TOWARD PARAMETERISATION OF E-MAIL MEDIATED COMMUNICATION

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SUMMARY

E-mail mediated communication rapidly intensifies, both in quantity and quality and so does the need to understand its psycho-social context.

In this article we formulated a model of psycho-social elements of the process of receiving an e-mail. The corresponding technique starts by recognising the relevant states of a human receiver and a received e-mail. The states are parameterised, paying special attention to the description of receiver's emotional states, as the event of receiving is more localised in time than that of sending an e-mail. Possible changes are collected into a vertex, a structure expressing the probability that a received e-mail induces the receiver from initial state into a given final state. We conducted a preliminary study that included 87 e-mail messages. 97 attributes were determined for each of the considered e-mails. The analysis shows that acceptance and total receiver's change of state induced by e-mails depend on the combination of several e-mail characteristics. These are interpreted as projections of the sender's states. In this view the e-mail arises as a discrete unit with a finite spectrum of transferable qualities, mediating complex human interaction.

KEY WORDS

e-mail mediated communication, mediators, vertex

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1.   INTRODUCTION

Internet based services have proliferated during the last several years. It is stated that the e-mail mediated communication (EMC), one of the oldest among the Internet services, is for many Internet users the most important reason for using the Internet [1, 2]. Both the number of e-mail users and the number of ways they use e-mail service constantly enlarge [2, 3]. While in the beginning EMC consisted of infrequently sent short text messages, nowadays it includes almost arbitrarily large, multimedia, business and private messages, covered with sets of formal and informal rules of use, i.e. legislative and customs, respectively. The informal rules, adopted among the interested groups, favour a particular e-mail composing style and define the ways to express emotions. Along with these, the individual preferences are observable [4]. Furthermore, while in the beginning e-mail software was sideways to computer hardware, nowadays we witness its influence on computer hardware in that on key-boards and other devices, e.g. scanners, there is usually a separate button which automatically e-mails the screen content. Such an abundance of e-mail messages revealed the possibility to link the intensity of EMC with other modes of communication, interaction, and generally relations between humans [5].

Such a quantitatively and qualitatively rapid development of the EMC has motivated researches ranging from the technical aspects of information theory, through the socially oriented researches to psychologically based researches, including both the macro- and the micro-scale [6]. The objectives of the researches are to understand the possibilities of using EMC and its consequences, thereby contributing to improvement of the human-computer relations (HCR). The rapidity of the development makes harder the conducting of the analyses, as well as incorporation of their results. In such a dynamic environment it is, therefore possible to overlook a particular stage in the development of EMC and HCR in general.

Regarding the macro-scale oriented researches, the Internet became a representative of a complex system, the characteristics of which are traced down to its segments, like is EMC. Its status in the set of complex systems is somewhat special. While on the one hand it has partially organic nature in the sense that there is significant spontaneity in its development, on the other hand a firm set of rules has been applied constantly onto it, thus partially directing its development. The organic and the formal character are interconnected - users extract and emphasize some of the available options, which are subsequently further developed and formalized in newer and newer hardware and software. EMC is a part of a rather complex human environment if compared to elementary actions, yet an environment rather simple if compared to total human environment. Therefore, EMC is a segment of a complex system, the segment being relatively simple to make possible thorough analysis, yet sufficiently complex to contain significant part of complexity of structures and relations of the general human system. In that way, on the macro-scale the EMC is useful in general human system researches. To its suitability for that purpose one adds that its development is relatively well documented. Finally, the very fact that the total EMC development spans rather short time period is of importance for researches, as it means that for majority of changes in EMC both the state before and the state after its application are known.

Within the micro-scale, the overall result is that the impact of EMC on the human business and private relations, and working and private place organization is appreciated, yet still unanticipated completely. In the micro approach the important facts are analyses of e-mail use with the individuals explicitly considered. They reveal on the one hand several causes of e-mail suitability and un-suitability. Generally the two groups are considered as advantages and disadvantages, respectively. However, such a classification is based on the underlying referent set of (dis)advantages which is formulated on the types of communication used for a long time. Considering that e-mail use is rather new, hence unresolved human activity in comparison with other communicating modes, it is to

be expected that EMC will evolve in such a way that (presently considered) advantages will be maximized, and disadvantages minimized. In that way, all characteristics of e-mail use are considered here without their classification into (dis)advantages.

