

BUSINESS PERFORMANCE ANALYSIS FOR SMALL AND MEDIUM
ENTERPRISES THROUGH SYSTEM DYNAMICS MODELLING: A CASE
STUDY OF CHEMICAL PRODUCTION INDUSTRY

SEK WEI YEE

A thesis submitted in partial fulfillment of the
requirements for the award of the degree of Master of Science
(Industrial Engineering)

Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

JANUARY 2015

I Declare that this thesis entitled “*Business Performance Analysis for Small and Medium Enterprises through System Dynamics Modelling: A Case Study of Chemical Production Industry*” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : SEK WEI YEE

Date : 14th JANUARY 2016

ABSTRACT

Most research on business performance analysis was done using Traditional Costing (TC). Little research was carried out using Activity Based Costing (ABC). This research aims to support small medium enterprises (SMEs) in business planning through the use of system dynamics models. In particular, it has been hypothesized that through the use of a system dynamics model building process, SMEs' entrepreneurs can better understand the cause-and-effect relationships underlying company's product costing. Such an approach also enables decision makers to improve their understanding about the cost drivers affecting the price of product with the integration of ABC. In order to reach such a goal, this research has been carried out through the use of a case-study. A small company investigated is household chemical company operating in Johor, Malaysia. The report makes explicit main feedback mechanisms underlying company profit, product costing and return of investment. Summary of this research helps entrepreneurs on the business planning through study of SMEs in business performance analysis using System Dynamics (SD) models. This study has shown that SD model is effective in helping SMEs in its business performance analysis. This research also analyze cause and effect relationship underlying business performance such as the effect of each cost drivers to the profit, the effect of varying the sales volume forecast to the profit and also the effect of production rate to the cost per unit of product and integrate SD models with ABC. This research shows that the result of SD modelling able to achieved 80% of the actual performance of the case study company. Through the integration of ABC into SD model, this research predicts the profit, product cost per unit and return of investment. Thus, it provides evidence that SD model can be used as a tool to analyze business performance of other SME companies. This helps SMEs entrepreneurs for future business planning and decision making.

ABSTRAK

Kebanyakan kajian mengenai analisis prestasi perniagaan telah dilakukan dengan menggunakan “Traditional Costing” (TC). Hanya sedikit penyelidikan telah dijalankan dengan menggunakan “Activity Based Costing: (ABC). Kajian ini bertujuan untuk membantu Perusahaan Kecil dan Sederhana (SME) dalam perancangan perniagaan melalui penggunaan model “System Dynamics” (SD). Hipotesis kajian ini adalah; melalui penggunaan satu proses pembinaan model SD, usahawan SME dapat memahami dengan jelas hubungan sebab-dan-akibat yang mendasari prestasi syarikat. Pendekatan ini membolehkan usahawan meningkatkan pemahaman mereka mengenai “cost drivers” yang memberi kesan kepada harga produk dengan integrasi ABC. Dalam usaha untuk mencapai matlamat ini, kajian telah dijalankan melalui penggunaan kajian kes. Syarikat SME yang dikaji adalah syarikat pengeluaran bahan kimia kegunaan domestik. Secara ringkasnya, kajian ini membantu usahawan SME merancang perniagaan dengan menganalisa prestasi perniagaan melalui penggunaan model SD. Kajian ini telah membuktikan bahawa model SD berkesan dalam membantu SME meningkatkan prestasi perniagaannya. Kajian ini menganalisa sebab dan akibat hubungan asas prestasi perniagaan seperti kesan setiap ‘cost drivers’ kepada keuntungan. Misalnya kesan kepada pertukaran ramalan jumlah jualan untuk keuntungan dan juga kesan kadar pengeluaran kepada kos seunit produk. Keputusan kajian ini mendapati bahawa SD model mampu mencapai 80% ketepatan prestasi sebenar syarikat kajian kes. Kajian ini mengintegrasikan model SD dengan ABC. Dengan integrasi ABC ke dalam SD model, kajian ini dapat meramal keuntungan, kos produk seunit dan pulangan pelaburan syarikat. Ini membuktikan SD model sesuai digunakan sebagai salah satu alat untuk menganalisa prestasi syarikat SME yang lain. Ini amat membantu usahawan SME dalam perancangan perniagaan dan membuat keputusan untuk pelan perniagaan masa depan.

