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APPENDIX A
List of Published Papers

No	Title	Name of Journal / Conference	Publication Year	Indexed In
1	An Analysis of Various Algorithms For Text Spam Classification and Clustering Using RapidMiner and Weka	*International Journal of Computer Science and Information Security (IJCSIS)*	2015	Google Scholar
2	A Perception Model of Spam Risk Assessment Inspired by Danger Theory of Artificial Immune Systems	*International Conference on Computer Science and Computational Intelligence (ICCSCI)*	2015	Scopus
3	A Review of Feature Extraction Optimization in SMS Spam Messages Classification	*International Conference on Soft Computing in Data Science (SCDS)*	2016	Scopus / ISI Proceedings
4	The Design and Development of Spam Risk Assessment Prototype: In Silico of Danger Theory Variants	*International Journal of Advanced Computer Science and Applications (IJACSA)*	2017	Thomson Reuters Emerging Sources Citation Index
5	The Significant Effect of Feature Selection Methods in Spam Risk Assessment Using Dendritic Cell Algorithm	*International Conference on Information and Communication Technology (ICoICT)*	2017	Scopus
6	Comparative Analysis of Danger Theory Variants in Measuring Risk Level for Text Spam Messages	*International Symposium on Data Mining Applications (SDMA)*	2018	Scopus / ISI Proceedings
7	An Immunological-based Simulation: A Case Study of Risk Concentration for Mobile Spam Context Assessment	*International Journal of Advanced Science, Engineering and Information Technology (IJASEIT)*	2018	Scopus

APPENDIX B

Research Operational Template (ROT)

RESEARCH GAP

Spam management consists phases of classification, clustering and determination of spam severity level (as integrated with common standard of Risk Management). Numerous works have been found for the spam classification and clustering, but only small number of research available for the final phase, risk assessment. This missing piece is needed to be filled in order to assist users to decipher the spam's risk and help them respond accordingly against spam.

WORKING TITLE

Risk Concentration for Context Assessment (RiCCA) of SMS Messages Using Danger Theory

THEORITICAL MODEL

Danger Theory by Matzinger (1994)
Dendritic Cell Algorithm (DCA) by Greensmith (2007)
Deterministic Dendritic Cell Algorithm (dDCA) by Greensmith (2010)

PROBLEM STATEMENT

Unknowing of a risk level of the received spam would lead to serious adverse impact, since human is the weakest link in security chain and due to lacking of awareness and knowledge, users tend to response inappropriately. Hence, there is a critical need to develop an intelligent decision support system in aiding users to make decision wisely in reminding the potential risk and responding against spam.

RESEARCH QUESTIONS

i. How text spam messages can be assessed for its risk value?
ii. What is the possible mechanism to apply Danger Theory in risk assessment of text spam messages?
iii. How can the proposed risk assessment model for text spam messages identified as a reliable solution?

OBJECTIVES

i. to study and evaluate the Danger Theory of AIS for application in risk identification and assessment on text spam messages;
ii. to propose and develop a model that is related to the assessment of spam risk level using an integration of the Danger Theory, text mining and risk assessment methodology; and
iii. to evaluate the accuracy of the proposed model with the aim of more than 90% accuracy rate.

INSTRUMENT

i. Immunological-based simulation cycle
ii. Prototype designed and developed that is inspired from Danger Theory of AIS

ANALYSIS

Performance Metrics: Accuracy in spam categorizing according to 3 distinguished severity levels (high, medium and low)

RESEARCH DESIGN

Mixed methods: qualitative and quantitative

SAMPLING FRAME / TECHNIQUE

Datasets SMS collected from the public shared corpus and self-collected data.

CONTRIBUTION TO THE BODY OF KNOWLEDGE

i. Danger Theory of AIS is recognized as one of the applied alternative in assessing risk.
ii. The findings of this works can be extended in determination of severity level for other form of spam message such as email spamming, instant messaging or chat media such as WhatsApp and other's Internet spamming such in social media and blog website.
iii. The automated mechanism that has been developed could enhance the research work in text mining, specifically in computational linguistics and information retrieval.