E-mails are purposeful structures occurring prevalently non-periodically, yet regularly in cyberspace. Each e-mail has a sending location and a receiving address as its parts. In some cases these two may not be known, the receiving address may not exist, hence the e-mail need not to be received by some human. We consider further in the text e-mails received by humans. That influence may range from a negligible to a crucial one, depending on the various factors found in the parts of e-mail related to sender, subject, place or time it is sent, message content and attachments. Different sender constructs e-mails in different ways. Generally, in the same situation different senders will construct different e-mails. Likewise, two different receivers will generally perceive the same e-mail in different ways. The human states, which are on average changed because of an e-mail receipt, are referred to here as the relevant human states (RHS). Similarly, the e-mail characteristics related to the RHS are called here the e-mail parameters (EP). With a large number of possible e-mail induced changes a question arises whether there are some constants in the elementary e-mail send/receive act. Here the constants represent the alignment of e-mail influence as assumed by a sender and as interpreted by a receiver.

The function of a particular e-mail in the cyberspace includes more details. In order to create and send an e-mail, some energy is needed, both in the form of electrical supply of previous hardware and software formation, and in the form of human efforts. In that sense, an e-mail is a specific excitation of the cyberspace, characterized with the energy and the EP. The interaction between two people through the e-mail exchange, then, is realised as a sequence of mediated cyberspace excitations.

The topic of this article is the parameterisation of the e-mail receiving process which on the one hand includes all relevant psychological moments, and on the other hand makes possible transparent macro-quantities determination. In order to align the work conducted in the broader context of EMC analysis other aspects are mentioned, e.g., informational and financial. However, the emphasis is put on the psychological elements. Nowadays, these are insufficiently analysed, and further deepening of their understanding contributes to development of EMC modalities which overcome presently considered not-rich character of the communication medium. In particular, the formulation and conduction of preliminary e-mail use based analysis, centred on (i) parameterisation of the structures involved, i.e. RHS and EP, and (ii) extraction of the relations between the EP and RHS, is presented. These relations are a particular type of HCR. The relations are collected into a structure called a vertex. The vertex represents a link between the micro- and the macro-approach. It is a function determining how probable a particular combination of the RHS and EP is. This, seemingly timeless interpretation is equivalent to stating that a vertex expresses the possibility of occurrence of a particular final human state for a given combination of initial human state and received e-mail parameters. The emphasis is put on the receiving of an e-mail, as generally that process is more localized in time than the sending of an e-mail. Because of that localization, the RHS is expectedly smaller then RHS corresponding to e-mail sending, hence easier for determination and analysis. The underlying assumptions regarding the vertex formulation are that there exist well defined referent classes of receivers and senders in EMC, and that the vertices are formulated for referent classes. The simulation of EMC is optimally performed in an agent based modelling, which makes possible optimisation of EP and semi-quantitative predictions of consequences of changes in EP. The approach represents an application of the notion of mediated human interaction [7]. The very notion of vertex, encountered here, and other units of mediated communication [7] are of meta-theoretic origin. The approach based on vertices is extensively used in theoretical physics, in the description of interactions of elementary particles in terms of exchanges of quantised environment excitations.

While in this article only EMC is considered, similar analysis is straightforwardly applicable for other types of mediated communications, i.e. short messages and multimedia messages in the mobile telephony, or different communication units in modern Internet-telephony.

The article is organized as follows. In the second section the performed preliminary experiment is described, followed in the third section with the procedures of data analysis and results thereby obtained. The results are discussed in the fourth section. The main results are summarized in the fifth section, in which the lines of future development of the subject, as presently projected, are given.

2. RELEVANT DATA

2.1. UNITS OF E-MAIL MEDIATED COMMUNICATION

Questionnaire to be filled for each e-mail is developed form of the following three questions:

1. What are relevant human states?
2. What are relevant classes of e-mail messages?
3. How are relevant human states and e-mail parameters related?