LIST OF TABLES

TABLE NO	TITLE	PAGE
1.1	Malaysia SME definition based on sized (Economic Census 2011)	2
1.2	Contribution of Malaysia SMEs to overall GDP (Economic Census 2011)	3
1.3	Percentage of Malaysia SMEs Establishment to Overall Companies (Economic Census 2011)	4
2.1	Examples of views expressed in the literature regarding the comparison of DES and SD modeling	11
2.2	Summary of past research	29
3.1	Summary of research method and tool used.	40
4.1	Company cost drivers and detail	47
4.2	Company production rate and sales record for Y2014	48
4.3	Comparison of validation data (Profit for 1 Year)	55
4.4	Result of product cost for integration of ABC into the Company System Dynamic model and its activity usage (First 12 Months)	60
5.1	Summary of research	67

LIST OF FIGURES

FIGURE NO	TITLE	PAGE
2.1	Part of a DES Model to Model an A&E Department (Maidstone, 2012)	13
2.2	An SD model to simulate patients flow through a hospital (Maidstone, 2012)	15
2.3	Diagram showing relationships between feedback loops and the behavior of the system (Maidstone, 2012)	16
2.4	SD diagram of a production process (Sweetser, 1999)	17
2.5	DES diagram of a production process (Sweetser, 1999)	19
2.6	Production planning policy (Subroto, 2010)	23
2.7	Implementation of ABC in SME (Gunasekaran et. al, 1999)	25
2.8	Selling price and product cost estimation (Khataie et. al, 2011)	27
2.9	Basic production firm model (Aksu, 2013)	28
4.1	Production flow of Case Study	44
4.2	Closed loop dynamic model of the case study company production and cost structure	45
4.3	Integration of ABC into the company closed loop dynamic model	46
4.4	Sales volume Goodness-of-Fit	49
4.5	Production Rate Goodness-of-Fit test	49
4.6	Stock and Flow of company current model	50

4.7	Simulation result of company 60 months look ahead	52
4.8	Cost per unit of Product A	53
4.9	Validation of model using minimum sales volume	54
4.10	Validation of model using maximum sales volume	54
4.11	Stock and Flow diagram – Combination of Profit, Product Cost per unit and Return of Investment	57
4.12	Integration of ABC into the company system dynamic model	58
4.13	Result of profit for integration of ABC into the company system dynamic model	59
4.14	Cost per unit of Product A and Product B	61
4.15	Result of Cost per unit for Product A and Product B	62
4.16	ROI of SD model of Product B	63
4.17	Result of ROI for Product B	63

LIST OF APPENDICES

Appendix	TITLE	PAGE
A	SD Model Equations	74
B	Picture of Case Study Company	77
C	Profit and Loss Statement for Case Study Company	80

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	TITLE PAGE	i
	DECLARATION	ii
	ABSTRACT	iii
	ABSTRAK	iv
	TABLE OF CONTENTS	v
	LIST OF TABLES	viii
	LIST OF FIGURES	ix
	LIST OF APPENDICES	xi
1	INTRODUCTION	
	1.1 Introduction	1
	1.2 Background of Studies	1
	1.3 Problem Statement	6
	1.4 Objectives	7
	1.5 Research Questions	7
	1.6 Scope	8
	1.7 Significance and Implications of the Study	8
	1.8 Conclusion	8
2	LITERATURE REVIEW	
	2.1 Introduction	9
	2.2 Methodology of Literature Review	9

2.3	Topics of Research	10
2.3.1	Comparison of Modelling Technique	10
2.3.2	Past Research on Activity Based Costing or System Dynamics	21
2.4	Gap and Summary	35
2.5	Conclusion	35
3	METHODOLOGY	
3.1	Introduction	36
3.2	Structure of Methodology	36
3.2.1	Stage 1	38
3.2.2	Stage 2	38
3.2.3	Stage 3	38
3.2.4	Stage 4	39
3.3	Case Study	41
3.4	Selection and Validation of Analysis	41
3.5	Conclusion	42
4	RSEULT ANALYSIS AND DISCUSSION	
4.1	Introduction	43
4.2	Case Study	43
4.2.1	Data Collection	47
4.2.1.1	Goodness-of-Fit	46
4.2.2	Stock and Flow – Current Performance	50
4.2.3	Verification and Validation	53
4.3	Experiment	55
4.4	Result Analysis and Discussion	64
4.5	Conclusion	65

5	CONCLUSION	
5.1	Introduction	66
5.2	Finding of Study	68
5.3	Limitation of Study	69
5.4	Recommendation for Future Study	69

	REFERENCES	71
--	-------------------	----

	APPENDICES	
	Appendix A	74
	Appendix B	77
	Appendix C	80

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents an overview of this study. This includes the background of the study, problem statement, objectives and scopes of the research, as well as the significance and implications of the study.

