

RELIABILITY INVESTIGATION IN EXEMPLARY SEGMENT OF POLISH DISTRIBUTION NETWORK

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Abstract: Reliability of distribution network based on Correlation Critical Clusters is taken into account. Method allows to assess risk of power stoppage in analysed network. Therefore, it allows to estimate the reliability of analysed distribution network. Presented analysis is carried out on distribution network located in south Poland where data was collected.

Keywords: Correlation Critical Clusters, distribution network, probability of power stoppage.

1. Preface

Every distribution network has one of the main aims of its existence, namely the assurance of appropriate service level [1]. Adjusting the technical requirements to final user is already assured in the phase of network projecting, for instance other transmissions of electricity used for industrial users or hospitals have differ construction than those which are applied for urban/ country users [2]. There are three categories of power continuousness: the highest standards – the first category where each power stoppage cause threat of human life, damage of building or machineries. To the second category rank receivers for which power stoppage may cause production losses (the total power stoppage can not exceed 25 minutes) [2]. In the third category ranks all the remaining receivers. As it is shown power continuousness is one of the most important qualities demanded from electric industry, hence this characteristic is authors object of interest. Method presented is based on research results concerning network diagrams [3]. By power stoppage author means any break in energy supply.

In literature there are many methods where network is treated as elements set (smaller network is integral part of larger one) [4]. However, this allows for analysing segment of network and treat it as complete one. Thus, author will carry out the analysis on the distribution network which is a segment of larger power grid.

2. Analyzed network

Analysis will be carried out on 110 kV distribution network composed of 20 transmission stations (TS). Each TS consist with at least two power high-voltage transformers 110/30 kV, 110/15 kV as well as 110/30/15 kV. This gives 43 observed nodes. The distribution network is built on the *n-1* rule which means that every TS is powered by two alternative tracks. The network distribute medium size city with >250000 inhabitants and it is stretched out on the 45 km² surface. Data of power sent through the network was gathered in period of one month (in winter) with frequency of 48 times a day and night (every half an hour). This gives

amount of about 1400 menstruations by each *TS*. The structure of analysed network is presented in simplify way in order to keep confidentiality of analysed network.

