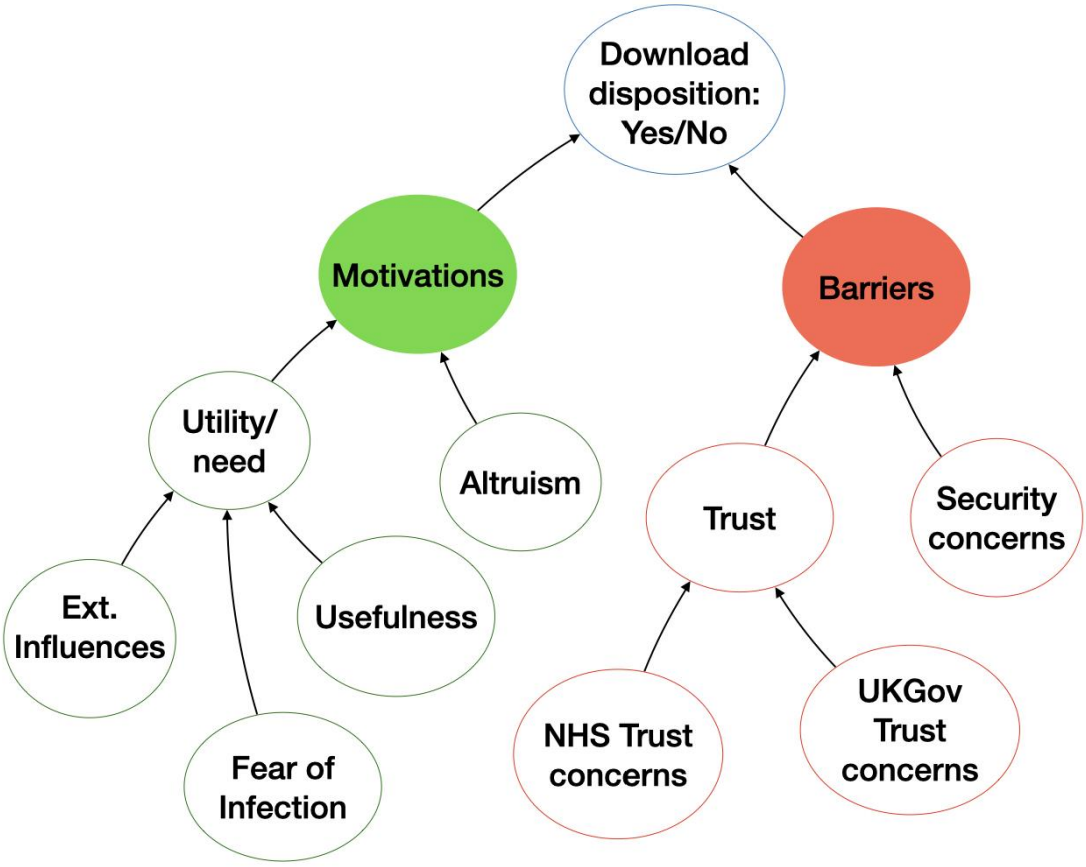
Towards Technology Acceptance: a Bayesian Network of soft requirements, the case of the NHS COVID-19 Test and Trace App
(Paper submitted to RENEXT '21)

Conditional Probability Distributions (CPDs) for the NHS COVID-19 Test and Trace app Bayesian Network (BN)



Bayesian Network specification

The Bayesian Network (BN) aims to predict the probability of downloading the COVID-19 app, given value assessments for Usefulness, Her Majestic Government (UKGov) trust, The UK's National Health Service (NHS) trust, Altruism (social responsibility) and Security, with two input specialisations to reflect the COVID-19 context: fear of the disease (Fear of Infection) and external influences (Ext. Influences) promoting a positive view of the App.