1.2 Background of Studies

Small and Medium Enterprises (SMEs) in Malaysia is being categorized by the category and sizes explained in Table 1.1. The role of SMEs in a national economy has been emphasized all over the world considering their contribution to the total manufacturing output and employment opportunities. Also, SMEs are flexible and innovative taking into account the size and business structure. Hence, there is a potential to improve the overall performance of SMEs and hence their competitiveness. In Malaysia, SME companies contributed to over 97% of total companies in Malaysia while the contributions of SMEs to overall Malaysia GDP is around 32% on 2012 and projected to reach 40% by 2020 year. Table 1.2 and Table 1.3 showed the contribution of SMEs to Overall Malaysia GDP by key Economic Activity and Percentage of Malaysia SME's establishment to overall Malaysia's companies respectively. In recognizing SME companies play an important role in Malaysia economics, this paper aimed to help SMEs in analyzing its business performance.

Table 1.1: Malaysia SME Definition Based on Sized (Economic Census 2011)

New SME Definition Based on Size			
Category	Micro	Small	Medium
Manufacturing	Sales turnover of less than RM300,000 OR employees of less than 5	Sales turnover from RM300,000 to less than RM1.5 mil OR employees from 5 to less than 75	Sales turnover from RM1.5 mil to not exceeding RM 50 mil OR employees from 75 to not exceeding 200
Service and other sectors	Sales turnover of less than RM300,000 OR employees of less than 5	Sales turnover from RM300,000 to less than RM 3 mil OR employees from 5 to less than 30	Sales turnover from RM3 mil to not exceeding RM 20 mil OR employees from 30 to not exceeding 75

Table 1.2: Contribution of Malaysia SMEs to overall GDP (Economic Census 2011)

Year	2005	2006	2007	2008	2009	2010	2011	2012
% Share to GDP								
Agriculture	3.4	3.5	3.4	3.3	3.4	3.4	3.4	3.3
Mining & Quarrying	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9
Manufacturing	8.1	8.1	8.2	7.8	7.4	7.7	7.9	7.9
Services	17.0	17.2	18.2	19.1	19.9	19.8	20.1	20.2
Plus: Import Duties	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4
Share of SME GDP to Overall GDP	29.4	29.6	30.4	31.2	31.7	32.0	32.5	32.7

Table 1.3: Percentage of Malaysia SMEs Establishment to Overall Companies (Economic Census 2011)

Number of establishments	Census of Establishments and Enterprises 2005 (Reference Year 2003)				Economic Census 2011 (Reference Year 2010)			
	Total	SMEs	Percentage of SMEs over total	Percentage of SMEs over total SMEs	Total	SMEs	Percentage of SMEs over total	Percentage of SMEs over total SMEs
Services	477,525	474,706	99.4	86.6	591,883	580,985	98.2	90.0
Manufacturing	40,793	39,373	96.5	7.2	39,669	37,861	95.4	5.9
Agriculture	34,486	34,188	99.1	6.2	8,829	6,708	76.0	1.0
Construction	-	-	-	-	22,140	19,283	87.1	3.0
Mining & Quarrying	-	-	-	-	418	299	71.5	0.1
Total Establishments	552,804	548,267	99.2	100	662,939	645,136	97.3	100

In general, all data above reflects the importance of SMEs' role in economic growth. But factually, as Brusa (1986) pointed out that business planning and control systems currently used in small firms are mainly based on accounting models and may not allow entrepreneurs to properly capture the dynamics relationships between day-to-day policies and consequent future outcomes. Meanwhile, Bianchi and Bivona (2000) emphasized that matching System Dynamics (SD) methodology with the accounting approach may allow entrepreneurs to better understand the strategic relevance of their current decisions and in fact, SD allows policy makers to understand managerial processes underlying accounting information.

Accurate cost information is critical for every aspect of a business, from its pricing policies to its product designs and performance reviews. However, most companies are still using the same Traditional Costing (TC) systems that were developed decades ago (Kaplan and Cooper, 1998). For the last two decades, a new type of accounting system, Activity-Based Costing (ABC), has been gaining acceptance in the USA as well as in Pacific Rim and European-based companies (Keegan and Eiler, 1994). ABC is being increasingly implemented as an alternative to TC. ABC has been shown to reflect the cost of operations in a company in a more accurate and consistent manner than TC. Gunasekaran pointed out (Gunasekaran et. al, 1999) ABC has been successful in large scale industries for improving the operational performance by providing appropriate and accurate information on the consumption of resources. However, ABC has not received a significant attention from small companies inspite of the fact that it has an important role to play in improving the performance of them.

