 5: Cross Tabulation result 4

		Q37 (%)				
		Very often	Sometimes	Rarely	Never	Total
Q30	Outdoor	0.571	0.276	0.100	0.053	1.000
	Indoor	0.755	0.123	0.065	0.058	1.000
	Either	0.597	0.264	0.069	0.069	1.000
Sum		0.638	0.223	0.079	0.060	1.000

Real number	Use	Not use	Sum
Outdoor	144	26	170
Indoor	136	19	155
Sum	280	45	325

Expectation	Use	Not use	Sum
Outdoor	146.462	23.53846	170
Indoor	133.538	21.46154	155
Sum	280	45	325

Statistic	0.626487
Rejection region	3.84146

The hypothesis is not rejected.

There is not so much difference in the frequency of using Internet whether those who like indoor lifestyle or not.

Once, there was an image that indoor typed people often use Internet. But nowadays, it became common to use Internet whenever and wherever.

Theme 5. Company employee uses Internet Shopping much more frequently than student or housewife.

Null hypothesis: There is not so much difference in the frequency of using Internet whether they are company workers or not.

Table 6: Cross Tabulation result 5

		Q47 (Occupation) (%)						
		Student	Officer	Company Employee	Clerk of Organization	Independents	Miscellaneous	Total
Q38	Very often	0.238	0.016	0.540	0.000	0.127	0.079	1.000
	Sometimes	0.293	0.005	0.571	0.005	0.066	0.061	1.000
	Rarely	0.446	0.036	0.422	0.012	0.024	0.060	1.000
	Never	0.559	0.021	0.301	0.000	0.049	0.070	1.000
Sum		0.390	0.016	0.462	0.004	0.062	0.066	1.000

Real number	Student	Worker	Sum
Use	90	171	261
Not use	132	94	226
Sum	222	265	487

Expectation	Student	Worker	Sum
Use	118.977	142.0226	261
Not use	103.023	122.9774	226
Sum	222	265	487

Statistic	27.948
Rejection region	6.6349

The hypothesis is rejected with 1% significance level.

It can generally be said that company employee uses Internet shopping much more frequently than student or housewife.

Company employees are accustomed to use Internet and they have hard time to go out shopping while in week days.

Therefore they may use Internet for shopping. Actually, the most frequent access times to Cherish Co. Ltd. are around 21 o'clock. They may be making Internet shopping at home after work.

Theme 6. Those who like shopping esteem brand, trend and design.

Null hypothesis: There is not so much difference in esteeming brand, trend and design whether those who like shopping or not.

Table 7: Cross Tabulation result 6

		Q4 (Fad) (%)					
		Very important	Slightly important	Ordinary level	Not so important	Not important	Total
Q23 (Shopping)	Very important	0.588	0.267	0.097	0.036	0.012	1.000
	Slightly important	0.318	0.473	0.118	0.091	0.000	1.000
	Ordinary level	0.297	0.506	0.127	0.063	0.006	1.000
	Not so important	0.270	0.378	0.216	0.135	0.000	1.000
	Not important	0.500	0.000	0.500	0.000	0.000	1.000
Sum		0.403	0.403	0.123	0.066	0.006	1.000

Real number	important	Not important	Sum
Like	228	18	246
Dislike	25	5	30
Sum	253	23	276

Expectation	important	Not important	Sum
Like	225.5	20.5	246
Dislike	27.5	2.5	30
Sum	253	23	276

Statistic	3.0599
Rejection region	2.8744

The hypothesis is rejected with 9% significance level.

It can generally be said that those who like shopping esteem brand, trend and design. Those who like shopping are accustomed to go shopping and generally have information about brand, trend and design therefore thy have own standard what to buy.

Theme 7. Budget amount is large when he / she has someone to consult with in making present.

Null hypothesis: There is not so much difference for the budget amount whether they have someone to consult with or not in making present.

