RGC Ref. No.:
UGC/FDS14/B08/14
(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

Integrated modeling approach for increasing Hong Kong Port competitiveness

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

Research Team	Name / Post	Unit / Department / Institution
Principal Investigator	Dr. Karolina Glowacka / Assistant Professor	Department of Supply Chain and Information Management, Hang Seng Management College
Co-Investigator(s)	Dr. Wong, Yin Cheung, Eugene / Assistant Professor	Department of Supply Chain and Information Management, Hang Seng Management College
Others	Lam, Yuen Ying, Avis / Research Assistant	Department of Supply Chain and Information Management, Hang Seng Management College

3. Project Duration

	Original	Revised	Date of RGC / Institution Approval *(must be quoted)*
Project Start Date	1st January 2015		

Project Completion Date	31st December 2016	30 June 2017	28/10/2016
Duration *(in month)*	24	30	28/10/2016
Deadline for Submission of Completion Report	31st December 2017	30 June 2018	28/10/2016

Part B: The Final Report

5. Project Objectives

5.1 Objectives as per original application

1. Optimize resource allocation and usage at Hong Kong container ports, in presence of demurrage and despatch credits tied to work completion time
2. Build a detailed simulation model of Hong Kong container port operations
3. Evaluate the impact of including time incentives in shipping contracts for port operators, shipping lines, and the overall supply chain
4. Measure the impact of various factors on the benefits realized through the use of incentive contracts
5. Analyze whether inclusion of time incentives would allow Hong Kong port operators to lower terminal handling fees without decreasing their profits
6. Disseminate our findings through peer reviewed scholarly publications and conference presentations
7. Incorporate the results of the project into our teaching, either through developing short case studies or using the findings to illustrate and explain relevant concepts.

5.2 Revised objectives

Date of approval from the RGC: N/A

Reasons for the change: N/A

5.3 Realisation of the objectives

Objectives 1-5 have been completed. A detailed simulation model (in Python 3) was built, and, using data obtained from Modern Terminals Limited (MTL), several experiments have been conducted. Unfortunately, the results showed that the inclusion of time incentives does not provide any significant benefit in terms of faster work completion. These results were surprising, especially since an earlier, simpler model (Ref to WSC), showed a potential improvement through the use of contractual time incentives. The researchers ran multiple experiments with various settings (such as the availability of resources and different arrival rates); however, under no experimental conditions were the proposed methods better than the existing procedures at the port. This discrepancy between earlier results and the detailed model are likely due to the oversimplifications made in the earlier version. For example, the location of cargo was not taken into consideration in the initial model and it appears that it is likely a driving factor in how much we can speed up the loading/discharging and reduce time in port.

Because of these issues, the results were deemed unpublishable. Another difficulty encountered during the project execution was the quality of data. To our knowledge, there is no standard method of recording time of arrival in port. We have considered three different sources: Vesseltracker.com, Hong Kong Marine Department, and data from the port operator; however, the discrepancies between these sources are extreme (up to 12 hours in some cases).

We have written a paper describing some statistical properties of the vessel load (in particular, with respect to cargo location). The paper was rejected three times, and with the PI's departure from Hong Kong and academia in general, no further steps were taken towards its publication.

5.4 Summary of objectives addressed to date

Objectives *(as per 5.1/5.2 above)*	Addressed *(please tick)*	Percentage achieved *(please estimate)*
1. Optimize resource allocation and usage at Hong Kong container ports, in presence of demurrage and despatch credits tied to work completion time	√	100%
2. Build a detailed simulation model of Hong Kong container port operations	√	100%
3. Evaluate the impact of including time incentives in shipping contracts for port operators, shipping lines, and the overall supply chain	√	100%
4. Measure the impact of various factors on the benefits realized through the use of incentive contracts	√	100%
5. Analyze whether inclusion of time incentives would allow Hong Kong port operators to lower terminal handling fees without decreasing their profits	√	100%
6. Disseminate our findings through peer reviewed scholarly publications and conference presentations	√	80%
7. Incorporate the results of the project into our teaching, either through developing short case studies or using the findings to illustrate and explain relevant concepts	√	70%