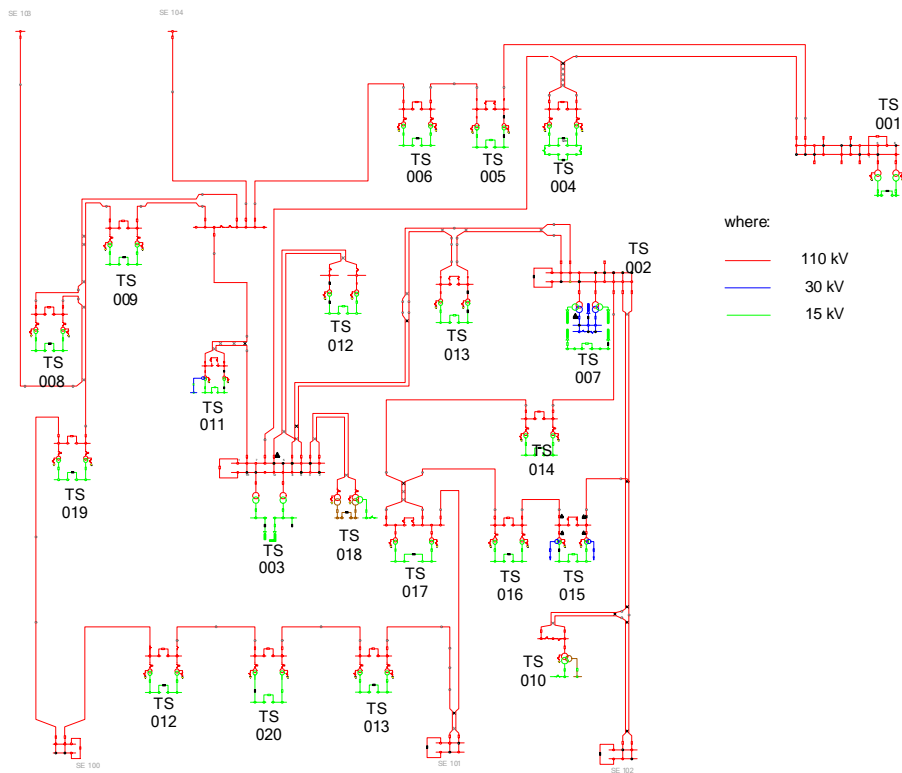


Figure 1. Distribution network diagram

3. Method of assessment

Method is based on the fact, that between distant nodes (*TS*) consist the distribution network correlation exists [3]. The idea means that for instance the node *TS20* can be correlated on nodes *TSn* with such a strength that their correlation will disturb the current flow in the network causing for instance the voltage fluctuation/ flicker effect in the high/middle voltage tension system [5] as well as blackout. What's more the correlation appears between distant nodes what gives opportunity to eliminate the reason of the power stoppage not only the effect of it. Simply by modernization of endangered nodes.

Correlation coefficient allows to observe this influence in the network. Method gathers nodes in clusters of established interval. This provides important information to the board as well as to electrical engineers.

The following intervals of correlation coefficient have been determined:

1. The Correlation Critical Cluster is a subset of arcs with the interval $(1; 0,9]$ of correlation coefficient which is not a continuous path. It creates a subset of all nodes with the highest correlation coefficient interval.
2. The Correlation Sub-Critical Cluster which is a subset of nodes with the interval $(0,9; 0,7]$ of correlation coefficient.
3. The Correlation Cluster is a subset of nodes with correlation coefficient $(0,7; 0]$ which can be analyzed whenever the need arises.

4. Result of research

All results were based on correlation matrix presented in appendix 1. To obtain taxed correlation matrix three steps are necessary [3,6]:

1. Gathering data describing given state of distribution network (in demanded period of time).
2. Correlation matrix calculation based on gathered data (calculation can be easily achieved by using standard office software).
3. Use taxonomy method [7] allowing to transform obtained results to clear form (in this point advanced software is required or ability of programming in Visual Basic for instance).

Obtained results indicate that in analysed distribution network there is lack of Correlation Critical Clusters. That means the biggest threat for continuity of network does not exist. However, there is large amount of nodes (*TS*) which correlation coefficient value classify them as Correlation Sub-Critical Cluster. This relation is presented in figure 2. In the figure each transmission station was marked as it follows for instance: *TS003/TR1* – transmission station 003 high voltage transformer 1. This nomenclature allows to determine the exact high voltage transformer in transmission station. Structure of distribution network is forced by system *n-1* where in case of failure one of the high-voltage transformer the second one leads first one role. In order to clarify presented figure author decided to classify high-voltage transformers in group of four and five, otherwise presentation of correlation between 19 transformers would be undecipherable.

Moreover, results presented in appendix 1 are in round figures. Although, not all Correlation Sub-Critical Clusters are presented, only the biggest one containing even some nodes with lower correlation coefficient interval. This decision was dictated approaching to simplify the figure and further calculations.