Table 8: Cross Tabulation result 7

		Q12 (%)							
		～5000	～10000	～15000	～20000	～25000	～30000	more	Total
Q15	Boy(Girl)friend	0.061	0.210	0.144	0.238	0.022	0.193	0.133	1.000
	friend	0.196	0.346	0.215	0.121	0.028	0.075	0.019	1.000
	clerk	0.141	0.250	0.156	0.266	0.047	0.141	0.000	1.000
	Do not consult with anybody	0.205	0.197	0.189	0.220	0.016	0.102	0.071	1.000
	Miscellaneous	0.200	0.000	0.000	0.000	0.000	0.200	0.600	1.000
Sum		0.140	0.240	0.171	0.209	0.025	0.136	0.079	1.000

	～5000	～10000	～15000	～20000	～25000	～30000	more	Total
Consult with somebody	0.118	0.255	0.165	0.204	0.028	0.148	0.081	1.000
Do not consult with anybody	0.214	0.136	0.175	0.243	0.019	0.126	0.087	1.000
Sum	0.139	0.228	0.167	0.213	0.026	0.143	0.083	1.000

Real number	0～20,000（Cheap）	20,000～（High）	Sum
Important	265	92	357
Not Important	79	24	103
Sum	344	116	460

Expectation	0～20,000（Cheap）	20,000～（High）	Sum
Important	266.97391	90.026087	357
Not Important	77.026087	25.973913	103
Sum	344	116	460

Statistic	0.25847
Rejection region	3.84146

The hypothesis is not rejected.

It cannot be said that the budget is high for those who have someone to consult with in making present compared with those who do not have.

Theme 8. Those who like shopping do not hesitate to consult with sales clerk.

Null hypothesis: There is not so much difference whether they like shopping or not, for those who do not hesitate to consult with sales clerk.

Table 9: Cross Tabulation result 8

		Q45 (%)					
		Boy(Girl) friend	Friend	Clerk	Do not consult with anybody	Miscellaneous	Total
Q23 (Shopping)	Very important	0.315	0.321	0.117	0.241	0.006	1.000
	Slightly important	0.330	0.259	0.098	0.313	0.000	1.000
	Ordinary level	0.433	0.121	0.172	0.255	0.019	1.000
	Not so important	0.371	0.171	0.143	0.286	0.029	1.000
	Not important	1.000	0.000	0.000	0.000	0.000	1.000
Sum		0.365	0.226	0.132	0.265	0.011	1.000

Real number	Consult	Not consult	Sum
Like	30	74	104
Dislike	5	10	15
Sum	35	84	119

Expectation	Consult	Not consult	Sum
Like	30.58824	73.41176	104
Dislike	4.411765	10.58824	15
Sum	35	84	119

Statistic	0.127137
Rejection region	6.634897

The hypothesis is not rejected.

Generally, there are few people to consult with sales clerk while shopping. It may be because they hear the request before making present. Sales talk of sales clerk may be backed away at any rate.

Theme 9. Those who often use Internet shopping live far from urban.
Null hypothesis: There is not so much difference among those who live urban and those who do not live, in the use of Internet shopping.

Table 10: Cross Tabulation result 9

		Q48 (Address) (%)							
		Aichi	Ibaragi	Kyoto	Kagawa	Kouchi	Saitama	Yamaguchi	Shiga
Q38	Very often	0.016	0.032	0.016	0.129	0.016			0.016
	Sometimes		0.010	0.026	0.052		0.010	0.005	0.005
	Rarely		0.026	0.039					
	Never		0.044	0.007	0.015		0.007		
Sum		0.002	0.026	0.021	0.043	0.002	0.006	0.002	0.004

		Akita	Chiba	Nara	Sizuoka	Osaka	Tokyo	Kanagawa	Fukui
Q38	Very often		0.048	0.032	0.016	0.403	0.032	0.016	0.065
	Sometimes		0.021	0.073	0.021	0.578	0.005	0.010	0.031
	Rarely	0.013				0.701			0.039
	Never		0.007	0.030	0.007	0.659	0.007		0.030
Sum		0.002	0.017	0.043	0.013	0.599	0.009	0.006	0.036

		Oita	Hyougo	Mie	Fukuoka	Nagano	Hirosima	Wakayama	Total
Q38	Very often		0.081		0.016			0.065	1.000
	Sometimes		0.094	0.005	0.016	0.021		0.036	1.000
	Rarely	0.013	0.078		0.026	0.021		0.065	1.000
	Never		0.074	0.007	0.030	0.021	0.007	0.059	1.000
Sum		0.002	0.084	0.004	0.021	0.021	0.002	0.052	1.000

Real number	urban	far	Sum
use	139	115	254
Not use	144	68	212
Sum	283	183	466

期待値	urban	far	Sum
use	154.2532	99.74678	254
Not use	128.7468	83.25322	212
Sum	283	183	466

Statistic	8.44255
Rejection region	6.634897

The hypothesis is rejected with 1% significance level.