Additional illustration of the meaning of these questions is seen in Figure 1, where an interaction between a human and an e-mail is sketched. Human initial (i) and final (f) states are represented by two full lines, and set of EP with dashed line. Assumed direction of time flow is from left to the right in the picture. Relation between the changes in human states caused because of e-mail receiving is represented with a circle, referred to as vertex. Question 1, then, points to the characteristics of human, which changed in going from initial to final state, and question 2 points to the characteristics of e-mail encountered. Similarly, question 3 points to the functional form of vertex. The questionnaire was based having this connection in mind. Questions it contains are, therefore, described based on the division of the e-mail receiving process on initial human state / final human state / EP. Relations between RHS and EMC are extracted subsequently.
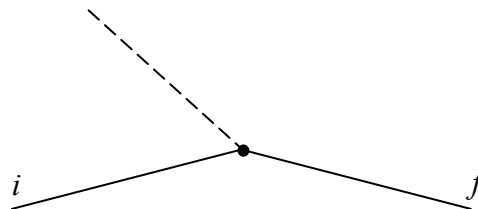

Figure 1. Graphical representation of the e-mail receiving process.

2.2. QUESTIONS ABOUT HUMAN STATES

From the three questions we proceed using the social field theory. We interpret the receiving of an e-mail as an instantaneous change in intensities of different components of social field in which an individual is. In that way, each e-mail perturbs the social field resultant configuration, thus puts e-mail receiver into non-equilibrium state. We try to characterize that, newly formed state asking about the characteristics of the state immediately before e-mail receiving and impressions induced by it. Therefore, question 1 is transformed into the question:

1.1. What are the changes in human states caused by e-mail receiving?

The assumption beyond the question 1.1 is that there is significant, i.e. statistically determinable, human state change caused by e-mail which is independent on the particular human state, as long as it belongs to set of average states. A question of the form

1.2. What are characteristics of average human states?

is therefore naturally added, but has to be answered in a different survey.

Question 1.1. is developed in two directions:

      1.1.1.   What are induced receiver impressions?
      1.1.2.   What actions were undertaken because of received e-mail?

Considered aspects of impressions include emotional aspect, social aspect (change in intimacy or attraction toward the sender) and self-satisfaction, for which the existing scales were used, as well as informational aspect (change in uncertainty about the sender, or some other topic). Furthermore, within the aspects the financial one is considered. It links the e-mail receiving with the material consequences (information about change in salary, bank account, sale about needed things, etc.), i.e. it incorporates EMC into larger human environment.

The actions undertaken belong to the behavioural aspect of the e-mail receiving process. Several questions were prepared in order to structure that aspect.

Following the social exchange theory, the interpretation of e-mail induced actions is found within the cost-benefit approach – further actions are taken if its predicted benefits overcome the required costs (see Figure 2).
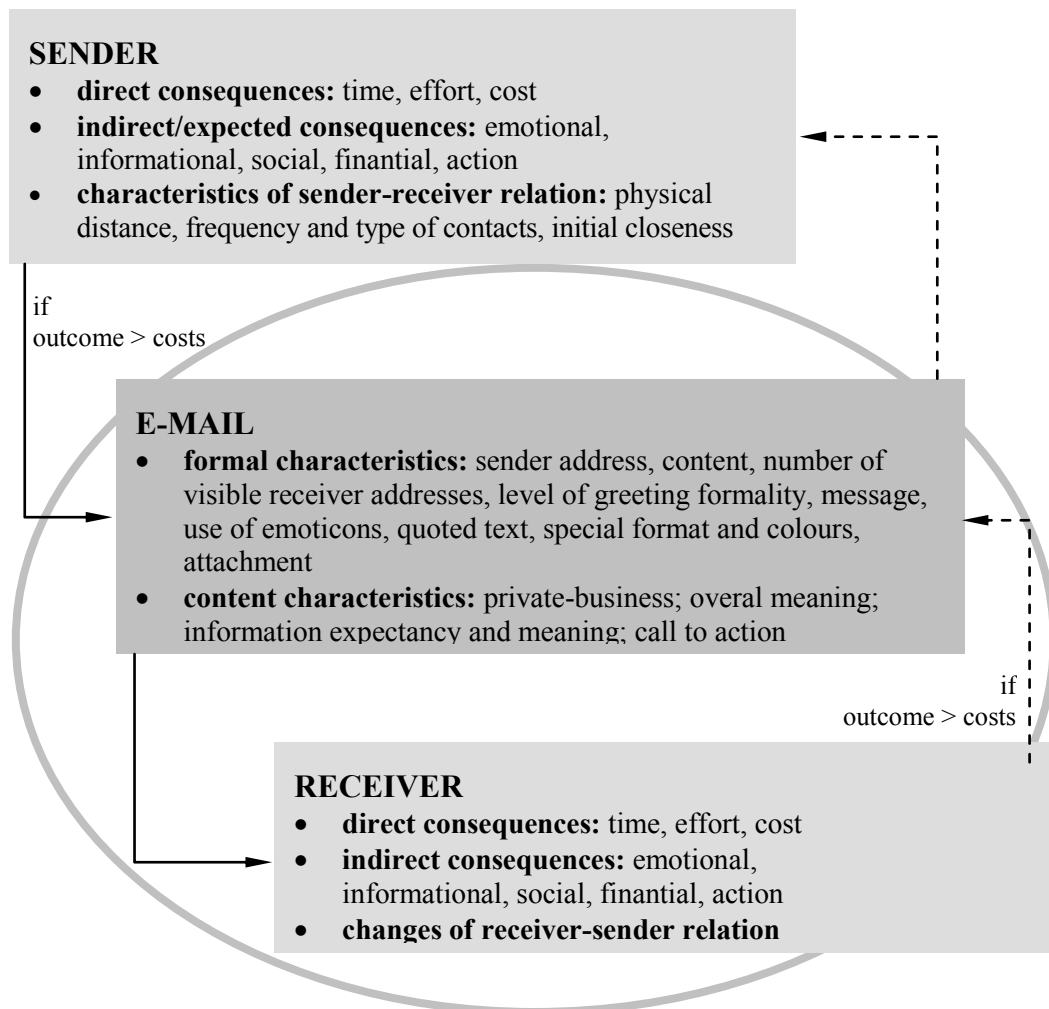