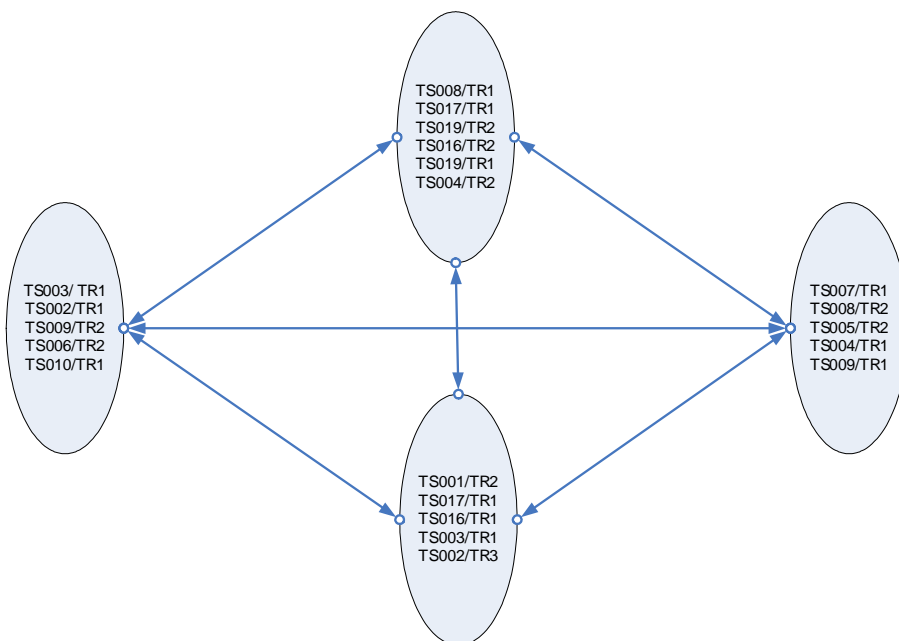


Figure 2. Correlation Sub-Critical Cluster

Presented Sub-Critical Cluster gives information allowing to track interactions causing power stoppage occurring in the distribution network. That means that correlation arise without structure relations. Therefore, failure in one node will take an effect in others nodes with sufficiently high correlation coefficient. Thus, determination of critical clusters allows to predict this situation and apply appropriate solution earlier.

Based on obtained results author estimated risk of appearance power stoppage in Correlation Sub-Critical Cluster. Estimation of power stoppage probability in this cluster was conducted based on variance [6]. Thus, variance, probability of power stoppage in analysed subset of nodes was calculated on 38%.

This result indicates that there is a high probability of power stoppage in analysed network. However, analysed subset of nodes (Sub-Critical Cluster) is characterized by correlation coefficient containing in interval $(0,9; 0,7]$. That value of probability is high and with 0,38 probability we know that for failure is responsible correlation between analysed clusters.

5. Conclusion

In distribution networks very short failure appearance of power supply is rather common situation. Although, as stronger correlation between nodes as grater probability that small failure in power supply turn into serious breakdown.

Thus, analysis of correlation clusters in distribution network allows to have indispensable knowledge where it may occur and gives a chance to prevent it by for instance modernization of critical clusters (if their exist).

Presented method gives a tool for electrical engineers as well as for a electricity board which allows to manage the process of power supply and plan repair/renovation works.

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Appendix 1

In order to be able to present research results correlation matrix was divided on four parts each part has its name, the structure of the whole matrix presents table 1. Table 2 consist correlation intervals, tables 3-6 correlation matrix is shown.

Table 1 Structure of correlation matrix

1A	2A
1B	2B

Table 2 Correlation coefficient intervals

(1;0,9]
(0,9;0,7]
(0,7;0]