It is generally assumed that residents in urban area have less need to use Internet because shops are near.

But the actual order number is many for the residents in urban area. It does not depend upon the place where they live but lifestyle and/or hobby may have correlation for the utilization of Internet for shopping.

Theme 10. Those who like shopping also like Internet shopping.

Null hypothesis: There is not so much difference whether those who like shopping also like Internet shopping or not.

Table 11: Cross Tabulation result 10

		Q38 (%)				
		Very often	Sometimes	Rarely	Never	Total
Q23 (Shopping)	Very important	0.167	0.395	0.111	0.327	1.000
	Slightly important	0.124	0.513	0.133	0.230	1.000
	Ordinary level	0.119	0.396	0.208	0.277	1.000
	Not so important	0.081	0.243	0.270	0.405	1.000
	Not important	0.000	0.000	0.000	1.000	1.000
Sum		0.133	0.410	0.161	0.296	1.000

Real number	Use	Not use	Sum
Like	163	112	275
Dislike	12	27	39
Sum	175	139	314

期待値	Use	Not use	Sum
Like	153.26433	121.73567	275
Dislike	21.735669	17.264331	39
Sum	175	139	314

Statistic	11.2479
Rejection region	6.6349

The hypothesis is rejected with 1% significance level.

It can generally be said that those who like shopping also like Internet shopping. Internet shopping became popular and it is one of the style of shopping in general. In particular, those who like shopping may feel convenient in selecting goods as there are so many goods sold in Internet shop.

4. Bayesian Network Analysis

In constructing Bayesian Network, it is required to set an outline of the model reflecting the causal relationship among groups of items. Concept chart in this case is exhibited in Figure 1.

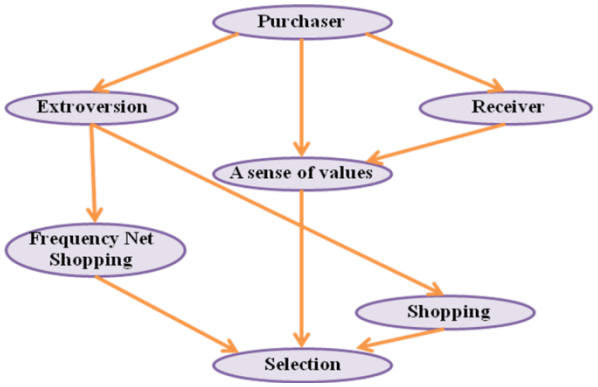

Figure 1: Node and Parameter

Based on this, a model is built as is shown in Figure 2.

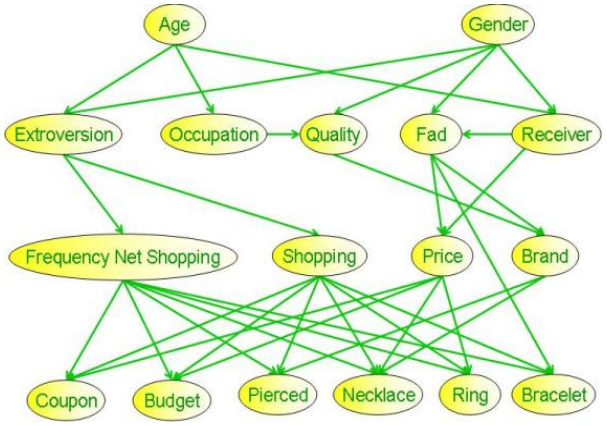

Figure 2: A Built Model

We used BAYONET software (http://www.msi.co.jp/BAYONET/). When plural nodes exist in the same group, it occurs that causal relationship is hard to set a priori. In that case, BAYONET system set the sequence automatically utilizing AIC standard. Node and parameter of Figure 2 are exhibited in Table 12.

