RGC Ref. No.:
UGC/FDS14/B16/16
(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

Consumer carbon label: development of supply chain product carbon footprint and consumer carbon index for beverage merchandise

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

Research Team	Name / Post	Unit / Department / Institution
Principal Investigator	Dr. WONG Yin Cheung, Eugene / Assistant Professor	Department of Supply Chain and Information Management, School of Decision Sciences, The Hang Seng University of Hong Kong
Co-Investigator(s)	Dr. HO Chi Kuen, Danny / Assistant Professor	Department of Supply Chain and Information Management, School of Decision Sciences, The Hang Seng University of Hong Kong
	Dr. CHAN Fong Yee, Fanny / Assistant Professor	Department of Marketing, School of Business, The Hang Seng University of Hong Kong
	Prof. CHAN Tung Sun, Felix / Professor	Department of Industrial and Systems Engineering, The Hang Seng University of Hong Kong
	Ms. HO Wai Ping, Linda / Chief Executive Officer	The Green Council
Others	Dr. WEI Yan / Senior Research Assistant	Department of Supply Chain and Information Management, School of Decision Sciences, The Hang Seng University of Hong Kong

3. Project Duration

	Original	**Revised**	**Date of RGC / Institution Approval** *(must be quoted)*
Project Start Date	1 November 2016	N/A	
Project Completion Date	31 October 2018	30 April 2019	2 October 2018
Duration *(in month)*	24 months	30 months	2 October 2018
Deadline for Submission of Completion Report	31 October 2019	30 April 2020	2 October 2018

Part B: The Final Report

5. Project Objectives

5.1 Objectives as per original application

1. *To develop a novel methodology for assessing the life-cycle carbon footprints of beverage products along the supply chain.*
2. *To establish a research measurement methodology and conduct a comprehensive survey in assessing consumers' awareness and acceptance of and attitudes towards carbon labels, and their intention to purchase beverage products with and without carbon labels.*
3. *To increase the awareness of students and industry practitioners of the importance of carbon emissions along the supply chain and the usefulness of carbon-label data, and to provide them with a methodology for estimating supply-chain product carbon footprints.*
4. *To promote the use of carbon labels and Consumer Carbon Index among the public and enhance consumers' understanding of the role of carbon labels in reducing carbon emissions.*
5. *To establish best-practice measures for minimising the carbon footprints of Hong Kong products along the supply chain.*
6. *To enhance existing educational and reference materials on products' supply chain carbon footprints through seminars, workshops and the development and implementation of a supply chain carbon footprint quantification methodology.*

5.2 Revised objectives

Date of approval from the RGC: N/A

Reasons for the change: N/A

1. N/A

2. N/A

3. N/A

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)

1. *Objective 1: To develop a novel methodology for assessing the life-cycle carbon footprints of beverage products along the supply chain.*
   (1) Through literature review, company operations review, research workshops and discussion, a novel beverage merchandise carbon footprint model is developed with calculation and reporting tool available. It has been implemented in two pilot companies. Details have been published in the International Society for Ecological Modelling Global Conference 2017.
   (2) A journal paper, "Product carbon footprint of beverage merchandise in a supply chain process-based approach" has been compiled and submitted in Journal of Cleaner Production.

2. *Objective 2: To establish a research measurement methodology and conduct a comprehensive survey in assessing consumers' awareness and acceptance of and attitudes towards carbon labels, and their intention to purchase beverage products with and without carbon labels.*
   (1) Consumer Carbon Label Survey: A survey with 1,000 respondents on 79 questions have been conducted with results analysed and published in a policy report (Annex I). A press media conference held in the Hong Kong Green Day on 5 June 2018.
   (2) A journal paper, "Consumer perceptions on product carbon footprints and carbon labels of beverage merchandise in Hong Kong" has been published in the Journal of Cleaner Production.
   (3) A Consumer carbon Index (CCI) has been published with sub-index on consumer readiness, social influence and purchase behavior intention. It has been published in the policy report.