Table 3 Correlation matrix part 1A

1A	TS001/TR1	TS003/TR2	TS002/TR1	TS009/TR2	TS006/TR2	TS010/TR1	TS001/TR2	TS017/TR1	TS016/TR1	TS003/TR1	TS002/TR3	TS007/TR1	TS008/TR2	TS005/TR2	TS004/TR1	TS009/TR1	TS008/TR1	TS017/TR1	TS019/TR2	TS016/TR2
TS001/TR1	1	0,87	0,87	0,83	0,84	0,83	0,79	0,84	0,74	0,83	0,80	0,74	0,75	0,68	0,76	0,78	0,72	0,68	0,77	0,72
TS003/TR2	0,87	1	0,90	0,84	0,83	0,84	0,88	0,87	0,75	0,84	0,81	0,72	0,69	0,66	0,73	0,82	0,72	0,70	0,76	0,72
TS002/TR1	0,87	0,90	1	0,88	0,86	0,84	0,85	0,85	0,73	0,82	0,87	0,76	0,73	0,69	0,76	0,82	0,72	0,73	0,81	0,72
TS009/TR2	0,83	0,84	0,88	1	0,88	0,86	0,84	0,82	0,69	0,81	0,85	0,77	0,78	0,75	0,77	0,76	0,72	0,75	0,85	0,78
TS006/TR2	0,84	0,83	0,86	0,88	1	0,87	0,83	0,79	0,69	0,81	0,87	0,83	0,82	0,77	0,81	0,82	0,75	0,79	0,83	0,77
TS010/TR1	0,83	0,84	0,84	0,86	0,87	1	0,89	0,85	0,71	0,72	0,80	0,75	0,72	0,70	0,73	0,80	0,70	0,70	0,76	0,76
TS001/TR2	0,79	0,88	0,85	0,84	0,83	0,89	1	0,88	0,77	0,75	0,78	0,70	0,66	0,65	0,72	0,79	0,65	0,64	0,71	0,72
TS017/TR1	0,84	0,87	0,85	0,82	0,79	0,85	0,88	1	0,81	0,76	0,77	0,64	0,64	0,61	0,67	0,74	0,63	0,58	0,68	0,69
TS016/TR1	0,74	0,75	0,73	0,69	0,69	0,71	0,77	0,81	1	0,67	0,65	0,56	0,56	0,54	0,63	0,66	0,53	0,48	0,56	0,43
TS003/TR1	0,83	0,84	0,82	0,81	0,81	0,72	0,75	0,76	0,67	1	0,79	0,74	0,77	0,73	0,76	0,75	0,71	0,70	0,76	0,72
TS002/TR3	0,80	0,81	0,87	0,85	0,87	0,80	0,78	0,77	0,65	0,79	1	0,85	0,83	0,82	0,74	0,79	0,73	0,81	0,78	0,76
TS007/TR1	0,74	0,72	0,76	0,77	0,83	0,75	0,70	0,64	0,56	0,74	0,85	1	0,88	0,83	0,80	0,79	0,77	0,83	0,71	0,70
TS008/TR2	0,75	0,69	0,73	0,78	0,82	0,72	0,66	0,64	0,56	0,77	0,83	0,88	1	0,84	0,77	0,72	0,73	0,82	0,72	0,74
TS005/TR2	0,68	0,66	0,69	0,75	0,77	0,70	0,65	0,61	0,54	0,73	0,82	0,83	0,84	1	0,75	0,70	0,66	0,74	0,67	0,72
TS004/TR1	0,76	0,73	0,76	0,77	0,81	0,73	0,72	0,67	0,63	0,76	0,74	0,80	0,77	0,75	1	0,77	0,68	0,70	0,71	0,64
TS009/TR1	0,78	0,82	0,82	0,76	0,82	0,80	0,79	0,74	0,66	0,75	0,79	0,79	0,72	0,70	0,77	1	0,78	0,72	0,74	0,67
TS008/TR1	0,72	0,72	0,72	0,72	0,75	0,70	0,65	0,63	0,53	0,71	0,73	0,77	0,73	0,66	0,68	0,78	1	0,74	0,70	0,61
TS017/TR1	0,68	0,70	0,73	0,75	0,79	0,70	0,64	0,58	0,48	0,70	0,81	0,83	0,82	0,74	0,70	0,72	0,74	1	0,76	0,68
TS019/TR2	0,77	0,76	0,81	0,85	0,83	0,76	0,71	0,68	0,56	0,76	0,78	0,71	0,72	0,67	0,71	0,74	0,70	0,76	1	0,71
TS016/TR2	0,72	0,72	0,72	0,78	0,77	0,76	0,72	0,69	0,43	0,72	0,76	0,70	0,74	0,72	0,64	0,67	0,61	0,68	0,71	1