APPENDIX C
Research Milestone

APPENDIX C -
Research Milestone

WBS	Tasks	Start	End	Duration (Days)
1.0	**Draft the Research Proposal**	13-Feb-14	14-Jul-14	152
1.1	Attending Research Methodology and Data Analysis class (compulsory)	13-Feb-14		
1.2	Do Literature Review as background study			
1.3	Formulate the research gap and objectives			
1.4	Identify research methodology and approach			
1.5	Thesis writing - Chapter 1			
1.6	Design the proposed framework			
1.7	Plan for data collection, processing and analysis			
1.8	Thesis writing - Chapter 2		14-Jul-14	
2.0	**Presenting and Submission of Research Proposal**	15-Jul-14	31-Mar-15	260
2.1	Prepare research proposal	15-Jul-14		
2.2	Present (and defence) the research proposol in Qualifying Test (QT) session	21-Jan-15	21-Jan-15	
2.3	Making correction or amendment of the proposal document			
2.4	Submission of edited version of the proposal	30-Mar-15	30-Mar-15	
2.5	Accepted paper for journal publication (Paper #1)		31-Mar-15	
3.0	**Designation of the Proposed Framework**	01-Apr-15	30-Sep-16	549
3.1	Designation of algorithm and framework	01-Apr-15		
3.2	Accepted paper for proceeding (Paper #2)	24-Aug-15	26-Aug-15	
3.3	Data collection			
3.4	Initial data analysis			
3.5	Accepted paper for proceeding (Paper #3)	21-Sep-16	22-Sep-16	
3.6	Thesis writing - Chapter 3		30-Sep-16	
4.0	**Algorithm Testing as Initial Evaluation**	01-Oct-16	31-May-17	231
4.1	Evaluation of the initial algorithm design and re-design as necessary	01-Oct-16		
4.2	Execute testing to identify algorithm feasibility			
4.3	Accepted paper for journal publication (Paper #4)	30-Apr-17	30-Apr-17	
4.4	Accepted paper for proceeding (Paper #5)	17-May-17	19-May-17	
4.5	Development of prototype		31-May-17	
5.0	**Development of the Prototype and Final Testing**	01-Jun-17	30-Nov-17	183
5.1	Development of prototype (continued)	01-Jun-17		
5.2	Thesis writing - Chapter 4			
5.3	Additional data collection			
5.4	Final testing and data analysis			
5.5	Thesis writing - Chapter 5 and Chapter 6		30-Nov-17	
6.0	**Thesis Submission For Viva-voce**	01-Dec-17	31-Mar-18	121
6.1	Submission for proofreading	01-Dec-17		
6.2	Final editing of the thesis			
6.3	Softbound submission (via iPPS portal)	11-Mar-18	11-Mar-18	
6.4	Accepted paper for proceeding (Paper #6)	21-Mar-18	22-Mar-18	
6.5	Thesis submission for viva session	19-Mar-18	31-Mar-18	
7.0	**Viva-voce and Thesis Final Submission**	01-Apr-18	30-Aug-18	152
7.1	Accepted paper for journal publication (Paper #7)	02-May-18	02-May-18	
7.2	Viva-voce session	25-May-18	25-May-18	