3. *Objective 3: To increase the awareness of students and industry practitioners of the importance of carbon emissions along the supply chain and the usefulness of carbon-label data, and to provide them with a methodology for estimating supply-chain product carbon footprints.*
   (1) Two Final Year Project teams have participated in the development of product carbon footprint tool. They increased the awareness of beverage product carbon footprint and acquired knowledge and skills in carbon reporting, verification and simulation tools development.
   (2) Two pilot companies, Swire Beverage and Vitasoy, participated in the project, with operation reviews, site visits, meetings, and data collection carried out. A prototype tool has been developed for product carbon footprint reporting.
   (3) A seminar on carbon calculation, labelling and consumer responsibility has been held on 7 April 2018. Ir. Stephen Y. T. Yu shared his substantial experience to industrial practitioners, students and project team members. They gained the knowledge of the principle, calculation and international standards on beverage product carbon footprint.
   (4) A book titled "Supply Chain Decabonisation – Organisation and Product Carbon Footprint" (Annex II) has been published. It includes product carbon footprint concepts, principles, and guideline, pilot companies and case studies.
   (5) Website News: Project news are posted in the website of the Supply Chain Decarbonisation.

4. *Objective 4: To promote the use of carbon labels and Consumer Carbon Index among the public and enhance consumers' understanding of the role of carbon labels in reducing carbon emissions.*

(1) Results on the consumer perception on carbon label, consumer carbon index and product carbon footprint project implementation have been compiled in a policy report, titled "Research on Consumer Perceptions of Product Carbon Label in Hong Kong". It is shared in a press media conference held in the Hong Kong Green Day on 5 June 2018.
(2) Four newspaper articles (Annex III), Sing Pao Daily News, Oriental Daily, Yahoo News, and Hong Kong Economic Times have reported the press release.

5. *Objective 5:* To establish best practice for minimising the carbon footprints of Hong Kong products along the supply chain.
(1) The two pilot companies participated in the project with best-practice cases on beverage product carbon footprint in Hong Kong have been shared in the published book.
(2) Two case studies have been compiled for the case study section of book published, including Tropicana and Tesco. They are best-practice reference for students, scholars, industry and the public in minimizing product carbon footprint.
(3) Carbon emission mitigation in the sea transport routing segment of supply chain is evaluated with the results published in a paper.

6. *Objective 6: To enhance existing educational and reference materials on products' supply chain carbon footprints through seminars, workshops and the development and implementation of a supply chain carbon footprint quantification methodology.*
(1) A seminar on carbon calculation, labelling and consumer responsibility has been held on 7 April 2018. Industrial practitioners, academics and students have gained knowledge of the principle, calculation and international standards on beverage product carbon footprint.
(2) Two workshops on the principle, practice and international standards on product carbon footprint have been held 21 January 2017 and 13 February 2017. Practitioners, academics and students have gained important concepts and skills from the speakers.
(3) A book has been published with product carbon footprint concepts, principles, and guideline, pilot companies and case studies. It has been distributed to university libraries, students, professional associations, and industry practitioners.

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 novel methodology for assessing the life-cycle carbon footprints of beverage products along the supply chain.*	✓	100%
2. *To establish a research measurement methodology and conduct a comprehensive survey in assessing consumers' awareness and acceptance of and attitudes towards carbon labels, and their intention to purchase beverage products with and without carbon labels.*	✓	100%
3. *To increase the awareness of students and industry practitioners of the importance of carbon emissions along the supply chain and the usefulness of carbon-label data, and to provide them with a methodology for estimating supply-chain product carbon footprints.*	✓	100%
4. *To promote the use of carbon labels and Consumer Carbon Index among the public and enhance consumers' understanding of the role of carbon*	✓	100%

labels in reducing carbon emissions.		
5. *To establish best-practice measures for minimising the carbon footprints of Hong Kong products along the supply chain.*	✓	100%
6. *To enhance existing educational and reference materials on products' supply chain carbon footprints through seminars, workshops and the development and implementation of a supply chain carbon footprint quantification methodology.*	✓	100%