Subroto (2010) has studied the integration of financial reports for Leather Handicraft SMEs and the impact of policy lever that the SMEs take during the period of the simulation, so that the development of SMEs from time to time can be observed.

1.3 Problem Statement

ABC has been gaining acceptance in an increasing number of organizations ranging from manufacturing to retailing, from profit oriented businesses to Government institutions. These organizations adopted ABC because it provides critical decision information, such as product pricing, investment on product engineering, improving product mix, etc., for which accurate cost information is crucial (Zhuang and Bums, 1992). However, ABC not received due attention from SMEs although they have potential to improve the performance.

In the last two decades, several factors have forced global manufacturers to make dramatic changes in their products, markets, and manufacturing strategies. The market place of the twenty first century is evolving into one of merging national markets, fragmented consumer markets, and rapidly changing product technologies. To stay in the market place it is necessary for SMEs to adopt activity based costing and management for reasons such as ABC operations not only produce parts at faster rates, but they produce parts with greater consistency and conformity to quality specifications. Also, ABC allows the manufacturers to reduce the time between customer order and product delivery, this gives the manufacturer a competitive advantage in promoting good customer service.

However, implementing it has led to a much more limited success than expected as pointed out by Martha (Martha et al, 2014), with many failing in the attempt due to coming up against internal and external problems and this situation has occurred even more in small and medium-sized firms (SMEs) since they have fewer resources than big firms. The possible problems could be as follows:

- (a) The system not properly fitting in with the organizational structure;
- (b) The firm's management has doubts as to whether the system can provide information for decision-making;
- (c) Compatibility problems between financial accounting, analytical accounting and administrative control;
- (d) Problems of rising indirect costs; and
- (e) Problems of a fiscal nature or with auditing.

The contribution of Malaysia SMEs to overall GDP is still growing, however it is still far from maturity level. Furthermore SMEs resources are fewer compared to big firms, SME in Malaysia may need more help on business performance analysis.

1.4 Objectives

This study attempts to explore the analysis of business performance of Malaysia's SME. Specifically, this study seeks to

- a) study small medium enterprises (SMEs) in business performance analysis through the use of system dynamics models;
- b) analyze cause and effect of business performance
- c) integrate system dynamics models with Activity Based Costing.

1.5 Research Question

This study attempts to explore the analysis of business performance of Malaysia's SME. Specifically, this study seeks to understand

- a) How to support SME in Business Planning?
- b) How to model the interrelationships between causes of enterprise issues with the effects of business performance?
- c) How efficient is the integration of system dynamics models with Activity Based Costing?

1.6 Scope

The integration of SD models with ABC is relatively new in Malaysia, this study is aimed to case study a small scale company in Malaysia on the company's business

performance analysis through the introduction of SD models with ABC. Stella System Dynamics software is used for modeling purposes and historical data based on January until December 2014 for validation of model.

Model of the study on for cost of product and prediction of sales based on historical data. The model does not consider holding cost, inventory cost, marketing cost, machine repair cost and asset depreciation cost. All data analysed based on historical data collected (January to December 2014) and did not consider any Ad-Hoc project received.

1.7 Significance and Implications of the Study

This study emphasized on the cause and effect underlying the business performance. With the model, entrepreneur able to better plan on the limited resources on hand and probably use the model for business plan. Other than TC used, this model promotes ABC which is more accurate in costing and pricing of products, thus increased the competitive of the business.

1.8 Conclusion

The described chapter is dedicated to the thesis introduction and background. It introduces the thesis objectives, the problems and questions to be solved, the scope to which the thesis is limited to, the expected significant results, and finally, the structure in which the thesis is conducted.