APPENDIX D

Source Code For The RiCCA Prototype

DCA Calculation

```
import java.util.Map;

public class CalculatorDca {
        public static boolean calculate(ProcessInput procInput, ProcessResult procResult,
Map<String, Double> schemes) {

                // Level of input signals
                for (String x : procResult.words) {
                        // TODO: ?
                        // if (x.equals("ok")) {
                        // continue;
                        // }

                        if (schemes.containsKey(x)) {
                                if (procResult.listOfTerm1.containsKey(x)) {
                                        ListOfTerm lot = procResult.listOfTerm1.get(x);
                                        lot.n++;
                                } else {
                                        Double v = schemes.get(x);
                                        ListOfTerm lot = new ListOfTerm();
                                        lot.word = x;
                                        lot.value = v.doubleValue();
                                        lot.n = 1;

                                        if (lot.value <= procInput.dcaPamp1 && lot.value >=
procInput.dcaPamp2)
                                                lot.level = AppConst.LEVEL_PAMP;
                                        else if (lot.value < procInput.dcaPamp2 && lot.value
>= procInput.dcaDanger2)
                                                lot.level = AppConst.LEVEL_DANGER;
                                        else if (lot.value < procInput.dcaDanger2 && lot.value
>= procInput.dcaSafe2)
                                                lot.level = AppConst.LEVEL_SAFE;

                                        procResult.listOfTerm1.put(x, lot);
                                }
                        }
                }

                // Calculate (max, min, average) value of terms
                ListOfTerm maxPamp = null;
                ListOfTerm maxDanger = null;
                ListOfTerm maxSafe = null;

                ListOfTerm minPamp = null;
                ListOfTerm minDanger = null;
                ListOfTerm minSafe = null;

                double totalPamp = 0.0;
                double totalDanger = 0.0;
                double totalSafe = 0.0;
```

```
int nPamp = 0;
int nDanger = 0;
int nSafe = 0;

for (String key : procResult.listOfTerm1.keySet()) {
        ListOfTerm lot = procResult.listOfTerm1.get(key);
        // System.out.println(lot.word + ", " + lot.value + ", " + lot.n + ", " +
        // AppConst.getLevelName(lot.level));

        if (lot.level == AppConst.LEVEL_PAMP) {
                if (maxPamp == null || maxPamp.value < lot.value)
                        maxPamp = lot;

                if (minPamp == null || minPamp.value > lot.value)
                        minPamp = lot;

                totalPamp += (lot.value * lot.n);
                nPamp += lot.n;
        } else if (lot.level == AppConst.LEVEL_DANGER) {
                if (maxDanger == null || maxDanger.value < lot.value)
                        maxDanger = lot;

                if (minDanger == null || minDanger.value > lot.value)
                        minDanger = lot;

                totalDanger += (lot.value * lot.n);
                nDanger += lot.n;
        } else if (lot.level == AppConst.LEVEL_SAFE) {
                if (maxSafe == null || maxSafe.value < lot.value)
                        maxSafe = lot;

                if (minSafe == null || minSafe.value > lot.value)
                        minSafe = lot;

                totalSafe += (lot.value * lot.n);
                nSafe += lot.n;
        }
}

procResult.maxPamp = maxPamp == null ? 0 : maxPamp.value;
procResult.maxDanger = maxDanger == null ? 0 : maxDanger.value;
procResult.maxSafe = maxSafe == null ? 0 : maxSafe.value;
procResult.minPamp = minPamp == null ? 0 : minPamp.value;
procResult.minDanger = minDanger == null ? 0 : minDanger.value;
procResult.minSafe = minSafe == null ? 0 : minSafe.value;
procResult.avgPamp = nPamp > 0 ? (totalPamp / nPamp) : 0;
procResult.avgDanger = nDanger > 0 ? (totalDanger / nDanger) : 0;
procResult.avgSafe = nSafe > 0 ? (totalSafe / nSafe) : 0;

// System.out.println("Max-> " + procResult.maxPamp + " : " +
// procResult.maxDanger + " : " + procResult.maxSafe);
// System.out.println("Min-> " + procResult.minPamp + " : " +
// procResult.minDanger + " : " + procResult.minSafe);
// System.out.println("Avg-> " + procResult.avgPamp + " : " +
// procResult.avgDanger + " : " + procResult.avgSafe);

// Calculate output signals - Cycle 1
```

```
                procResult.outputCsm1 = (procInput.dcaCsm1 * procResult.maxPamp) +
(procInput.dcaCsm2 * procResult.maxDanger)
                        + (procInput.dcaCsm3 * procResult.maxSafe);

                // System.out.println(String.format("CSM1 = (%f * %f) + (%f * %f) + (%f * %f)
=>
                // %f", procInput.dcaCsm1,
                // procResult.maxPamp, procInput.dcaCsm2, procResult.maxDanger,
                // procInput.dcaCsm3, procResult.maxSafe,
                // procResult.outputCsm1));

                procResult.outputSmdc1 = (procInput.dcaSmdc1 * procResult.maxPamp) +
(procInput.dcaSmdc2 * procResult.maxDanger)
                        + (procInput.dcaSmdc3 * procResult.maxSafe);

                // System.out.println(String.format("smDC1 = (%f * %f) + (%f * %f) + (%f *
%f)
                // => %f", procInput.dcaSmdc1,
                // procResult.maxPamp, procInput.dcaSmdc2, procResult.maxDanger,
                // procInput.dcaSmdc3, procResult.maxSafe,
                // procResult.outputSmdc1));

                procResult.outputMdc1 = (procInput.dcaMdc1 * procResult.maxPamp) +
(procInput.dcaMdc2 * procResult.maxDanger)
                        - (procInput.dcaMdc3 * procResult.maxSafe);

                // System.out.println(String.format("mDC1 = (%f * %f) + (%f * %f) + (%f * %f)
=>
                // %f", procInput.dcaMdc1,
                // procResult.maxPamp, procInput.dcaMdc2, procResult.maxDanger,
                // procInput.dcaMdc3, procResult.maxSafe,
                // procResult.outputMdc1));

                // Calculate output signals - Cycle 2
                procResult.outputCsm2 = (procInput.dcaCsm1 * procResult.minPamp) +
(procInput.dcaCsm2 * procResult.minDanger)
                        + (procInput.dcaCsm3 * procResult.minSafe);
                procResult.outputSmdc2 = (procInput.dcaSmdc1 * procResult.minPamp) +
(procInput.dcaSmdc2 * procResult.minDanger)
                        + (procInput.dcaSmdc3 * procResult.minSafe);
                procResult.outputMdc2 = (procInput.dcaMdc1 * procResult.minPamp) +
(procInput.dcaMdc2 * procResult.minDanger)
                        - (procInput.dcaMdc3 * procResult.minSafe);

                // Calculate output signals - Cycle 3
                procResult.outputCsm3 = (procInput.dcaCsm1 * procResult.avgPamp) +
(procInput.dcaCsm2 * procResult.avgDanger)
                        + (procInput.dcaCsm3 * procResult.avgSafe);
                procResult.outputSmdc3 = (procInput.dcaSmdc1 * procResult.avgPamp) +
(procInput.dcaSmdc2 * procResult.avgDanger)
                        + (procInput.dcaSmdc3 * procResult.avgSafe);