6. Research Outcome

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

Major findings and research outcome include:

- *Product carbon footprint (PCF) methodology and tool* – With literature review, pilot company operations review, data collection, and statistical analysis conducted, a PCF methodology and a novel beverage merchandise carbon footprint model are developed. A PCF calculation and reporting system is developed using Visual Basic Application (VBA) and excel-based programming. A conference paper has been presented and published in the International Society for Ecological Modelling Global Conference 2017.
- *Journal publication on consumer perceptions on PCF and carbon labels* – Upon conducting a survey with 1,000 respondents on 79 questions, the results are analysed and published as a paper "Consumer perceptions on Product carbon footprint and carbon labels of beverage merchandise in HK" in the Journal of Cleaner Production (Impact Factor: 6.395).
- *Journal publication on carbon footprint sustainable data analytics* – The development of environmental performance and data analytics tools and how the awareness of societal stakeholders acting as key-drivers in motivating corporations to improve their operations related to environment and social responsibility are compiled in a journal paper "Sustainable Data Analytics for Environmental Performance Monitoring in Dynamic Supply Chain Infrastructure" and published in Management Studies.
- *Pilot companies' implementation* – The developed PCF tool is applied to two pilot companies, Swire Beverage and Vitasoy.
- *Journal paper on PCF on beverage products* – The PCF methodology, system, and modelling results are compiled into a journal paper titled "Product carbon footprint of beverage merchandise in a supply chain process-based approach" submitted to Journal of Cleaner Production. Carbon emission mitigation in the sea transport routing segment of supply chain is evaluated and published in a paper.
- *Consumer Carbon Index* – Consumer carbon Index (CCI) is developed with sub-indexes on consumer readiness, social influence and purchase behavior intention. It has been published in the policy report and released in a press media conference.
- *Policy Report and Press Media Conference* – The results in the survey studies and project implementation have been compiled in a policy report, titled "Research on Consumer Perceptions of Product Carbon Label in Hong Kong", and shared in a press media conference held in the Hong Kong Green Day on 5 June 2018.
- *Newspaper articles* – Four newspaper, Sing Pao Daily News, Oriental Daily, Yahoo News, and Hong Kong Economic Times, have reported the policy report and press conference.
- *Book publication* – A book titled "Supply Chain Decarbonisation – Organisation and Product Carbon Footprint" has been published. Concepts, exercises, case studies, case implementation, and reference database on PCF are included in the book.

- *Final Year Project* – Two final year project student teams participated in the development of product carbon footprint tool. They increased the awareness of beverage PCF and acquired knowledge and skills in carbon reporting, verification and simulation tools development.
- *Seminar and Workshops* – One seminar and two workshops are successfully organised. Students, academics and practitioners gained the knowledge of the principle, calculation and international standards on beverage product carbon footprint
- *Newsletter and website* – Seminars, workshops and media conference has been published in the college news and website news. Details of the projects are also shared in the website.

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

Potential for further development of research include:
- Evaluating and comparing on consumer perception on carbon label and their related purchasing behavior in Hong Kong against other countries, e.g. Taiwan, Korea, and Japan.
- Evaluating and comparing the product carbon footprint of the same product while produced and consumed in various countries.
- Analysing the carbon footprint in industry segments and city districts
- Investigating the carbon emission and renewable energy in the transportation vehicles

1. **Layman's Summary**
(Describe <u>in layman's language</u> the nature, significance and value of the research project, in no more than 200 words)