Next, the Conditional Probability Distribution (CPDs) for the BN model are presented:

1. Download disposition (Yes/No) node

   CPD: P (Download disposition | Motivations, Barriers)

T1.1

Motivations	H	H	H	M	M	M	L	L	L
Barriers	H	M	L	H	M	L	H	M	L
Download == **Yes**	0.4	0.7	1	0.2	0.3	**0.5**	0	0	0.1
Download == **No**	0.6	0.3	0	0.8	0.7	**0.5**	1	1	0.9

Key:

H = High M = Medium L=Low

Parent nodes explanation:

The values in this CPD represent the hypothesis that the Motivations branch is more important than Barriers in determining a positive decision, therefore Medium (M) Motivation in the absence of Barriers or few Barriers (L) predicts a 50-50 trade off.

2. "Motivations" node

CPD: P (Motivations | Utility/Need, Altruism)

T2.1

Utility/Need	**H**	H	H	M	M	M	L	L	L
Altruism	**H**	M	L	H	M	L	H	M	L
Motivations == **High**	**0.9**	0.8	0.7	0.8	0.6	0.5	0.3	0.1	0
Motivations == **Medium**	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.2	0.1
Motivations == **Low**	0	0	0.1	0	0.1	0.2	0.3	0.7	0.9

Parent nodes explanation:

Utility/Need models the perceived need which depends on how much we want the COVID-19 app driven by (1) Fear of infection, and (2) how effective we think it will be the COVID-19 app, which depends on our assessment of its features (Usefulness) and External Influences (e.g., Word of Mouth, Social Media, etc) which might either increase our perceived Utility/Need or not.

When we have a high perceived Utility/Need and high altruistic (Altruism) motivation, the probability of being highly motivated is very good (.9), conversely if we are not altruistic and do not feel we need the COVID-19 app, our motivation will be low.

3. "Utility/need" node

CPD: P (Utility/Need | External Influences, Usefulness, Fear of infection)

T3.1

Ext. influences	**H**	H	H	H	H	H	H	H	H
Usefulness	**H**	H	H	M	M	M	L	L	L
Fear of infection	**H**	M	L	H	M	L	H	M	L
Utility/Need == **High**	**1.0**	0.9	0.8	0.8	0.7	0.7	0.7	0.5	0.3
Utility/Need == **Medium**	0	0.1	0.2	0.1	0.2	0.2	0.2	0.3	0.3
Utility/Need == **Low**	0	0	0	0.1	0.1	0.1	0.1	0.2	0.4

T3.2

Ext. influences	M	M	M	M	M	M	M	M	M
Usefulness	H	H	H	M	M	M	L	L	L
Fear of infection	H	M	L	H	M	L	H	M	L
Utility/Need == **High**	0.9	0.9	0.8	0.7	0.6	0.6	0.6	0.4	0.2
Utility/Need == **Medium**	0.1	0.1	0.1	0.2	0.3	0.2	0.3	0.3	0.4
Utility/Need == **Low**	0	0	0.1	0.1	0.1	0.2	0.1	0.3	0.4

T3.3

Ext. influences	L	L	L	L	L	L	L	L	L
Usefulness	H	H	H	M	M	M	L	L	L
Fear of infection	H	M	L	H	M	L	H	M	L
Utility/Need == **High**	0.8	0.7	0.5	0.7	0.5	0.4	0.5	0.4	0.1
Utility/Need == **Medium**	0.1	0.2	0.3	0.2	0.3	0.4	0.3	0.4	0.2
Utility/Need == **Low**	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.7

Parent nodes explanation:

Ext. influences models positive recommendations from several sources: e.g., Social Media, Word of Mouth Friends, Word of Mouth Family, etc. Usefulness maps to a value assessment of the COVID-19 app, which in turn could be driven by general impressions or more systematic investigation of the App features. Fear of infection models a negative belief which increases the Utility/Need assessment, hence, if we are scared over Covid (H), and Ext. influences are very positive (H) and we perceive that the App will be very Useful, then the probability that the Utility/Need will be high is 100%. Fear of infection tends to dominate perceived Usefulness, and Ext. influences are stronger that the perception of Usefulness.