                procResult.outputMdc3 = (procInput.dcaMdc1 * procResult.avgPamp) +
(procInput.dcaMdc2 * procResult.avgDanger)
                        - (procInput.dcaMdc3 * procResult.avgSafe);

                // System.out.println("procResult.outputCsm1: " + procResult.outputCsm1);
                // System.out.println("procResult.outputSmdc1: " + procResult.outputSmdc1);
```

```
                // System.out.println("procResult.outputMdc1: " + procResult.outputMdc1 +
"\n");

                // System.out.println("procResult.outputCsm2: " + procResult.outputCsm2);
                // System.out.println("procResult.outputSmdc2: " + procResult.outputSmdc2);
                // System.out.println("procResult.outputMdc2: " + procResult.outputMdc2 +
"\n");

                // System.out.println("procResult.outputCsm3: " + procResult.outputCsm3);
                // System.out.println("procResult.outputSmdc3: " + procResult.outputSmdc3);
                // System.out.println("procResult.outputMdc3: " + procResult.outputMdc3 +
"\n");

                // Compare value mDC and smDC
                procResult.mdc = 0;
                procResult.smDc = 0;

                if (procResult.outputMdc1 > procResult.outputSmdc1)
                        procResult.mdc++;

                if (procResult.outputMdc2 > procResult.outputSmdc2)
                        procResult.mdc++;

                if (procResult.outputMdc3 > procResult.outputSmdc3)
                        procResult.mdc++;

                if (procResult.outputMdc1 < procResult.outputSmdc1)
                        procResult.smDc++;

                if (procResult.outputMdc2 < procResult.outputSmdc2)
                        procResult.smDc++;

                if (procResult.outputMdc3 < procResult.outputSmdc3)
                        procResult.smDc++;

                // procResult.mdcGreaterThanSmdc = 0;
                // procResult.mdcGreaterThanSmdc += (procResult.outputMdc1 >
                // procResult.outputSmdc1) ? 1 : 0;
                // procResult.mdcGreaterThanSmdc += (procResult.outputMdc2 >
                // procResult.outputSmdc2) ? 1 : 0;
                // procResult.mdcGreaterThanSmdc += (procResult.outputMdc3 >
                // procResult.outputSmdc3) ? 1 : 0;

                // Identify terms with High, Medium & Low
                for (String x : procResult.words) {
                        if (schemes.containsKey(x)) {
                                if (procResult.listOfTerm2.containsKey(x)) {
                                        ListOfTerm lot = procResult.listOfTerm2.get(x);
                                        lot.n++;
                                } else {
                                        Double v = schemes.get(x);
                                        ListOfTerm lot = new ListOfTerm();
                                        lot.word = x;
                                        lot.value = v.doubleValue();
                                        lot.n = 1;

                                        if (lot.value <= procInput.dcaPamp1 && lot.value >=
procInput.dcaPamp2)
```

```
                                        lot.level = AppConst.LEVEL_HIGH;
                                    else if (lot.value < procInput.dcaPamp2 && lot.value
>= procInput.dcaDanger2)
                                        lot.level = AppConst.LEVEL_MEDIUM;
                                    else if (lot.value < procInput.dcaDanger2 && lot.value
>= procInput.dcaSafe2)
                                        lot.level = AppConst.LEVEL_LOW;

                                    procResult.listOfTerm2.put(x, lot);
                                }
                            }
                        }

                        // Calculate MCAV
                        procResult.totalHighMedium = 0;
                        procResult.totalAll = 0;

                        for (String key : procResult.listOfTerm2.keySet()) {
                            ListOfTerm lot = procResult.listOfTerm2.get(key);

                            if (lot.level == AppConst.LEVEL_HIGH || lot.level ==
AppConst.LEVEL_MEDIUM) {
                                procResult.totalHighMedium += lot.n;
                            }

                            procResult.totalAll += lot.n;
                        }

                        procResult.mcav = ((double) procResult.totalHighMedium) / ((double)
procResult.totalAll);

                        if (procResult.mdc > procResult.smDc && procResult.mcav > procInput.dcaTm)
{
                            procResult.mcavResultLevel = getResultHighMedium(procInput,
procResult.mcav);
                        } else if (procResult.mdc < procResult.smDc && procResult.mcav <
procInput.dcaTm) {
                            procResult.mcavResultLevel = getResultLow(procInput,
procResult.mcav);
                        } else if (procResult.mdc == procResult.smDc && procResult.mcav >
procInput.dcaTm) {
                            procResult.mcavResultLevel = getResultHighMedium(procInput,
procResult.mcav);
                        } else if (procResult.mdc == procResult.smDc && procResult.mcav <
procInput.dcaTm) {
                            procResult.mcavResultLevel = getResultLow(procInput,
procResult.mcav);
                        } else if (procResult.mdc > procResult.smDc && procResult.mcav ==
procInput.dcaTm) {
                            procResult.mcavResultLevel = getResultHighMedium(procInput,
procResult.mcav);
                        } else if (procResult.mdc < procResult.smDc && procResult.mcav ==
procInput.dcaTm) {
                            procResult.mcavResultLevel = getResultLow(procInput,
procResult.mcav);
                        } else if (procResult.mdc > procResult.smDc && procResult.mcav <
procInput.dcaTm) {
```

```
                    procResult.mcavResultLevel =
AppConst.LEVEL_CONDITION_MISMATCH;
                } else if (procResult.mdc < procResult.smDc && procResult.mcav >
procInput.dcaTm) {
                    procResult.mcavResultLevel =
AppConst.LEVEL_CONDITION_MISMATCH;
                }

                return true;
        }

        private static int getResultHighMedium(ProcessInput procInput, double mcav) {
                if (mcav <= procInput.dcaPamp1 && mcav >= procInput.dcaPamp2)
                        return AppConst.LEVEL_HIGH;
                else if (mcav < procInput.dcaPamp2 && mcav >= procInput.dcaDanger2)
                        return AppConst.LEVEL_MEDIUM;
                else if (mcav < procInput.dcaDanger2 && mcav >= procInput.dcaSafe2)
                        return AppConst.LEVEL_VALUE_MISMATCH;
                return 0;
        }

        private static int getResultLow(ProcessInput procInput, double mcav) {
                if (mcav <= procInput.dcaPamp1 && mcav >= procInput.dcaPamp2)
                        return AppConst.LEVEL_VALUE_MISMATCH;
                else if (mcav < procInput.dcaPamp2 && mcav >= procInput.dcaDanger2)
                        return AppConst.LEVEL_VALUE_MISMATCH;
                else if (mcav < procInput.dcaDanger2 && mcav >= procInput.dcaSafe2)
                        return AppConst.LEVEL_LOW;
                return 0;
        }
}
```