Table 4 Correlation matrix part 2A

2A	TS019/TR1	TS004/TR2	TS015/TR1	TS021/TR1	TS017/TR2	TS013/TR2	TS014/TR1	TS015/TR2	TS012/TR2	TS012/TR1	TS013/TR1	TS006/TR1	TS011/TR1	TS020/TR2	TS002/TR2	TS002/TR4	TS018/TR2	TS014/TR3	TS014/TR4	TS018/TR1	TS021/TR2	TS014/TR2
TS001/TR1	0,75	0,73	0,59	0,59	0,70	0,67	0,56	0,43	0,46	0,16	0,36	0,35	0,49	0,24	0,09	0,05	0,09	0,11	0,00	0,04	0,04	0,12
TS003/TR2	0,78	0,76	0,62	0,66	0,76	0,76	0,58	0,39	0,41	0,18	0,31	0,36	0,48	0,26	0,10	0,05	0,08	0,16	0,01	0,04	0,04	0,12
TS002/TR1	0,80	0,78	0,68	0,66	0,72	0,71	0,61	0,46	0,46	0,17	0,30	0,37	0,50	0,18	0,03	-0,14	0,06	0,17	-0,03	0,03	0,03	0,08
TS009/TR2	0,79	0,76	0,69	0,61	0,61	0,62	0,62	0,51	0,54	0,12	0,35	0,39	0,52	0,18	0,07	0,04	0,07	0,15	-0,03	0,06	0,05	0,10
TS006/TR2	0,79	0,76	0,61	0,64	0,68	0,67	0,62	0,62	0,55	0,14	0,36	0,31	0,54	0,17	0,06	0,02	0,04	0,15	0,01	0,09	0,03	0,12
TS010/TR1	0,76	0,75	0,55	0,57	0,72	0,68	0,56	0,45	0,45	0,15	0,39	0,31	0,60	0,24	0,10	0,01	0,05	0,09	0,04	0,09	0,04	0,15
TS001/TR2	0,76	0,71	0,57	0,60	0,72	0,72	0,57	0,37	0,48	0,09	0,35	0,33	0,53	0,27	0,09	0,03	0,07	0,16	0,00	0,06	0,03	0,10
TS017/TR1	0,71	0,70	0,52	0,57	0,70	0,67	0,51	0,32	0,37	0,17	0,34	0,33	0,52	0,26	0,09	0,02	0,06	0,12	0,01	0,03	0,03	0,14
TS016/TR1	0,60	0,58	0,39	0,49	0,60	0,57	0,46	0,29	0,31	0,17	0,32	0,35	0,44	0,22	0,13	0,06	0,08	0,08	0,09	0,13	0,01	0,07
TS003/TR1	0,72	0,74	0,68	0,67	0,60	0,59	0,61	0,53	0,54	0,10	0,31	0,35	0,29	0,18	0,08	0,10	0,14	0,24	-0,04	0,01	0,03	0,11
TS002/TR3	0,78	0,80	0,72	0,70	0,65	0,65	0,68	0,61	0,55	0,17	0,36	0,38	0,54	0,13	0,04	-0,15	0,00	0,12	0,06	0,09	0,03	0,09
TS007/TR1	0,77	0,72	0,69	0,64	0,65	0,64	0,69	0,74	0,62	0,12	0,35	0,35	0,45	0,03	0,00	-0,04	0,04	0,09	0,12	0,02	0,07	0,07
TS008/TR2	0,74	0,69	0,71	0,61	0,56	0,51	0,71	0,74	0,64	0,08	0,36	0,35	0,44	0,07	0,04	0,03	0,05	0,14	0,06	0,11	0,02	0,05
TS005/TR2	0,64	0,70	0,67	0,56	0,48	0,45	0,70	0,73	0,60	0,16	0,35	0,35	0,44	0,17	0,03	0,01	0,02	0,14	0,02	0,08	0,01	0,05
TS004/TR1	0,69	0,54	0,59	0,60	0,60	0,56	0,68	0,60	0,53	0,16	0,29	0,28	0,40	0,12	0,03	0,04	0,08	0,17	-0,04	0,03	0,03	-0,04
TS009/TR1	0,76	0,75	0,65	0,63	0,73	0,69	0,59	0,56	0,50	0,12	0,35	0,34	0,45	0,09	0,07	0,05	0,05	0,08	0,17	-0,01	0,05	0,10
TS008/TR1	0,73	0,70	0,63	0,64	0,66	0,64	0,56	0,54	0,43	0,17	0,26	0,26	0,39	0,07	0,09	0,16	0,08	0,16	0,01	0,05	0,02	0,12
TS017/TR1	0,74	0,68	0,74	0,68	0,59	0,62	0,70	0,69	0,54	0,09	0,25	0,33	0,43	0,06	0,05	0,03	0,05	0,17	0,05	0,10	0,02	0,01
TS019/TR2	0,66	0,71	0,71	0,61	0,54	0,58	0,54	0,52	0,48	0,12	0,32	0,34	0,42	0,11	0,06	0,05	0,08	0,18	-0,06	0,05	0,03	0,13
TS016/TR2	0,69	0,69	0,62	0,56	0,50	0,48	0,57	0,51	0,52	0,09	0,40	0,31	0,46	0,22	0,07	0,04	0,06	0,13	0,02	0,10	0,03	0,12