Figure 2. Model of EMC based on social exchange theory. Encircled elements are targeted in this article.

Costs are partially computer-determined, e.g. some time may be needed to formulate and send proper e-mail reply, to write, otherwise prepare and attach files in the reply message, to print supplied materials etc. Partially, costs are defined with other elements of environment, e.g. expenses connected to other actions, and partially to broader social environment, e.g. (non-)acceptance of some actions within the local community.

2.3.   QUESTIONS ABOUT E-MAIL CHARACTERISTICS

E-mail characteristics are partially software-dependent and partially individual receiver-dependent. In that way, they combine the accepted norms, as applied into a particular software, and individual value sets. Several questions are needed in order to collect data available about the e-mail structure (subject, other recipients, attachments, etc.). Considerably more questions are needed in order to collect data about the e-mail content. In this group are questions which we considered to bring about objective answers, i.e. as independent of the receiver value set as possible.

2.4.   RELATIONS BETWEEN HUMAN RECEIVER STATES AND E-MAIL CHARACTERISTICS

Within this group there are questions about the interpretation of the e-mail by a receiver. This interpretation is conducted within the individual value set. In this survey the individual value sets were relatively homogeneous and there was no need to differ between them. Naturally, characterization of the individual value set is necessary if broader survey is initiated.

The relations in question partially are extracted statistically from the questionnaires and partially are asked for in separate questions.

3.   DATA ANALYSIS

Each entry was quantified and ranked in such a way that standard analysis was applicable. Using it, the independent factors were extracted, Table 1. The extraction technique is *Principal Axis Factoring*, and the rotation technique is *Varimax* with Kaiser normalization.

In the case considered, 13 factors were revealed as EP (denoted E1, … E13), and 10 as related to relevant human receiver states (denoted R1, … R10). The factors were attributed names according to their manifest character. E.g., factor R1 collects questions about frequency of telephone, visual, and other communication modes, hence is rather objective in the sense that some informed observer could have collect needed data. Some other factors collect prevalently individual emotional states, hence are subjective. The example of that is R5 which collects questions about the capability, efficacy, usefulness, self-satisfaction as well as of material aspects related to received e-mails. Using the decomposition, 74,8% of total variance was described.

The relation between the groups of E and R factors is shown in Table 2.

Table 1. Extracted factors.

Notation	Meaning	Notation	Meaning
E1	Information rich	R1	Frequency of contacts
E2	Non-individuality	R2	Affirmative feelings
E3	Action call	R3	Calmness and openness
E4	Ordinariness	R4	Concentration
E5	Expectation	R5	Self-satisfaction
E6	Ending quotation	R6	Attraction raise
E7	Friendly	R7	Formal connection
E8	Ending remarks	R8	Other communication modes
E9	Subject length	R9	Non-irritant
E10	Reply & little information	R10	Angriness
E11	Informal greetings		
E12	Saved		
E13	Forwarded or with attachment		

Table 2. Relations between factors related to e-mail (E-factors) and receiver (R-factors).