dDCA Calculation

```
import java.util.Map;

public class CalculatorDdca {

	public static boolean calculate(ProcessInput procInput, ProcessResult procResult,
Map<String, Double> schemes) {

		// Level of input signals
		for (String x : procResult.words) {
			if (schemes.containsKey(x)) {
				if (procResult.listOfTerm1.containsKey(x)) {
					ListOfTerm lot = procResult.listOfTerm1.get(x);
					lot.n++;
				} else {
					Double v = schemes.get(x);
					ListOfTerm lot = new ListOfTerm();
					lot.word = x;
					lot.value = v.doubleValue();
					lot.n = 1;

					if (lot.value <= procInput.ddcaInputA1 && lot.value
>= procInput.ddcaInputA2)
						lot.level = AppConst.LEVEL_DANGER;
					else if (lot.value < procInput.ddcaInputA2 && lot.value
>= procInput.ddcaInputB2)
						lot.level = AppConst.LEVEL_DANGER;
					else if (lot.value < procInput.ddcaInputB2 && lot.value
>= procInput.ddcaInputC2)
						lot.level = AppConst.LEVEL_SAFE;

					procResult.listOfTerm1.put(x, lot);
				}
			}
		}

		procResult.totalDanger = 0.0;
		procResult.totalSafe = 0.0;
		procResult.numOfTerms = 0;

		for (String key : procResult.listOfTerm1.keySet()) {
			ListOfTerm lot = procResult.listOfTerm1.get(key);
			// System.out.println(lot.word + ", " + lot.value + ", " + lot.n + ", " +
			// AppConst.getLevelName(lot.level));

			if (lot.level == AppConst.LEVEL_DANGER)
				procResult.totalDanger += (lot.value * lot.n);
			else if (lot.level == AppConst.LEVEL_SAFE)
				procResult.totalSafe += (lot.value * lot.n);

			procResult.numOfTerms += lot.n;
		}

		procResult.sk = procResult.totalDanger - (2 * procResult.totalSafe);
		procResult.k = procResult.sk / procResult.numOfTerms;

		if (procResult.k > 0 && procResult.k > procInput.ddcaTk) {
```

```
                        procResult.outputResultLevel = getResultHighMedium(procInput,
procResult.k);
                } else if (procResult.k < 0 && procResult.k < procInput.ddcaTk) {
                        procResult.outputResultLevel = getResultLow(procInput,
procResult.k);
                } else if (procResult.k == 0 && procResult.k > procInput.ddcaTk) {
                        procResult.outputResultLevel = getResultHighMedium(procInput,
procResult.k);
                } else if (procResult.k == 0 && procResult.k < procInput.ddcaTk) {
                        procResult.outputResultLevel = getResultLow(procInput,
procResult.k);
                } else if (procResult.k > 0 && procResult.k == procInput.ddcaTk) {
                        procResult.outputResultLevel = getResultHighMedium(procInput,
procResult.k);
                } else if (procResult.k < 0 && procResult.k == procInput.ddcaTk) {
                        procResult.outputResultLevel = getResultLow(procInput,
procResult.k);
                } else if (procResult.k > 0 && procResult.k < procInput.ddcaTk) {
                        procResult.outputResultLevel =
AppConst.LEVEL_CONDITION_MISMATCH;
                } else if (procResult.k < 0 && procResult.k > procInput.ddcaTk) {
                        procResult.outputResultLevel =
AppConst.LEVEL_CONDITION_MISMATCH;
                }
                return true;
        }

        private static int getResultHighMedium(ProcessInput procInput, double k) {
                if (k <= procInput.ddcaOutputA1 && k >= procInput.ddcaOutputA2)
                        return AppConst.LEVEL_HIGH;
                else if (k < procInput.ddcaOutputA2 && k >= procInput.ddcaOutputB2)
                        return AppConst.LEVEL_MEDIUM;
                else if (k < 0)
                        return AppConst.LEVEL_VALUE_MISMATCH;
                return 0;
        }

        private static int getResultLow(ProcessInput procInput, double k) {
                if (k <= procInput.ddcaOutputA1 && k >= procInput.ddcaOutputA2)
                        return AppConst.LEVEL_VALUE_MISMATCH;
                else if (k < procInput.ddcaOutputA2 && k >= procInput.ddcaOutputB2)
                        return AppConst.LEVEL_VALUE_MISMATCH;
                else if (k < 0)
                        return AppConst.LEVEL_LOW;
                return 0;
        }
}
```