REFERENCES

- Glasgow, Scotland: Glasgow Caledonian University. Cox, G. B., P. Harrison and C. R. Dightman. 1978. "Computer Simulation of Adult Sentencing Proposals." *Evaluation Program Planning* 1(4): 297-308.
- Coyle, R. G. 1985. "Representing Discrete Events in System Dynamics Models: A theoretical Application to Modelling Coal Production." *Journal of the Operational Research Society* 36(4): 307-318.
- Brailsford, S., Desai, S., and Viana, J. (2010). Towards the holy grail: Combining system dynamics and discrete-event simulation in healthcare. In *Simulation Conference (WSC), Proceedings of the 2010 Winter*, pages 2293–2303.
- Brailsford, S. and Hilton, N. (2001). A comparison of discrete event simulation and system dynamics for modelling health care systems. In Riley, J., editor, *Planning for the Future: Health Service Quality and Emergency Accessibility. Operational Research Applied to Health Services (ORAHs)*. Glasgow Caledonian University.
- Chan, W., Son, Y.-J., and Macal, C. (2010). Agent-based simulation tutorial - simulation of emergent behavior and differences between agent-based simulation and discrete-event simulation. In *Simulation Conference (WSC), Proceedings of the 2010 Winter*, pages 135 –150.
- Yamaguchi, Kaoru (2003)., *Principle of Accounting System Dynamics a Modeling Corporate Financial Statements.*, the 21st International Conference of the System Dynamics Society, New York City, July 20 - 24, 2003.
- Yamaguchi, Kaoru (2006)., *Integration of Real and Monetary Sectors with Labor markets a System Dynamics Macroeconomic Modeling.*, the 24th International Conference of the System Dynamics Society, Nijmegen, The Netherlands, July 23-27, 2006

- S. Nielsen and E.H. Nielsen (2013). Transcribing the balanced scorecard into system dynamics: From Idea to Design. *Int. J. Business and Systems Research*, Vol. 7, No. 1, 2013
- A.Subroto (2010). Supporting Small Medium Enterprises planning through the use of a step-by-step System Dynamics model building process A Case Study from Leather Handicraft at Tanggulangin, Sidoharjo, East Java, Indonesia. 27th ISDC's proceedings 2010
- Ibrahim Aksu (2013). System Dynamics Approach as a Tool of Strategic Cost Management. *The International Journal of Social Sciences*, Vol 15, No. 1, 2013
- Kaoru Yamaguchi (2013), "Principle of Accounting System Dynamics – Modeling Corporate Financial Statements", 29th ISDCs proceedings, 2013
- M. Gupta and K. Galloway (2003), Activity-based costing/management and its implications for operations management, *Technovation* 23 (2003) 131–138
- A. Gunasekaran, H.B. Marri and R.J. Grieve (1999), Activity Based Costing in Small and Medium Enterprises, *Computers & Industrial Engineering* 37 (1999) 407-411
- M.C. Andrade et al (1999), Activity-based costing for production learning, *Int. J. Production Economics* 62 (1999) 175}180
- A. Gunasekaran and D.Singh (1999), Design of Activity Based Costing in a Small Company: A Case Study, *Computers & Industrial Engineering* 37 (1999) 413-416
- A. Gunasekaran and M. Sarhadi (1998), Implementation of activity-based costing in manufacturing, *Int. J. Production Economics* 5657 (1998) 231-242
- Amir H. Khataie, Akif A. Bulgak and Juan J. Segovia (2011), Activity-Based Costing and Management applied in a hybrid Decision Support System for order management, *Decision Support Systems* 52 (2011) 142–156
- Bianchi, Carmine (2002)., Introducing SD modelling into planning and control systems to manage SMEs' growth: a learning-oriented perspective., *System Dynamics Review*; Autumn 2002; 18, 3; ABI/INFORM Global pg. 315

- Bianchi, Carmine. Graham Winch ., Colin Grey (1998)., The Business Plan As A LearningOriented Tool For Small/Medium Enterprises: A Business Simulation Approach
- Sweetser, Al. A comparison of system dynamics (SD) and discrete event simulation (DES). 17th International Conference of the System Dynamics Society. 1999.
- Antuela A. Tako (2009). Comparing Model Developemnt in Descrete Event Simulation and System Dynamics Proceedings of the 2009 Winter Simulation Conference, 979 – 991
- Robert Maidstone (2012). Discrete Event Simulation, System Dynamics and Agent Based Simulation: Discussion and Comparison
- Artamonov, A. 2002. Discrete-event Simulation vs. System Dynamics: Comparison of Modelling Methods. Warwick Business School, University of Warwick, Coventry.
- Baines, T. S., D. K. Harrison, J. M. Kay and D. J. Hamblin. 1998. A consideration of modelling techniques that can be used to evaluate manufacturing strategies. The International Journal of Advanced Manufacturing Technology 14(5): 369375.
- Bard, J. F. 1978. "The Use of Simulation in Criminal Justice Policy Evaluation. Journal of Criminal Justice 6(2): 99-116.
- Brailsford, S. and N. Hilton. 2001. A Comparison of Discrete Event Simulation and System Dynamics for Modelling Healthcare Systems. In Proceedings of the 26th meeting of the ORAHS Working Group 2000, ed. J. Riley, pp.18-39.