Table 5 Correlation matrix part 1B

1B	TS001/TR1	TS003/TR2	TS002/TR1	TS009/TR2	TS006/TR2	TS010/TR1	TS001/TR2	TS017/TR1	TS016/TR1	TS003/TR1	TS002/TR3	TS007/TR1	TS008/TR2	TS005/TR2	TS004/TR1	TS009/TR1	TS008/TR1	TS017/TR1	TS019/TR2	TS016/TR2
TS019/TR1	0.75	0.78	0.80	0.79	0.79	0.76	0.76	0.71	0.60	0.72	0.78	0.77	0.74	0.64	0.69	0.76	0.73	0.74	0.66	0.69
TS004/TR2	0.73	0.76	0.78	0.76	0.76	0.75	0.71	0.70	0.58	0.74	0.80	0.72	0.69	0.70	0.54	0.75	0.70	0.68	0.71	0.69
TS015/TR1	0.59	0.62	0.68	0.69	0.61	0.55	0.57	0.52	0.39	0.68	0.72	0.69	0.71	0.67	0.59	0.65	0.63	0.74	0.71	0.62
TS021/TR1	0.59	0.66	0.66	0.61	0.64	0.57	0.60	0.57	0.49	0.67	0.70	0.64	0.61	0.56	0.60	0.63	0.64	0.68	0.61	0.56
TS017/TR2	0.70	0.76	0.72	0.61	0.68	0.72	0.70	0.60	0.60	0.65	0.65	0.56	0.48	0.60	0.73	0.66	0.59	0.54	0.50	0.50
TS013/TR2	0.67	0.76	0.71	0.62	0.67	0.68	0.72	0.67	0.57	0.59	0.65	0.64	0.51	0.45	0.56	0.69	0.64	0.62	0.58	0.48
TS014/TR1	0.56	0.58	0.61	0.62	0.62	0.56	0.57	0.51	0.46	0.61	0.68	0.69	0.71	0.70	0.68	0.59	0.56	0.70	0.54	0.57
TS015/TR2	0.43	0.39	0.46	0.51	0.62	0.45	0.37	0.32	0.29	0.53	0.61	0.74	0.74	0.73	0.60	0.56	0.54	0.69	0.52	0.51
TS012/TR2	0.46	0.41	0.46	0.54	0.55	0.45	0.48	0.37	0.31	0.54	0.55	0.62	0.64	0.60	0.53	0.50	0.43	0.54	0.48	0.52
TS012/TR1	0.16	0.18	0.17	0.12	0.14	0.15	0.09	0.17	0.17	0.10	0.17	0.12	0.08	0.16	0.16	0.12	0.17	0.09	0.12	0.09
TS013/TR1	0.36	0.31	0.30	0.35	0.36	0.39	0.35	0.34	0.32	0.31	0.36	0.35	0.36	0.35	0.29	0.35	0.26	0.25	0.32	0.40
TS006/TR1	0.35	0.36	0.37	0.39	0.31	0.31	0.33	0.33	0.35	0.35	0.38	0.35	0.35	0.35	0.28	0.34	0.26	0.33	0.34	0.31
TS011/TR1	0.49	0.48	0.50	0.52	0.54	0.60	0.53	0.52	0.44	0.29	0.54	0.45	0.44	0.44	0.40	0.45	0.39	0.43	0.42	0.46
TS020/TR2	0.24	0.26	0.18	0.18	0.17	0.24	0.27	0.26	0.22	0.18	0.13	0.03	0.07	0.17	0.12	0.09	0.07	0.06	0.11	0.22
TS002/TR2	0.09	0.10	0.03	0.07	0.06	0.10	0.09	0.09	0.13	0.08	0.04	0.00	0.04	0.03	0.03	0.07	0.09	0.05	0.06	0.07
TS002/TR4	0.05	0.05	-0.14	0.04	0.02	0.01	0.03	0.02	0.06	0.10	-0.15	-0.03	0.03	0.01	0.04	0.05	0.16	0.03	0.05	0.04
TS018/TR2	0.09	0.08	0.06	0.07	0.04	0.05	0.07	0.06	0.08	0.14	0.00	-0.04	0.05	0.02	0.08	0.08	0.08	0.05	0.08	0.06
TS014/TR3	0.11	0.16	0.17	0.15	0.15	0.09	0.16	0.12	0.08	0.24	0.12	0.04	0.14	0.14	0.17	0.17	0.16	0.17	0.18	0.13
TS014/TR4	0.00	0.01	-0.03	-0.03	0.01	0.04	0.00	0.01	0.09	-0.04	0.06	0.09	0.06	0.02	-0.04	-0.01	0.01	0.05	-0.06	0.02
TS018/TR1	0.04	0.04	0.03	0.06	0.09	0.09	0.06	0.03	0.13	0.01	0.09	0.12	0.11	0.08	0.03	0.05	0.05	0.10	0.05	0.10
TS021/TR2	0.04	0.04	0.03	0.05	0.03	0.04	0.03	0.03	0.01	0.03	0.03	0.02	0.02	0.01	0.03	0.10	0.02	0.02	0.03	0.03
TS014/TR2	0.12	0.12	0.08	0.10	0.12	0.15	0.10	0.14	0.07	0.11	0.09	0.07	0.05	0.05	-0.04	0.11	0.12	0.01	0.13	0.12