APPENDIX E

Questionnaire: Implicit Risk Of Spam Messages

UNIVERSITI SAINS ISLAM MALAYSIA
جَامِعَة العُلوم الإسْلامِيَة المَالِيزِيَة
ISLAMIC SCIENCE UNIVERSITY OF MALAYSIA

QUESTIONNAIRE (4 pages)

"IMPLICIT RISK OF SPAM MESSAGES"

Researcher's General Information: Kamahazira Zainal is a Ph.D. student from Faculty of Science and Technology of Universiti Sains Islam Malaysia (USIM). Her research that is interest-based on information security focuses on assessing the potential risk of spam messages. An immunology theory that is known as Artificial Immune Systems (AIS) is applied in her research to verify its capability and reliability in measuring the severity concentration of spam content. The researcher can be contacted via arizah78@yahoo.com or +6012-9802629 for any further query.

Objective: This questionnaire is conducted with the purpose to verify the understanding of users and their abilities in identifying the risk and impact loss that may cause by spam messages. The result from this questionnaire will be considered as an **expert judgment resource** and will be compared to the risk-level calculated from the proposed solution, **RiCCA**. This automated version known as **Risk Concentration for Context Assessment** is developed and implemented in this research. This survey is divided into two (2) Sections; General information of respondent and their perspectives on spam's risk level.

Section A: Respondent's General Information

Please tick your answer.

1.	Age	☐ 21-30 years old	☐ 31-40 years old	☐ Over 41 years old
2.	Profession	☐ Government	☐ Private	☐ Other
3.	Are you using a **smartphone** for mobile communication?	☐ Yes	☐ No	
4.	Do you have **experience receiving spam** messages via SMS?	☐ Yes	☐ No	
5.	Have you ever **reply to the received SMS spam** messages? (please respond if answered *Yes* to question no.4)	☐ Yes, all the time	☐ Sometime	☐ Never

Based on your prior experience (if any) and common sense, please rate the following SMS spam messages for its possible risk level. The different risk levels are defined and distinguished as the following:

i. **HIGH RISK**: the spam message may cause SEVERE IMPACT if the user is responding accordingly as requested such as **clicking on a given URL link**. This action literally could activate phishing activity and scam/fraud action by the perpetrators. These may cause users to lose money and lead to identity theft.

ii. **MEDIUM RISK**: the spam message may cause SERIOUS IMPACT but lesser than high risk. This may happen if user responding to the message such as **return call or text back** to given unknown numbers. This action may impose some unnecessary/hidden cost to users or in worse case scenario; social-engineering technique may be applied for the perpetrator stealing confidential information such as bank card number and identification number.

iii. **LOW RISK**: the spam message basically only contains **information or notification** of something without requesting the user to reply or take any further action. This type of spam messages may have a NEGLIGIBLE RISK OR NONE at all. For certain circumstances, the very low risk for spam messages may validate as non-spam messages.

Section B: Respondent's Perspectives

Please tick your answer according to a reasonable risk level from your point of view (with the assistance of defined risk stated in the previous paragraph). This questionnaire has **20 samples** of SMS messages to be tagged for its possible risk level. These samples are adapted from the real-world case scenario.

No	SMS messages	Possible risk level		
1	Happy Birthday from TM Rewards! Get 96pcs 4R prints for RM9.90 (worth RM57.60)+FREE 1 box frame+2.5% Cashback www.shopback.my/tmb Valid till 31/3/17. T&;C apply	☐ High	☐ Medium	☐ Low
2	RM0 Guess the number of shuttlecocks & win! RM100K on Big Win now! Go2 www.bigwin.com.my & guess as many times you want! SincerelyCelcom.Info:1111	☐ High	☐ Medium	☐ Low
3	RM0 Have you heard CHARLIE PUTH's new hit single? Get WE DON'T TALK ANYMORE as your CallMeTones now! Dial *888*269129#.FREE 7days! SincrelyCelcom. info1111	☐ High	☐ Medium	☐ Low
4	You hv a missed call fr 067613333
5.3.2015 at 11:50 am)	☐ High	☐ Medium	☐ Low
5	Kindly note yr bill amounting to RM85.1 is now overdue. Pls remit pymt within 20 days to avoid call barring. Bill info: dial *111#.TQ	☐ High	☐ Medium	☐ Low
6	LAZADA: Your order 364244777 is being shipped. Please check your email for more info on the shipment.	☐ High	☐ Medium	☐ Low
7	RM0 BNM alert! Beware of phone calls or emails you receive. BNM/bank/PDRM will never require you to disclose your PIN or transfer your money to another	☐ High	☐ Medium	☐ Low

No	SMS messages	Possible risk level		
	account.			
8	RM0 Thank you for your payment of RM108.00. Stay connected with Celcom!	☐ High	☐ Medium	☐ Low
9	RM0 You've utilized 70% of your 4.00GB Internet. Thank you.	☐ High	☐ Medium	☐ Low
10	RM0.00 M2U: Your TAC No. is 933417. TRANSFER TO MAYBANK A/C ***0787/AMAN PALES for RM150.00 on 23 Dec 2016 17:43:31. Did not request? Call: 03-58914744	☐ High	☐ Medium	☐ Low
11	RM0 Your pay-per-use data roam charges have reached RMX. To continue using the service sends YESDATA to 28882. Thank you.	☐ High	☐ Medium	☐ Low
12	RM0.00 JQKclub.com; Live Casino, Slot Games Sportsbook & 4D; Register Now for 100% Welcome Bonus!; 0167909996	☐ High	☐ Medium	☐ Low
13	RM0.00 Maybank Cards: Spend & stand to buy Samsung Galaxy S6 at only RM188! SMS; space; New NRIC No; space; B2 to 66628 by 31/8/15. T&C: www.maybank.com.my	☐ High	☐ Medium	☐ Low
14	RM0.00 Win Cash Prize with Maybank EzyCash, EzyPay Plus or Balance Transfer from now till 21/08/16. Find out more http://mybk.co/wuis. T&C apply.	☐ High	☐ Medium	☐ Low
15	You have an important customer service announcement from PREMIER.	☐ High	☐ Medium	☐ Low
16	Hi - this is your Mailbox Messaging SMS alert. You have 4 messages. You have 21 matches. Please call back on 09056242159 to retrieve your messages and matches	☐ High	☐ Medium	☐ Low
17	Your unique user ID is 1172. For removal send STOP to 87239 customer services 08708034412	☐ High	☐ Medium	☐ Low
18	Check Out Choose Your Babe Videos @ sms.shsex.netUN fgkslpoPW fgkslpo	☐ High	☐ Medium	☐ Low
19	Congrats! 1-year special cinema pass for 2 is yours. call 09061209465 now! C Suprman V, Matrix3, StarWars3, etc all 4 FREE! bx420-ip4-5we. 150pm. Dont miss out!	☐ High	☐ Medium	☐ Low
20	URGENT! You have won a 1-week FREE membership in our RM100,000 Prize Jackpot! Txt the word: CLAIM to No: 81010 T&C www.dbuk.net LCCLTD POBOX 4403LDNW1A7RW18	☐ High	☐ Medium	☐ Low