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
E1	-0,15	0,02	0,10	0,21	0,26	0,25	0,04	0,11	0,06	0,07
E2	-0,35	0	-0,01	-0,19	0,07	-0,04	-0,15	-0,10	0,07	0,17
E3	-0,22	-0,07	-0,15	0,52	0,04	0,06	-0,01	0,3	-0,23	-0,09
E4	0,37	-0,42	0,10	0,27	0,13	-0,10	-0,02	0,05	0,01	0,26
E5	-0,17	0,04	-0,05	0,21	0,06	-0,31	0,04	0,14	0,08	0,23
E6	-0,10	0,17	**0,70**	-0,09	-0,14	0,23	-0,01	0,05	-0,05	0,03
E7	0,42	0,30	0,05	0,26	-0,20	0,09	0,09	0,09	0,20	0,20
E8	-0,05	0,01	-0,38	-0,19	-0,08	0,06	0,22	0,03	0,08	0,11
E9	-0,17	-0,1	0,04	-0,01	0,09	-0,04	0,22	0,08	0	0,03
E10	-0,13	0,17	0,03	0,12	-0,05	-0,01	-0,07	0,07	0,06	-0,04
E11	0,11	0,05	-0,14	-0,11	0,29	-0,07	-0,36	0,02	-0,23	-0,09
E12	-0,03	0	-0,05	0,12	0,26	0,12	-0,01	0,16	-0,04	-0,04
E13	-0,02	0	-0,18	-0,04	-0,12	0,10	0,12	-0,1	-0,3	-0,15

In Table 2, cells which are strongly (slightly) greyed denote quantity significant at the level of 0.01 (0.05). The bold value is the maximal number in the table.

4. DISCUSSION

4.1. SIGNIFICANT RELATIONS

In the initial study conducted, formal relations between the human receiver changes of state and e-mail characteristics are discussed.

Data in Table 2 shows that positive change in receiver state accompanies receiving of e-mails (i) with friendly overall tone (E7), (ii) with rich information content (E1), (iii) sent by a friend, and (iv) with informal ending. Characteristics (iii) and (iv) are observed from particular questions and are not connected to some of numerically extracted EP. Converse, negative change in receiver state is connected to (i) e-mail

sent to a number of receivers, (ii) unexpected messages and (iii) long subject. It is not clear from these facts whether they are sole source of receiver state change, or indicate some underlying content, e.g., whether long subjects are negatively interpreted independently of their meaning, or they occur in connection with a message which is a description of an unpleasant job to be done, of a spam, etc.

Among all combinations analysed, maximal correlation is between E6 and R3, i.e. the calmness and openness as characteristics of the receiver state are highly correlated with the presence of the earlier e-mail message at the end of received one, at the order of significance $p = 0.01$. Interpretation of that is not clear, as there are several possibilities: (i) the presence of such a text means that there is nothing particular in the previous text what needs clarification, or segmentation, i.e. whole message is one piece of information, (ii) significant portion of messages are replies, which are not necessarily aligned in the content of the message with the original message, but are used in order to gain speed and simplicity of the perpetual e-mail exchange – overall such an activity points to rather good relation between the sender and receiver, what naturally brings about calmness and openess[1]. Second highest correlation is between E3 and R4, i.e. concentration and action call, what means that receiver reads a message more carefully if he or she is to undertake some actions because of the text red. Additional inference here is that receiver considers an e-mail seriously, what could be broadened to sender-receiver relation. In other words, such e-mails are not spam.