Table 6 Correlation matrix part 2B

2B	TS019/TR1	TS004/TR2	TS015/TR1	TS021/TR1	TS017/TR2	TS013/TR2	TS014/TR1	TS015/TR2	TS012/TR2	TS012/TR1	TS013/TR1	TS006/TR1	TS011/TR1	TS020/TR2	TS002/TR2	TS002/TR4	TS018/TR2	TS014/TR3	TS014/TR4	TS018/TR1	TS021/TR2	TS014/TR2
TS019/TR1	1	0.71	0.64	0.63	0.68	0.68	0.58	0.50	0.46	0.11	0.31	0.34	0.46	0.13	0.08	0.03	0.10	0.13	0.04	0.09	0.02	0.08
TS004/TR2	0.71	1	0.62	0.57	0.59	0.62	0.45	0.50	0.52	0.09	0.32	0.31	0.43	0.12	0.09	0.03	0.05	0.11	0.00	0.06	0.03	0.28
TS015/TR1	0.64	0.62	1	0.62	0.48	0.44	0.60	0.56	0.57	-0.01	0.21	0.43	0.30	0.02	0.04	0.07	0.12	0.26	-0.04	0.04	0.03	0.06
TS021/TR1	0.63	0.57	0.62	1	0.60	0.58	0.58	0.46	0.33	0.17	0.26	0.29	0.27	0.15	0.10	0.07	0.08	0.20	0.11	0.08	-0.11	0.04
TS017/TR2	0.68	0.59	0.48	0.60	1	0.77	0.48	0.36	0.28	0.13	0.22	0.24	0.39	0.12	0.07	0.04	0.07	0.16	0.05	0.02	0.03	0.09
TS013/TR2	0.68	0.62	0.44	0.58	0.77	1	0.40	0.28	0.30	0.10	0.19	0.23	0.37	0.16	0.07	-0.05	-0.07	0.04	0.07	0.05	0.04	0.14
TS014/TR1	0.58	0.45	0.60	0.58	0.48	0.40	1	0.60	0.47	0.14	0.24	0.27	0.33	0.12	0.00	0.03	0.05	0.21	0.00	0.06	0.02	-0.52
TS015/TR2	0.50	0.50	0.56	0.46	0.36	0.28	0.60	1	0.56	0.06	0.25	0.26	0.29	-0.03	-0.02	0.00	0.00	0.12	0.02	0.10	-0.08	-0.01
TS012/TR2	0.46	0.52	0.57	0.33	0.28	0.30	0.47	0.56	1	-0.62	0.20	0.25	0.27	0.04	-0.04	0.02	0.03	0.13	-0.05	0.08	0.01	0.05
TS012/TR1	0.11	0.09	-0.01	0.17	0.13	0.10	0.14	0.06	-0.62	1	0.13	0.02	0.11	0.01	0.08	-0.01	-0.02	-0.03	0.05	-0.04	-0.01	-0.03