Table 12: Node and Parameter

Group Name	Node in Group	Parameter				
		1	2	3	4	5
Purchaser	Age	Under22	23~32	33~42	Over43	
	Gender	Male	Female			
	Occupation	Students	Employee	Independent	Others	
Receiver	Receiver	Lover	Parents	Sweet Heart	Myself	Others
Extroversion	Extroversion	Outdoor	Indoor	Not Either		
A sense of values	Fad, Brand, Price, Quality	Important	Ordinary	Not		
Internet Shopping	Frequency of Net Shopping	Often	Sometimes	Rarely	Never	
Shopping	Shopping	Important	Ordinary	Not		
Selection	Budget	~10000	~20000	~30000	Over 30000	
	Ring, Necklace, Pierced, Bracelet	Buy	Not			
	Coupon	Important	Ordinary	Not		

“Very important” and “Slightly important” are condensed into one as “Important” in order to decrease node number.

5. Sensitivity Analysis

Now, posterior probability is calculated by setting evidence as, for example, 1.0. Comparing Prior probability and Posterior probability, we can seek the change and confirm the instruction for purchasing. We set evidence to all parameters. Therefore the analysis volume becomes too large. In this paper, we pick up half of the total cases and make analysis. Nodes we analyze here are “Age”,

“Extroversion”, “Occupation”, “Quality”, “Frequency of Net Shopping”, “Shopping”, “Coupon” and “Budget”. We prepare another paper for the latter half.

As stated above, we set evidence for each parameter, and the calculated posterior probability is exhibited in Appendix Table A. The value of “Posterior probability – Prior probability” (we call this “Difference of probability” hereafter) is exhibited in Appendix Table B. The sensitivity analysis is executed by mainly using this table. It is well known that difference of probability becomes small as the node becomes distant (Takahashi et al.).

Here, we pick up major parameters by the distance of node.

・Node separated by 1 class: Select major parameter of which absolute value of difference of probability is more than 0.02

・Node separated by 2 class: Select major parameter of which absolute value of difference of probability is more than 0.005

・Node separated by 3 class: Select major parameter of which absolute value of difference of probability is more than 0.001

In selecting parameters, negative value does not necessarily have distinct meaning, therefore we mainly pick up positive value in the case meaning is not clear.

Now we examine each case.

5.1 Sensitively Analysis for “Age”

(1) Setting evidence to “Less than 22 years old”

①Node separated by 1 class

Occupation	Students	＋
Extroversion	Indoor	＋
Receiver	Lover	＋

②Node separated by 2 class

Quality	Not important	＋

Fad	Important	＋
Price	Important	－

③Node separated by 3 class

Coupon	Important	－
Budget	20,000～	＋
Pierced earrings	Buy	＋
Bracelet	Not buy	＋
Brand	Ordinary level	＋

We can observe that “Those who are less than 22 years old, are students of indoor type, make present to lover, do not esteem Quality but esteem Fad, Price and Coupon, and set Brand in intermediate level for it, do not buy Bracelet but buy Pierced earrings with Budget more than 20,000 yen.”

(2) Setting evidence to “ 23～32 years old”

①Node separated by 1 class

Occupation	Employee	＋
Extroversion	Not either	＋
Receiver	Lover	＋

②Node separated by 2 class

Quality	Ordinary	＋
Price	Important	－

③Node separated by 3 class

Coupon	Not important	＋
Budget	20,000～	＋
Pierced earrings	Not buy	＋
Bracelet	Not buy	＋
Brand	Important	＋

We can observe that “Those who are 23～32 years old, are Company Employee of

“Not either” of outdoor or indoor type, make present to lover, do not esteem price nor coupon but esteem Brand, and set Quality in intermediate level for it, do not buy Pierced earrings nor Bracelet with Budget more than 20,000 yen.”

(3) Setting evidence to “ 33～42 years old”

①Node separated by 1 class

Occupation	Employee	＋
Extroversion	Not either	＋
Receiver	Sweet Heart	＋

②Node separated by 2 class

Quality	Ordinary	＋
Fad	Important	－
Price	Important	－

③Node separated by 3 class

Coupon	Important	＋
Budget	10,000～20,000	＋
Pierced earrings	Not buy	＋
Bracelet	Buy	＋
Brand	Important	＋

We can observe that “Those who are 33～42 years old, are Company Employee of “Not either” of outdoor or indoor type, make present to Sweet Heart, do not esteem Fad but esteem Price, Coupon and Brand, and set Quality in intermediate level for it, do not buy Pierced earrings, but buy Bracelet with Budget of 10,000～20,000 yen”.