Factors E3, E4 and E7, i.e. action call, ordinariness and friendly tone, respectively, significantly correlate with two receiver factors at the level $p = 0.01$, and E3 and E4 in particular correlate with four receiver factors significantly at the level $p = 0.05$. Five E-factors correlate significantly at the level of $p = 0.05$ only with one R-factor. That means that these change several human receiver states simultaneously. In other words, characteristics of e-mails were not chosen as to correlate with mutually independent RHS. It is expected that in more precise questionnaire, more correlated E- and R-factors will be seen simultaneously. Factors E3, E4 and E7 significantly influence R-factors. Let us remark here that these three E-factors are all non-related with a particular e-mail structural characteristic, but contain several of such characteristics. That points to the complex processing of e-mails by receivers – conclusions, action plan and other responses are conducted after more than one of aspects extracted here are red and analysed. Factor E10 does not correlate significantly with either of the R-factors. Combination E4 and R2 brings about the largest absolute value of negative correlation, meaning that e-mails of ordinary appearance do not induce affirmative feelings. It could be argued that e-mails of ordinary appearance do not induce any feeling, either affirmative or negative, but in the set of considered e-mails the number of e-mails causing negative feelings was rather insignificant. That is expected considering that e-mails analysed were taken out of the set of spontaneously constructed e-mails, representing a part of a spontaneously conducted multi-channel interaction between humans. In that way EMC analysed could be related to their overall relation [5]. Converse case would be EMC based pooling. The very ordinariness is a complex quantity, owing to relatively large number of R-factors it significantly correlates with. It is seen from Table 2 that ordinariness is connected to large frequency of contacts, what points to the saturation of the relation. The combinations of values for E and R factors in cases of combinations E6-R3 and E3-R4 are shown in Figure 3.
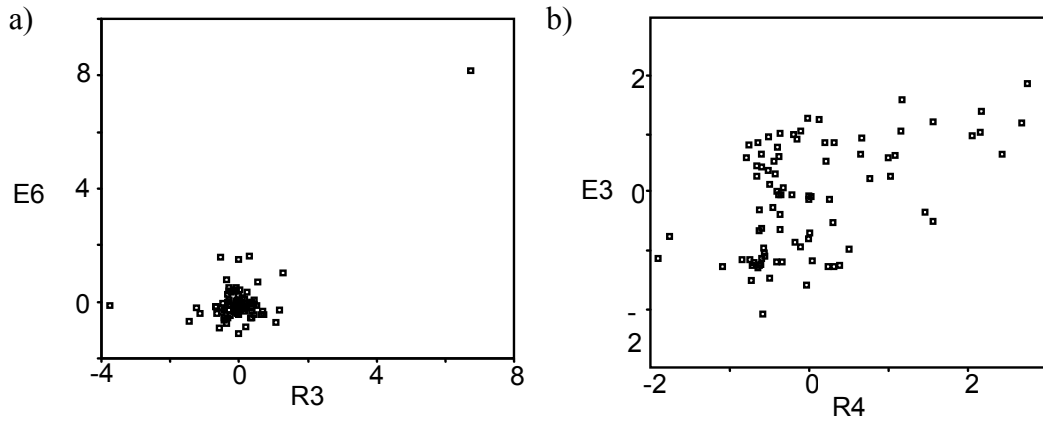
Figure 3. Determined relation between a) E6 and R3, b) E3 and R4.

On average, e-mails considered caused relatively little changes in any of the aspects considered. Because of the origin of the e-mails, we can only conclude that qualitatively, but cannot state anything about the overall proportion of the e-mails with significant influence. Partially that can be traced to the characteristics of existing communication channel, spanned by computer hardware and software which presents the channel with rather reduced types of communication transferable. The background of the e-mails considered includes information about other communication channels, and about the dynamics of the communication between a pair of a sender and a receiver. Other communication channels are introduced and used for stronger and agreed involvement of sender and a receiver, as is seen from the fact that R8 is significantly related only to E3 among the E-factors. That significance is a consequence of a need for further, synchronously conducted explanations, and of the fact that the very channels for action performance require the broadening.

The fact that factors are related to different number of questions means on the one hand impressions like non-irritability and angriness were asked about rather directly, while there were relatively large number of questions needed to present the change in receiver's calmness and openness (because of the complexity of such a characteristic), frequency of contacts (because of large number of different communication modes) and affirmative feelings. Nevertheless, this point is to be checked in future, somewhat modified questionnaire in which the two direct questions about R1 and R2 are poses.

