RGC Ref. No.:
UGC/FDS14/P05/16
(please insert ref. above)

RESEARCH GRANTS COUNCIL
COMPETITIVE RESEARCH FUNDING SCHEMES FOR
THE LOCAL SELF-FINANCING DEGREE SECTOR

FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report
(for completed projects only)

Submission Deadlines:
1. *Auditor's report with unspent balance, if any: within **six** months of the approved project completion date.*
2. *Completion report: within **12** months of the approved project completion date.*

Part A: The Project and Investigator(s)

1. Project Title

Statistical inference of sensitive randomized dichotomous responses with applications to information management and healthcare management

2. Investigator(s) and Academic Department(s) / Unit(s) Involved

Research Team	Name / Post	Unit / Department / Institution
Principal Investigator (from 28/12/2018 to 30/06/2020)	LIU Kar Wai, Connie / Senior Lecturer	Department of Supple Chain and Information Management / The Hang Seng University of Hong Kong
Principal Investigator (from 01/01/2017 to 27/12/2018)	CHU Man Ying / Assistant Professor	Department of Mathematics, Statistics and Insurance / The Hang Seng University of Hong Kong
Co-Investigator (from 28/12/2018 to 30/06/2020)	CHU Man Ying / Assistant Professor	Department of Social Sciences / The Education University of Hong Kong
Co-Investigator	SO, Mike K. P. / Professor	Department of Information Systems, Business Statistics & Operations Management / The Hong Kong University of Science and Technology
Co-Investigator	OR, Ka Lun / Associate Professor	Department of Industrial and Manufacturing Systems Engineering / The University of Hong Kong

3. Project Duration

	Original	Revised	Date of RGC / Institution Approval *(must be quoted)*
Project Start Date	01/01/2017		
Project Completion Date	31/12/2019	30/06/2020	22/07/2019
Duration *(in month)*	36	42	22/07/2019
Deadline for Submission of Completion Report	31/12/2020	30/06/2021	22/07/2019

Part B: The Final Report

5. Project Objectives

5.1 Objectives as per original application

1. To develop a generalized method of moments for estimating dependence among sensitive and non-sensitive dichotomous responses from randomized responses techniques, with a shrinkage penalty incorporated to handle a possibly large number of parameters.
2. To investigate the statistical properties of generalized method of moments estimators for choosing the probabilities that sensitive questions will be answered and for deriving effective sample sizes for assessing the statistical efficiency of the proposed estimation methods.
3. To perform dependence analysis on multiple sensitive questions.
4. To evaluate and apply the proposed methods in two empirical studies in the information and healthcare management contexts, with real survey data collected using an online platform and physical randomization devices.
5. To consider extensions of the regression modeling of the dependence parameters.

5.2 Revised objectives

Date of approval from the RGC: /

Reasons for the change: /

1.

2.

3. ....

5.3 Realisation of the objectives
(Maximum 1 page; please state how and to what extent the project objectives have been achieved; give reasons for under-achievements and outline attempts to overcome problems, if any)

With close collaboration and great effort paid by the team members, we have completed the project with four papers published, one paper under review, and some papers under preparation. The project objectives have been fully achieved.

5.4 Summary of objectives addressed to date

Objectives *(as per 5.1/5.2 above)*	**Addressed** *(please tick)*	**Percentage Achieved** *(please estimate)*
1. To develop a generalized method of moments for estimating dependence among sensitive and non-sensitive dichotomous responses from randomized responses techniques, with a shrinkage penalty incorporated to handle a possibly large number of parameters.	√	100%
2. To investigate the statistical properties of generalized method of moments estimators for choosing the probabilities that sensitive questions will be answered and for deriving effective sample sizes for assessing the statistical efficiency of the proposed estimation methods.	√	100%
3. To perform dependence analysis on multiple sensitive questions.	√	100%
4. To evaluate and apply the proposed methods in two empirical studies in the information and healthcare management contexts, with real survey data collected using an online platform and physical randomization devices.	√	100%
5. To consider extensions of the regression modeling of the dependence parameters.	√	100%

6. Research Outcome

6.1 Major findings and research outcome
(Maximum 1 page; please make reference to Part C where necessary)

Due to the high-dimensionality issue and incomplete information of the data collected, most existing studies using randomized response are based on one sensitive question. Our project is to extend and advance RRT in analyzing multiple sensitive randomized dichotomous responses that will be highly useful to understand behavior. Our research not only advances the knowledge by providing a viable solution to a statistical challenge, but also allows researchers to apply statistical techniques to study a behavior in a deeper sense and its relationship with other variables. We have applied our research findings in authentic scenarios in information and health management, such as information systems resource misuse (Chu and So, 2020; Chung et al., 2018), illegal waste disposal (Chong et al., 2019), and students' health and pressure (Chu et al., 2020). The applications are important for researchers in different domains to follow how to implement RRT in real settings.

In addition, we have one paper that is under review in a prestige journal and are now preparing several papers for publication.

6.2 Potential for further development of the research and the proposed course of action *(Maximum half a page)*

There is a great potential for further development of the research as the methodology can be used to ask sensitive questions which cover lots of research areas.