(4) Setting evidence to “More than 43 years old”

① Node separated by 1 class

Occupation	Independents	＋

Extroversion	Outdoor	＋
Receiver	Sweet Heart	＋

②Node separated by 2 class

Quality	Ordinary	＋
Fad	Not important	＋
Price	Important	＋

③Node separated by 3 class

Coupon	Important	＋
Budget	～20,000	＋
Bracelet	Buy	＋
Brand	Not important	＋

We can observe that “Those who are more than 43 years old, are Independents of Outdoor type, make present to Sweet Heart, do not esteem Fad nor Brand but esteem Price and Coupon, and set Quality in intermediate level for it, buy Bracelet with Budget less than 20,000 yen”.

5.2 Sensitivity Analysis for “Extroversion”

(1) Setting Evidence to “Outdoor”

① Node separated by 1 class

Age	43～	＋
Gender	Male	＋
Shopping	Like	＋

②Node separated by 2 class

Receiver	Sweet Heart	＋
Occupation	Miscellaneous	＋

③Node separated by 3 class

Price	Important	＋

	Not important	＋
Coupon	Important	＋
Bracelet	Buy	＋
Pierced earrings	Buy	＋
Ring	Not buy	＋
Budget	～20,000	＋
Quality	Important	－

④Miscellaneous（Although Node is located in ①or ② variance is small (③class).）

Frequency of Net shopping	Sometimes	＋
Fad	Ordinary	＋

(These words have weak meanings, therefore we state them by italic in the following statement.)

We can observe that “Those who are outdoor type, are male of more than 43 years old, whose Occupation are miscellaneous (Not : student, officer, Company employee, clerk of organization, Independents), like shopping and *sometimes execute net shopping*, make present to Sweet Heart, do not esteem Quality but esteem Price and Coupon, and set *Fad in intermediate level for it*, do not buy Ring but buy Bracelet and Pierced earrings with Budget less than 20,000 yen”.

(2) Setting evidence to “Indoor”

①Node separated by 1 class

Age	～22	＋
Gender	Female	＋
Shopping	Not important	＋

②Node separated by 2 class

Receiver	Myself	＋
Occupation	Student	＋
Fad	Important	＋

③Node separated by 3 class

Price	Ordinary	＋
Coupon	Not important	＋
Bracelet	Not buy	＋
Pierced earrings	Buy	＋
Budget	20,000～	＋
Quality	Important	＋

④Miscellaneous

Frequency of Net shopping	Often	＋
	Never	＋

We can observe that “Those who are Indoor type, are girl students of less than 22 years old, dislike shopping and *often or never execute net shopping*, make present to themselves, do not esteem Coupon but esteem Fad, and set Price in intermediate level for it, do not buy Bracelet but buy Pierced earrings with Budget more than 20,000 yen”.

5.3 Sensitivity Analysis for “Frequency of Net shopping”

(1) Setting evidence to “Often”

①Node separated by 1 class

Coupon	Not important	＋
Bracelet	Buy	＋
Pierced earrings	Buy	＋
Necklace	Buy	＋
Ring	Buy	＋
Budget	20,000～	＋

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

No corresponding data

④Miscellaneous

Age	～22	＋
Gender	Female	＋
Occupation	Student	＋
Extroversion	Indoor	＋

We can observe that “Those who often execute net shopping, are indoor typed girl students less than 22 years old, do not esteem Coupon, buy Bracelet, Pierced earrings, Necklace and Ring with Budget more than 20,000 yen”.

(2) Setting evidence to “Sometimes”

① Node separated by 1 class

Coupon	Important	＋
Pierced earrings	Not buy	＋
Necklace	Buy	＋
Ring	Buy	＋
Budget	10,000～20,000	＋

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

No corresponding data

④Miscellaneous

Gender	Male	＋
Extroversion	Outdoor	＋
Bracelet	Not buy	＋

We can observe that “Those who execute net shopping sometimes, are *Male of outdoor type*, esteem coupon, do not buy Pierced earrings nor *Bracelet* but buy Necklace and Ring with Budget of 10,000～20,000 yen”.