4.2.   VERTEX

Vertex formed for this case is represented by several quantities of the form

$$V_{ij}^{(k)}(a, b, c). \tag{1}$$

Indices i, and j range from 1 to 10 and denote particular R-factor. Similarly, index k = 1, …, 13 points to one of E-factors. Quantity a is a value of RHS denoted by index i, quantity b is a value of j-th RHS while c is value of k-th E-factor. Because R- factors are chosen as statistically orthogonal factors, their mutual relation is set equal to zero, hence $V_{ijk} = 0$ when i and j are different. Furthermore, from Table 2 it is seen that here are only 30 combinations of R- and E-factors which are statistically different in the range considered. Having in mind the origin of e-mails, we consider further in the section only the relations larger than 0,30 are relevant. Because of that, the number of combinations to be considered is 12. Finally, we will not relate in the vertex combinations with R1, R7 and R8, as

strictly considered, these factors are not local in time, hence are not consequences of a particular received e-mail, but of a large number of contacts in the past. That brings about the following 7 combinations: E4-R2, E7-R2, E6-R3, E8-R3, E3-R4, E5-R6 and E13-R9. The particular form of $V_{ii}^{(k)} \equiv v_i^{(k)}$ is the following (with row index $i = 2, 3, 4, 6$ and 9 and column index $k = 3, 4, 5, 6, 7, 8$ and 13):

$$
v_i^{(k)} =
\begin{matrix}
0 & \times & 0 & 0 & \times & 0 & 0 \\
0 & 0 & 0 & \times & 0 & \times & 0 \\
\times & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \times & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \times
\end{matrix}
, \tag{2}
$$

where $\times$'s stand for elements different from zero, while other 28 elements equal 0. From the results of the analysis obtained it is not possible to state precisely the numbers, or functions for which the $\times$'s stand.

5. CONCLUSIONS AND FUTURE DEVELOPMENT DIRECTIONS

Relatively large number of questions in questionnaire implies that despite its manifest simplicity, e-mail contains a large number of characteristics. In this initial survey we tried to extract them all, using the *brute force method*, i.e. asking about each of these. The emphasis in subsequent analysis is on psychological elements of EMC. In further phases of survey, the characteristics of e-mails will be covered with a smaller number of questions, owing to the relations between some of these.

The e-mails considered point that the e-mail based communication is on average used in low-quality information transfer, at least from the point of view of an individual. When possible it is accompanied if not changed for other, richer communication channel.

However, because that was even more appropriate conclusion several years ago, when different computer systems were used, it is appropriate to such a conclusion with the time interval in which e-mails in the basis of it were sent/received. It is to be expected that such a conclusion would change with future changes in software and hardware. Regarding that, it is opportune to periodically apply the same questionnaire (not necessarily the one considered here) in order to obtain longer-term changes, i.e. changes of evolutionary character, changes in place of e-mail in human-human communication.

The interpretation of the EMC in terms of vertices and accompanied structures is useful as it partitions structures encountered and compacts their mutual relation. Such an approach could be easily used in comparison of different communication channels, once it is formulated for other communication types.

6. ACKNOWLEDGMENTS

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PREMA PARAMETRIZACIJI KOMUNIKACIJE PUTEM ELEKTRONSKE POŠTE

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SAŽETAK

Komunikacija putem elektronske pošte intenzivira se kvalitativno i kvantitativno, a uporedo s tim i potreba razumijevanja njenih psihosocijalnih elemenata.

U ovom članku postavljen je model za uključivanje psihosocijalnih elemenata procesa primanja poruka elektronske pošte. Odgovarajuća tehnika polazi od raspoznavanja značajnih stanja primaoca i primljene poruke elektronske pošte. Stanja su parametrizirana, s posebnim opisom emocionalnih stanja primaoca, zbog toga što je primanje poruka elektronske pošte lokaliziranje u vremenu od slanja. Moguće promjene objedinjene su u verteks, strukturu kojom se iskazuje vjerojatnost da iz određenog početnog stanja primaoc prelazi u određeno završno stanje Provedeno preliminarno ispitivanje uključuje 87 poruka elektronske pošte. 97 podataka određeno je za svaku poruku. Na temelju analize zaključuje se da ukupna promjena stanja primaoca inducirana primljenom porukom elektronske pošte ovisi o kombinaciji nekoliko izdvojenih svojstava poruke. Ta su svojstva interpretirana kao projekcije stanja pošiljaoca. Na ovaj način poruke elektronske pošte postaju

diskretne cjeline konačnog spektra prenosivih svojstava, putem kojih se ostvaruje dio složenog ljudskog međudjelovanja.

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