Please state your **suggestion** if the definition of the stated risk level should be different (disagree) from the aforementioned paragraph (on page 2). Kindly please justify your suggestion.

Thank you for your co-operation.

Date: .....

-END OF QUESTIONNAIRE-

APPENDIX F

Validation Form: The Influence Of Risk Concentration For Context Assessment (RiCCA) Of SMS Messages In Daily Use

UNIVERSITI SAINS ISLAM MALAYSIA
جَامِعَة العُلُوم الإسْلَامِيَة المَالِيزِيَة
ISLAMIC SCIENCE UNIVERSITY OF MALAYSIA

VALIDATION FORM

THE INFLUENCE OF RISK CONCENTRATION FOR CONTEXT ASSESSMENT (RiCCA) OF SMS MESSAGES IN DAILY USE

Dear Datuk / Datin / Prof. / Assoc. Prof. / Dr.,

I am a Ph.D. student of Faculty of Science & Technology, Universiti Sains Islam Malaysia (USIM). My research that is interest-based on information security focuses on assessing the potential risk of SMS messages. An immunology theory that is known as Artificial Immune Systems (AIS) is applied in this research to verify its capability and reliability in measuring the severity concentration of spam content.

Due to your reputation in the field of information security, I would like to ask for your opinion in validating the proposed model in this study. I am grateful for your time and effort participating in this questionnaire.

Objective:
This questionnaire is conducted with the purpose to verify the necessity or influence of the proposed model, **R**isk **C**oncentration for **C**ontext Assessment (RiCCA) in assisting users in detecting danger that may cause by spam messages. There are many mobile apps available online for spam filtering, but so far none for anticipating the risk that may occur.

The result from this questionnaire will be considered in the literature review of the thesis.

Research Gap Analysis:
Theoharidou, Mylonas, & Gritzalis (2016) and Yeboah-Boateng & Amanor (2014) proclaimed that SMS spam has been observed as one of the mobile threats due to its malevolent impacts. Since spam is needed to be treated as threat, then it is required to be managed as proposed in most of the risk management standards in order to prevail over it. There are three (3) main processes involved in managing spam which are spam classification, spam clustering, and determination level of spam's severity which also includes the options available to the response against spam.

There are numerous study found for SMS spam filtering (Lota & Hossain, 2017; Choudhary & Jain, 2017; Abdulhamid et al., 2017; M.El-Alfy & Alhasan, 2016; Sulaiman & Jali, 2015; Mosquera et al., 2014) which differentiation of spam and ham (valid) messages. However, so far **there are no study found in assessing the risk of SMS spam messages**. A study done by

Theoharidou et al. (2012) shared a risk that may occurred for many type of threats in a smart phone which this study is more focus for threat assessment. Other than that, author in Adewole, Anuar, & Kamsin (2016) suggested a framework to assess the risk of microblogging comments into six (6) different levels; extremely normal, normal, low risk, medium risk, high risk, extremely harmful. This framework that combined multinomial NB and kNN consist of spam identification and risk assessment. However, this study did not provide proposal for SMS messages risk measurement. Expected as one of the complement safeguard to control the potential loss cause by spam messages, this RiCCA model is proposed as the following.