6. Research Outcome

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

The main research outcome is a comprehensive model of cargo location on container vessels. This allows for more detailed operations planning and scheduling. The 2-step model uses a hurdle negative binomial distribution to represent the number of container moves per vessel hold, followed by a multinomial Dirichlet regression for more detailed modeling of specific move types (based on the direction of the move, i.e. loading vs. discharging as well as the size of the container: 20 vs 40 foot). This work was presented at the 28th European Conference on Operational Research and was a subject of an unpublished manuscript "Count models for vessel workload in container terminals."

Another noteworthy contribution is a detailed simulation model of ship-to-shore operations, built from scratch in Python. It allows for simulating various port policies, for example, the impact of the berthing order or work priority. Unfortunately, based on the performed experiments, we could not find a method to improve current processes of quay crane assignment. This could be due to numerous reasons, for example, if berthing space is the main bottleneck, crane allocation decisions will not have a significant impact on the system performance.

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

While we did not succeed in developing a strategy for the port based on incentive contracts, the built simulation model can still be useful in other analyses – with some modifications and additions it might be possible to adapt it to examine other issues related to port operations. Further, the manuscript ("Count models for vessel workload in container terminals") can be revised in accordance with the reviewers' comments and submitted for consideration in a peer reviewed journal. However, this is work that would need to be carried out by the Co-I as the PI has left the academia.

7. 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)

Historically, the Port of Hong Kong has been a major contributor to Hong Kong's economic growth and prosperity. However, since the establishment of the Special Economic Zone in Shenzhen in 1980, Hong Kong has been steadily losing market share of ocean cargo to new, lower cost competitors in the Pearl River Delta. The biggest threat to Hong Kong Port is the Port of Shenzhen, which by the end of 2013 surpassed Hong Kong in terms of annual container throughput. As a newer port, Shenzhen offers more modern facilities, lower terminal handling fees, and has a higher capacity for handling container vessels. The purpose of this research project was to examine whether an inclusion of contractual time incentives for container vessels calling on Hong Kong port could improve Hong Kong's position among neighboring ports. These time incentives, if successful, would provide additional benefits in terms of shorter vessel turn-around time and, therefore, increase Hong Kong's competitiveness. However, through a detailed simulation model of port's operations, it was found that these additional contractual provisions do not provide sufficient benefit and should not be implemented.

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)*						
NA									

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)*
July, 2015 Hong Kong	Hierarchical Entities in Simulation of Container Ships at Port	20th Asia Pacific Decision Sciences Conference	2015	Yes	Yes	Yes
December, 2015 Huntington Beach, CA, USA	Benefits of Contractual Time Incentives in Container Shipping Industry: A Preliminary Study	2015 Winter Simulation Conference	2015	Yes	Yes	Yes
July, 2016 Poznan, Poland	Container-level simulation of quay-side crane operations	28th European Conference on Operational Research	2016	Yes	Yes	Yes
November 2016, Nashville, TN, USA	Effects of time incentives on container port operations	2016 INFORMS Annual Meeting	2016	Yes	Yes	Yes

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

The results of the research have been used in training a team of students for the Chartered Institute of Logistics and Transport in Hong Kong Student Competition as well as an illustrative example in delivering MSIM4101 Decision Analytics and SCM3102 Management of Service Operations courses.

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
NA			

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

13. 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
NA	

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FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report - Attachment
(for completed projects only)

RGC Ref. No.:	UGC/FDS14/B08/14
Principal Investigator:	Dr. Karolina Glowacka
Project Title:	Integrated modeling approach for increasing Hong Kong Port competitiveness

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 [or conference]	0	4	0	0	0