7. Layman's Summary

(Describe in layman's language the nature, significance and value of the research project, in no more than 200 words)

In the project, we developed statistical inference methods for estimating the dependence of sensitive dichotomous responses obtained from randomized response techniques without using the joint distribution of the responses, and also investigated the dependence analysis of multiple sensitive questions. In addition, we explored applications of the proposed inference method in information management and healthcare management.

In terms of theoretical contributions, the project provides viable solutions to statistical challenges, where the respondents' true sensitive responses are unobservable because of a randomization scheme that protects their data privacy. More sophisticated statistical analysis of multiple sensitive questions collected by randomized response in a survey research can now be carried out.

In terms of methodological contributions, the project demonstrates how to apply the method in online environment instead of traditional survey methods, such as face-to-face interviews to facilitate the randomization procedure and implementation of the survey.

In terms of managerial and policy implications, the proposed methodology in the project have been applied to investigate real problems. For example, we applied our research methods to study nurses' behavior in the drug administration, information systems resource misuse, and students' health and pressure.

Part C: Research Output

8. Peer-Reviewed Journal Publication(s) Arising Directly From This Research Project

(Please attach a copy of the publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)

The Latest Status of Publications				Author(s) *(denote the corresponding author with an asterisk*)*	Title and Journal / Book *(with the volume, pages and other necessary publishing details specified)*	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this Report *(Yes or No)*	Acknowledged the Support of RGC *(Yes or No)*	Accessible from the Institutional Repository *(Yes or No)*
Year of Publication	**Year of Acceptance** *(For paper accepted but not yet published)*	**Under Review**	**Under Preparation** *(optional)*						
2018				Chung, R. S. W., Chu, A. M. Y., & So, M. K. P.*	Bayesian Randomized Response Technique with Multiple Sensitive Attributes: The Case of Information Systems Resource Misuse, The Annals of Applied Statistics, 12(3), 1969-1992. https://doi.org/10.1214/18-AOAS1139	2018	Yes (Annex I)	Yes	Yes
2019				Chong, A. C. Y., Chu, A. M. Y.*, So, M. K. P., Chung, R. S. W.	Asking sensitive questions using the randomized response approach in public health research: An empirical study on the factors of illegal waste disposal. International Journal of Environmental Research and Public Health, 16(6), 970. http://dx.doi.org/10.3390/ijerph16060970	No	Yes (Annex II)	Yes	**Yes**
2020				Chu, A. M. Y., So, M. K. P.*, Chan, T.	Estimating the dependence of mixed sensitive response types	No	Yes (Annex III)	Yes	**Yes**

				W. C., Tiwari, A.	in randomized response technique. Statistical Methods in Medical Research, 29(3), 894–910. https://doi.org/10.1177/0962280219847492				
2020				Chu, A. M. Y.*, So, M. K. P.	Organizational information security management for sustainable information systems: An unethical employee information security behavior perspective. Sustainability, 12(8), 3163. https://doi.org/10.3390/su12083163	No	Yes (Annex IV)	Yes	**Yes**
		2020		Chu, A. M. Y., Omori, Y., So, H-y, So, M. K. P.*	A multivariate randomized response model for binary data: An application for understanding drug administration policies	No	Yes (Annex V) (abstract only)	Yes (It will be available after the article has been accepted for publication)	No

9. Recognized International Conference(s) In Which Paper(s) Related To This Research Project Was / Were Delivered

(Please attach a copy of each conference abstract)

Month / Year / Place	**Title**	**Conference Name**	**Submitted to RGC** *(indicate the year ending of the relevant progress report)*	**Attached to this Report** *(Yes or No)*	**Acknowledged the Support of RGC** *(Yes or No)*	**Accessible from the Institutional Repository** *(Yes or No)*
06/2017 Hong Kong	Bayesian Randomized Response Technique with Multiple Sensitive Attributes & Its Application to Behavioral Modeling	1st International Conference on Econometrics and Statistics	2018	Yes (Annex VI)	Yes (in the talk)	Yes

08/2017 Taiwan	Bayesian Randomized Response Technique with Multiple Sensitive Attributes & Its Application to Behavioral Modeling	International Workshop on New Developments in Business Analytics or Big Data	2018	Yes (Annex VI)	Yes (in the talk)	Yes

10. Whether Research Experience And New Knowledge Has Been Transferred / Has Contributed To Teaching And Learning

(Please elaborate)

Yes. For example, we delivered an invited talk relating to applying the proposed research methodology to investigate nurses' perceptions and behavior in the drug administration in the "Quality Workshop 2019" organized by the New Territories East Cluster, Hong Kong Hospital Authority on 10th September 2019.

11. Student(s) Trained

(Please attach a copy of the title page of the thesis)

Name	Degree Registered for	Date of Registration	Date of Thesis Submission / Graduation
/			

12. Other Impact

(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, teaching enhancement, etc.)

/

13. Statistics on Research Outputs

	Peer-reviewed Journal Publications	Conference Papers	Scholarly Books, Monographs and Chapters	Patents Awarded	Other Research Outputs (please specify)	
No. of outputs arising directly from this research project	4	1			Type	No.

14. Public Access Of Completion Report

(Please specify the information, if any, that cannot be provided for public access and give the reasons.)

Information that Cannot Be Provided for Public Access	Reasons
N/A	