(3) Setting evidence to “Rarely”

①Node separated by 1 class

Coupon	Ordinary	＋
Bracelet	Buy	＋
Pierced earrings	Not buy	＋
Necklace	Not buy	＋
Ring	Not buy	＋
Budget	20,000～	＋

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

No corresponding data

④Miscellaneous

Extroversion	Not either	＋

We can observe that “Those who rarely execute net shopping, are “Not either” of outdoor or indoor type, intermediate level in esteeming Coupon, do not buy Pierced earrings, Necklace nor Ring but buy Bracelet with Budget more than 20,000 yen”.

(4) Setting evidence to “Never”

①Node separated by 1 class

Coupon	Not important	＋
Bracelet	Not buy	＋
Necklace	Not buy	＋
Ring	Not buy	＋
Budget	～10,000	＋

②Node separated by 2 class

Extroversion	Indoor	＋

③Node separated by 3 class

Occupation	Student	＋

④Miscellaneous

Age	～22	＋
Gender	Female	＋
Pierced earrings	Buy	＋

We can observe that “Those who never execute net shopping, are Indoor typed girl students of less than 22 years old, do not esteem coupon, do not buy Bracelet, Necklace nor Ring but buy Pierced earrings with Budget less than 10,000 yen”.

5.4 Sensitivity Analysis for “Shopping”

(1) Setting evidence to “like”

①Node separated by 1 class

Coupon	Important	＋
Ring	Not buy	＋
Budget	～20,000	＋

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

Occupation	Student	＋

④Miscellaneous

Age	～22	＋
Gender	Male	＋
Extroversion	Outdoor	＋
Necklace	Buy	＋
Pierced earrings	Buy	＋
Bracelet	Buy	＋

We can observe that “Those who like shopping, are *outdoor typed male students of less than 22 years old*, esteem coupon, do not buy Ring but buy *Necklace, Pierced earrings and Bracelet* with Budget less than 20,000 yen”.

(2) Setting evidence to “Ordinary level”

①Node separated by 1 class

Pierced earrings	Not buy	+

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

Occupation	Employee	+

④Miscellaneous

Age	23～42	+
Gender	Female	+
Extroversion	Not either	+
Budget	～30,000	+
Ring	Buy	+
Necklace	Buy	+
Bracelet	Not buy	+
Coupon	Important	+

We can observe that “Those who put ordinary level concerning liking or disliking in shopping, are *Female Company Employee of 23～42 years old*, *“Not either” of outdoor or indoor type*, esteem coupon, do not buy Pierced earrings nor bracelet but *buy Ring and Necklace* with *Budget less than 30,000 yen*”.

(3) Setting evidence to “Dislike”

①Node separated by 1 class

Coupon	Not Important	+
Pierced earrings	Buy	+

Budget	30,000～	＋

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

Occupation	Student	＋

④Miscellaneous

Age	～22	＋
Gender	Female	＋
Extroversion	Indoor	＋
Ring	Buy	＋
Necklace	Not buy	＋
Bracelet	Buy	＋

We can observe that “Those who dislike shopping, are *Indoor typed girl students of less than 22 years old*, do not esteem coupon, *do not buy Necklace* but buy Pierced earrings, *Ring and Bracelet* with Budget more than 30,000 yen”.

5.5 Sensitivity Analysis for “Coupon”

(1) Setting evidence to “Important”

①Node separated by 1 class

Frequency of Net shopping	Sometimes	＋
Shopping	Important	＋
Price	Important	＋

②Node separated by 2 class

Budget	～20,000	＋
Pierced earrings	Not buy	＋
Ring	Not buy	＋

③Node separated by 3 class

Age	43～	＋
Gender	Female	＋
Fad	Important	＋

④Miscellaneous

Receiver	Myself	＋
Extroversion	Outdoor	＋
Necklace	Buy	＋
Bracelet	Not buy	＋

We can observe that “Those who esteem coupon, are *outdoor typed* Female of more than 43 years old, execute net shopping sometimes, like shopping, esteem Price and Fad, *make present to themselves*, do not buy Pierced earrings, Ring nor Bracelet *but buy Necklace* with Budget less than 20,000 yen”.