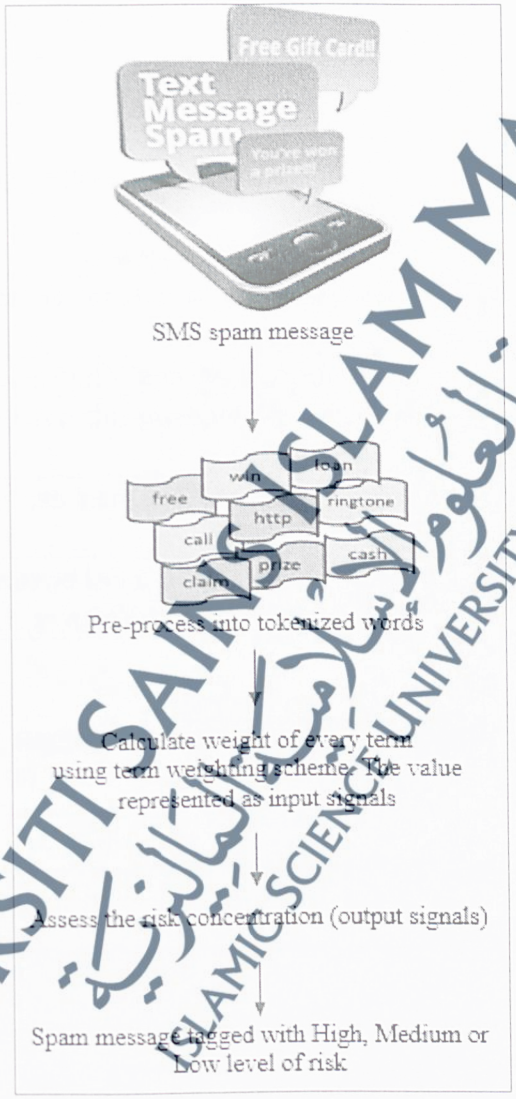

Figure 1: The flow process of functionality for the proposed model, RiCCA

The phase of determination of spam's severity level is divided into three (3) main risk category:

i. High – spam message could be expected to have a **severe or catastrophic** adverse effect;
ii. Medium – spam message could be expected to have a **serious** adverse effect; and
iii. Low – spam message could be expected to have a **limited or negligible** adverse effect.

As in a common risk assessment, the risk level of a threat is measured via the function of impact and likelihood of identified threat that exploiting vulnerabilities. Basically, risk assessment is the critical phase which the evaluation of risk will influence the decision on how to deal with it.

Validation of necessity:

Based on the aforementioned gap analysis and a model proposed (RiCCA) in this study, please circle the numbers corresponding to your degree of agreement to each item with the denoted scale.

1 Strongly disagree
2 Disagree
3 Neutral
4 Agree
5 Strongly agree

No.	Questions	Scale				
1.	The proposed model is reliable in assisting users to detect malicious messages.	1	2	3	4	5
2.	The proposed model is feasible in daily use as life routine.	1	2	3	4	5
3.	It is a good thing to have this proposed model as mobile apps for daily use.	1	2	3	4	5
4.	The proposed model can increase awareness on spam's impact among users.	1	2	3	4	5
5.	It is potentially to expand the usable of this proposed model to other platforms such as email and social media.	1	2	3	4	5

Please state any of your **suggestion** regarding to this matter. Kindly please justify your suggestion.

Thank you for your co-operation.

Date: .....

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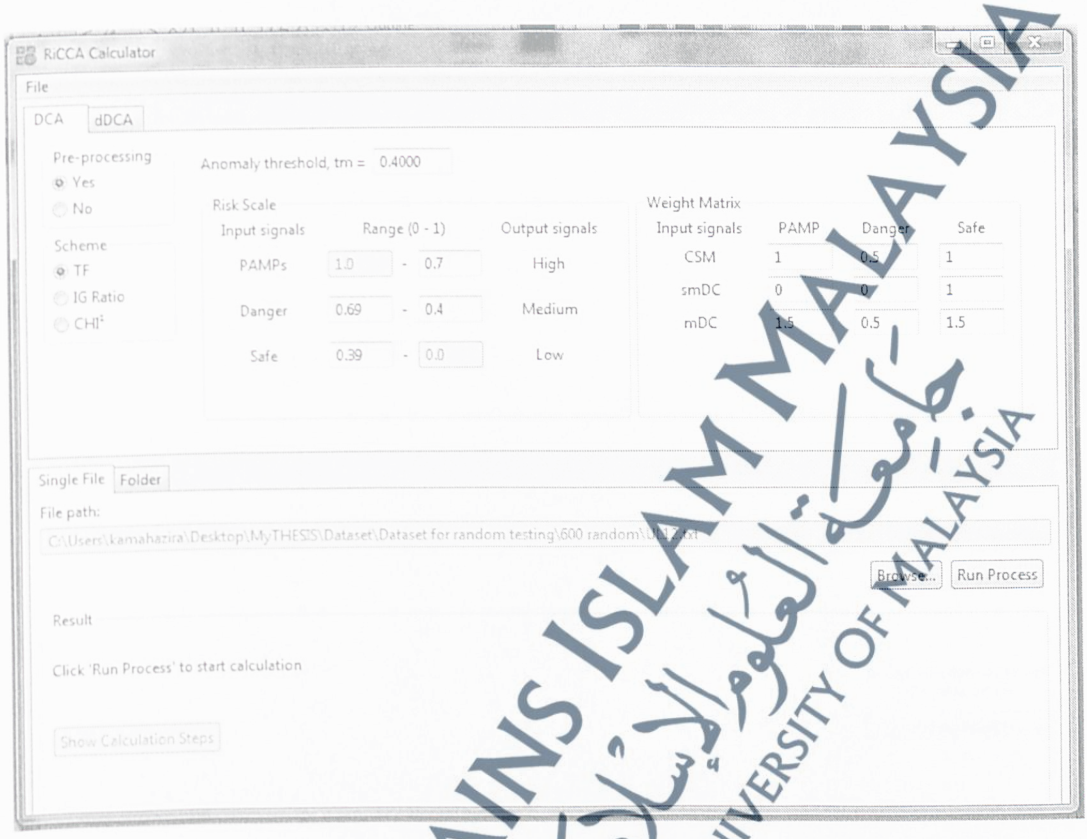
-END OF QUESTIONNAIRE-

APPENDIX G
Interface Of RiCCA Prototype

DCA Interface



dDCA Interface