TS013/TR1	0.31	0.32	0.21	0.26	0.22	0.19	0.24	0.25	0.20	0.13	1	0.32	0.23	0.09	0.17	0.00	0.00	-0.04	-0.07	0.22	0.12	0.03
TS006/TR1	0.34	0.31	0.43	0.29	0.24	0.23	0.27	0.26	0.25	0.02	0.32	1	0.25	0.05	0.06	0.00	0.01	0.08	0.09	0.05	0.05	0.08
TS011/TR1	0.46	0.43	0.30	0.27	0.39	0.37	0.33	0.29	0.27	0.11	0.23	0.25	1	0.21	0.01	-0.13	0.00	-0.07	0.08	0.10	0.03	0.07
TS020/TR2	0.13	0.12	0.02	0.15	0.12	0.16	0.12	-0.03	0.04	0.01	0.09	0.05	0.21	1	0.09	0.02	0.03	0.01	0.06	0.07	0.02	0.00
TS002/TR2	0.08	0.09	0.04	0.10	0.07	0.07	0.00	-0.02	-0.04	0.08	0.17	0.06	0.01	0.09	1	0.25	0.09	0.02	0.09	0.00	-0.02	0.07
TS002/TR4	0.03	0.03	0.07	0.07	0.04	-0.05	0.03	0.00	0.02	-0.01	0.00	0.00	-0.13	0.02	0.25	1	0.33	0.22	-0.08	-0.05	0.00	-0.01
TS018/TR2	0.10	0.05	0.12	0.08	0.07	-0.07	0.05	0.00	0.03	-0.02	-0.04	0.00	0.00	0.03	0.09	0.33	1	0.32	-0.13	-0.11	0.00	-0.01
TS014/TR3	0.13	0.11	0.26	0.20	0.16	0.04	0.21	0.12	0.13	-0.03	-0.07	0.01	-0.07	0.01	0.02	0.22	0.32	1	-0.38	-0.04	0.00	-0.09
TS014/TR4	0.04	0.00	-0.04	0.11	0.05	0.07	0.00	0.02	-0.05	0.05	0.22	0.08	0.08	0.06	0.09	-0.08	-0.13	-0.38	1	0.16	-0.02	0.08
TS018/TR1	0.09	0.06	0.04	0.08	0.02	0.05	0.06	0.10	0.08	-0.04	0.12	0.09	0.10	0.07	0.00	-0.05	-0.11	-0.04	0.16	1	-0.01	0.01
TS021/TR2	0.02	0.03	0.03	-0.11	0.03	0.04	0.02	-0.08	0.01	-0.01	0.03	0.05	0.03	0.02	-0.02	0.00	0.00	0.00	-0.02	-0.01	1	0.00
TS014/TR2	0.08	0.28	0.06	0.04	0.09	0.14	-0.52	-0.01	0.05	-0.03	0.08	0.08	0.07	0.00	0.07	-0.01	-0.01	-0.09	0.08	0.01	0.00	1