(2) Setting evidence to “Ordinary level”

①Node separated by 1 class

Frequency of Net shopping	Rarely	＋
	Often	＋
Shopping	Important	＋
	Not important	＋

②Node separated by 2 class

No corresponding data

③Node separated by 3 class

Gender	male	＋
Fad	Not important	＋
Receiver	Lover	＋

④Miscellaneous

Price	Not important	＋
Budget	20,000～	＋
Ring	Not buy	＋

Bracelet	Buy	＋

We can observe that “Those who put ordinary level concerning esteeming or not esteeming coupon, are male, execute Net shopping rarely or often, like or dislike shopping, make present to Lover, do not esteem Fad nor *Price, do not buy Ring but buy Bracelet with Budget more than 20,000 yen*”.

(3) Setting evidence to “Not important”

①Node separated by 1 class

Frequency of Net shopping	Often	＋
	Never	＋
Shopping	Not important	＋

②Node separated by 2 class

Budget	20,000～	＋
Pierced earrings	Buy	＋
Necklace	Not buy	＋
Ring	Buy	＋

③Node separated by 3 class

Age	～32	＋
Gender	Male	＋
Fad	Not important	＋
Receiver	Others	＋
	Lover	＋
Brand	Not important	＋

④Miscellaneous

Occupation	Student	＋
Extroversion	Indoor	＋
Price	Not important	＋
Bracelet	Buy	＋

We can observe that “Those who do not esteem Coupon, are *Indoor typed* Male *student of less than 32 years old*, execute Net shopping often or never, dislike shopping, make present to Lover or Miscellaneous (Not: Father/Mother, Children, Sweet heart, Myself), do not esteem Fad, Brand nor *Price*, do not buy Necklace but buy Pierced earrings, Ring and *Bracelet* with Budget more than 20,000 yen”.

5.6 Sensitivity Analysis for “Budget”

(1) Setting evidence to “～10,000 yen”

①Node separated by 1 class

Shopping	Important	＋
Frequency of Net shopping	Never	＋

②Node separated by 2 class

Price	Important	＋
Receiver	Myself	＋
Coupon	Important	＋
Pierced earrings	Not buy	＋
Necklace	Not buy	＋
Ring	Not buy	＋

③Node separated by 3 class

Age	43～	＋

④Miscellaneous

Extroversion	Outdoor	＋
Gender	Female	＋
Fad	Important	＋
Bracelet	Not buy	＋

We can observe that “Those who put Budget to “～10,000 yen”, are *outdoor*

typed Female of more than 43 years old, like shopping, never execute Net shopping, esteem *Fad*, Price and Coupon, make present to themselves, do not buy Pierced earrings, Necklace, Ring nor *Bracelet*".

(2) Setting evidence to "10,000～20,000 yen"

①Node separated by 1 class

Fad	Important	＋
Shopping	Important	＋
Frequency of Net shopping	Sometimes	＋

②Node separated by 2 class

Price	Important	＋
Pierced earrings	Not buy	＋

③Node separated by 3 class

Age	43～	＋

④Miscellaneous

Receiver	Myself	＋
	Sweet heart	＋
Extroversion	Outdoor	＋
Ring	Buy	＋
Necklace	Buy	＋
Bracelet	Not buy	＋
Coupon	Important	＋

We can observe that "Those who put Budget to "10,000～20,000 yen", are *outdoor typed* customers of more than 43 years old, like shopping, execute Net shopping sometimes, *make present to themselves or Sweet heart*, esteem Price and *Coupon*, do not buy Pierced earrings nor *Bracelet but buy Ring and Necklace*".

(3) Setting evidence to "20,000～30,000 yen"

①Node separated by 1 class

Shopping	Important	＋
Frequency of Net shopping	Rarely	＋
	Often	＋

②Node separated by 2 class

Coupon	Not important	＋

③Node separated by 3 class

Age	～22	＋

④Miscellaneous

Fad	Ordinary	＋
Occupation	Student	＋
Receiver	Myself	＋
	Miscellaneous	＋
Extroversion	Indoor	＋
Price	Ordinary	＋
Necklace	Not buy	＋
Pierced earrings	Buy	＋
Bracelet	Buy	＋

We can observe that “Those who put Budget to “20,000～30,000 yen”, are *indoor typed students* of less than 22 years old, dislike shopping, execute Net shopping Rarely or Often, *make present to themselves or miscellaneous (Not: Lover, Father/Mather, Children, Sweet Heart)*, do not esteem Coupon, intermediate level in esteeming *Fad* and *Price, do not buy Necklace but buy Pierced earrings and Bracelet*”.