In achieving carbon emission mitigation targets and combating against increasing occurrence of extreme weather, beverage product carbon footprint investigation becomes vital. A novel methodology for beverage product carbon footprint is developed to map and analyse the carbon emitted during the production and life cycle of beverage mechandise. The carbon emissions at eight major stages of product life cycle are evaluated. Consumer perception on carbon label are analysed using the diffusion of innovation theory and hierarchy of effects model. The project increases students' awareness in analysing carbon emissions throughout the consumable product's life cycle. The developed product carbon footprint methodology and tool assist industry practitioners in deriving carbon emissions and mitigating the carbon emitted at each stage. The results of a comprehensive consumer survey revealed the extent of Hong Kong consumers' awareness of carbon labels and their attitudes towards using carbon-label data, offering an important index for long-term longitudinal comparison of consumers' carbon consciousness. The project's deliverables supplemented existing teaching materials on corporate social responsibility, logistics and marketing. Overall, the product carbon footprint methodology, the carbon label and the results of analysing consumers' carbon-related behaviour have contributed the research on the beverage industry and increase consumers' awareness on carbon-labelled beverage products.

Part C: Research Output

2. **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)*						
2017	-	-	-	Eugene Wong, Tony Wines, and Serena Li	Sustainable Data Analytics for Environmental Performance Monitoring in Dynamic Supply Chain Infrastructure, Management Studies (Nov-Dec. 2017, Vol. 5, No. 6, 483-492.)	2017	Yes (Annex IV)	Yes	Yes
2020	-	-	-	Wong, E.Y.C., Chan, F., So, S.	Consumer perceptions on product carbon footprints and carbon labels of beverage merchandise in Hong Kong, Journal of Cleaner Production, 242	2018	Yes (Annex V)	Yes	Yes
-	-	2020	-	Wong, E.Y.C., Ho, D., So, S., Poo, M.	Modelling the product carbon footprint of beverage merchandise using a supply chain process-based approach	2018	Yes (Annex VI)	Yes	Yes

3. **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)*

Sept / 2017 / Korea	Modelling the impact of fixed and dynamic routing of beverage product carbon footprint	The International Society for Ecological Modelling Global Conference 2017	2017	Yes (Annex VII)	Yes	Yes
June / 2018 / Pennsylvania	Consumers' Perception of Carbon Footprint on Beverage Products	27th Annual World Business Congress of the International Management Development Association	2018	Yes (Annex VIII)	Yes	Yes
June / 2018 / Pennsylvania	Diffusion of Innovation: The adoption process of carbon footprint labelling	27th Annual World Business Congress of the International Management Development Association	2018	Yes (Annex IX)	Yes	Yes
October / 2018 / Hong Kong	Development of a carbon footprint model for attaining a low carbon economy from a transportation perspective	International Conference on Smart Mobility and Logistics in Future Cities	2018	Yes (Annex X)	Yes	Yes

4. **Whether Research Experience And New Knowledge Has Been Transferred / Has Contributed To Teaching And Learning**
(Please elaborate)

The product carbon footprint results and content has been added in the modules of (1) Shipping and Transport Logistics, (2) Sustainable Transportation, and (3) Final Year Project.

A book with concepts, exercises, and cases have been shared to the students in the lectures.

5. **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
	BBA-SCM	2013	May 2017
	BBA-SCM	2013	May 2017
	BBA-SCM	2013	May 2017
	BBA-SCM	2013	May 2017
	BBA-SCM	2013	May 2017
	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018

	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018
	BBA-SCM	2016	May 2018

*BBA-SCM – BBA in Supply Chain Management

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

- Collaboration with other research institutions: The development of product carbon footprint toolkit has been collaborated with Swire Beverage, Vitasoy, and Green Council and the seminars and workshops are collaborated with Green Council.
- A research policy report "Research on Consumer Perceptions of Product Carbon Label in Hong Kong" has been published.
- Letter of appreciation and e-mail thanks have been received from the two pilot companies.

7. **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	2 & 1 (under review)	4	1	N/A	Type	No.
					Policy report	1

8. **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	N/A