4. Ext. influences, Usefulness, Fear of infection and Altruism nodes (leaf nodes)

Priors: P (Ext. influences)

T4.1

Ext. Influences == **High**	0.4
Ext. Influences == **Medium**	0.3
Ext. Influences == **Low**	0.3

Priors: P (Usefulness)

T4.2

Usefulness == **High**	0.2
Usefulness == **Medium**	0.3
Usefulness == **Low**	0.5

Priors: P (Fear of infection)

T4.3

Fear of infection == **High**	0.65
Fear of infection == **Medium**	0.25
Fear of infection == **Low**	0.1

Priors: P (Altruism)

T4.4

Altruism == **High**	0.6
Altruism == **Medium**	0.2
Altruism == **Lows**	0.2

Prior values explanation:

The values reflect concrete findings collected from our preliminary study (interviews). Most people believe External Influences have Medium or High importance regarding their decisions to download the COVID-19 APP. Similarly, most people consider Altruism (social responsibility) as an important value regarding the COVID-19 disease. However, there is a generalised believe that the COVID-19 app is not useful, and people are scared to get the COVID-19 disease.

5. "Barriers" node

CPD: P (Barriers | Trust, Security concerns)

T8.1

Trust	H	H	H	M	M	M	L	L	**L**
Security concerns	H	M	L	H	M	L	H	M	**L**
Barriers == **High**	1.0	0.9	0.6	0.8	0.6	0.4	0.7	0.4	**0**
Barriers == **Medium**	0	0.1	0.3	0.2	0.3	0.4	0.2	0.4	**0.1**
Barriers == **Low**	0	0	0.1	0	0.1	0.2	0.1	0.2	**0.9**

Parent nodes explanation:

Trust has been modelled as a negative influence, i.e., when it is high (H), we distrust the COVID-19 app. Trust (L) models trust as a neutral to slight positive, hence if we have few Security concerns (L) and low Trust concerns (L) then the model has high confidence, and our Barriers will be low (p=0.9). Security concerns could be decomposed into concerns about potential data loss and privacy fears about location tracking. To keep within the spirit of simple value analysis, Security is treated as a leaf node in the model, however, survey data will collect more detailed information.

6. Trust node

CPD: P (Trust | NHS Trust concerns, UKGov Trust concerns)

T6.1

NHS Trust concerns	H	H	H	M	M	M	L	L	L
UKGov Trust concerns	H	M	L	H	M	L	H	M	L
Trust == **High**	1.0	0.9	0.6	0.9	0.6	0.4	0.6	0.4	0
Trust == **Medium**	0	0.1	0.3	0.1	0.3	0.4	0.3	0.4	0.1
Trust == **Low**	0	0	0.1	0	0.1	0.2	0.1	0.2	0.9

Two values contribute towards evaluation of Trust. In this case, we are modelling as influences trust in the brands National Health Service (NHS) and Her Majestic Government (UKGov). Both values have an approximately equal influence on Trust.

7. UKGov Trust concerns, NHS Trust concerns, and Security concerns nodes (leaf nodes)

Priors: P (NHS Trust concerns)

T7.1

NHS Trust concerns == **High**	0.2
NHS Trust concerns == **Medium**	0.3
NHS Trust concerns == **Low**	0.5

Priors: P (UKGov Trust concerns)

T7.2

UKGov Trust concerns == **High**	0.6
UKGov Trust concerns == **Medium**	0.2
UKGov Trust concerns == **Low**	0.2

Priors: P (Security concerns)

T7.3

Security == **High**	0.6
Security == **Medium**	0.2
Security == **Low**	0.2

Prior values explanation:

These nodes have been modelled as negative influences. The values reflect concrete findings from our preliminary study (interviews). There is a higher trust in the NHS brand in relation the UK's Government and there are general security concerns such as data privacy and tracking of personal information.