(4) Setting evidence to “30,000～ yen”

①Node separated by 1 class

Fad	Not important	＋
Shopping	Not important	＋

Frequency of Net shopping	Often	＋

②Node separated by 2 class

Price	Not important	＋
Receiver	Lover	＋
Coupon	Important	―
Pierced earrings	Buy	＋
Necklace	Not buy	＋
Ring	Buy	＋
Bracelet	Buy	＋

③Node separated by 3 class

Age	～32	＋

④Miscellaneous

Gender	Male	＋
Occupation	Student	＋
Extroversion	Indoor	＋

We can observe that “Those who put Budget to “30,000～ yen”, are *indoor typed male students* of less than 32 years old, dislike shopping, often execute Net shopping, make present to Lover, do not esteem Fad, Price nor Coupon, do not buy Necklace but buy Pierced earrings, Ring and Bracelet”.

6. Remarks

Setting evidence to all parameters, we can obtain following findings.

(1) If the model is spread toward lower level with branch, observation data tends to be small. Therefore ripple effect becomes small as it passes through node to node.

(2) The change of differences of probability (ie. “Posterior probability - Prior

probability") decreases exponentially as a node is separated from the source node where evidence is set. To cope with this, such methods as Reinforcement Learning, transformation by logarithmic scale would be effective. As the depth of a model becomes deep, above phenomenon occurs, therefore model building of shallow depth is required.

(3) In the case selecting items are, for example, "Yes", "Ordinary level"(intermediate one), "No", we can obtain more clear result by setting evidence to "Yes" or "No" rather than to "Ordinary level" (intermediate one) in general. For example, we pick up the case "coupon" and calculate the average of the sum of the differences of probability from Table B. Then it becomes as follows.

Table 13: Case of "Coupon"

Important	0.009
Ordinary level	0.004
Not	0.021

(4) We can state the condition strongly, ordinary or weakly by the value of the differences of probability. Therefore, if we take the following statement method, we can easily catch the characteristics of the contents. "We can say **strongly A**, ordinary B, and *weakly C*." In this paper, only the writing method of "*weakly C*" is adopted.

7. Discussion-Comparison with the experiences of Shop owner and employees

Shop owner and employees discussed about their own experiences based upon daily consumer's purchasing activities.

1) As ages increase, consumers esteem value of goods rather than fad or trend. Young people may not have enough knowledge about quality.

2) Female is more sensitive about coupon than male. Male is satisfied if the price is qualified to the value of the goods. They have less tendency than women that they buy goods because it becomes cheap.
3) Although ages increase, budget does not necessarily increase. If they are married, budget is restricted. Budget of female is lower than those of male in general. Women seek high quality goods with less amount of budget, therefore hurdle is high for purchasing.
4) We wonder if consumers think brand as a tool to measure quality of the goods concerning the theme whether they esteem brand or not. If so, it is assumed that those who esteem quality esteem brand.
5) There are many cases that young girl up to 22 years old often buy pierced earrings. It may be because these are cheap compared with other genre products. Those who have low budget can easily buy pierced earrings.
6) It is easy to gather repeated purchasing customer by the periodical distribution of coupon. Therefore, those who like shopping esteem coupon.
7) These can be observed strongly or weakly or partially in the above analysis. We are intending to confirm these instructions by analyzing the new consecutive purchasing records, the data of which are already obtained.

8. Conclusion

Jewelry/accessory buying via the Internet is increasing, especially for young people. They often had difficulty deciding what kind of jewelry/accessory to choose, because there were many kinds of jewelry/accessories to choose from. Consulting service to support decision was required for these matters. In this paper, a questionnaire investigation was executed for on-line network jewelry/accessory purchasing in order to get instruction for an on-line network consulting service. These were analyzed by using Bayesian network. Some interesting and instructive

results were obtained. We have already obtained the new consecutive purchasing record. To confirm instructions and their results would be our next step investigation.

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