

Investigating the Use of Software Negotiation for Adaptive Revenue Management



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

L.H.L.M. Wimalasena

08/10007

Faculty of Information Technology

University of Moratuwa

September 2010

Investigating the Use of Software Negotiation for Adaptive Revenue Management



L.H.L.M. Wimalasena
08/10007
University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Dissertation submitted to the Faculty of Information Technology,
University of Moratuwa, Sri Lanka for the partial fulfillment of the
requirements of the Degree of M.Sc. in Artificial Intelligence

September 2010

Declaration

I declare that this dissertation does not incorporate, without acknowledgment, any material previously submitted for a Degree or a Diploma in any University and to the best of my knowledge and belief, it does not contain any material previously published or written by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organization.

L.H.L.M. Wimalasena

Name of Student

Signature of Student



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Date

Supervised by

Prof. Asoka S. Karunananda

Name of Supervisor(s)

Signature of Supervisor(s)

Date

Dedication

This Thesis is dedicated to my beloved wife

Ranga Subhashi



for her great support and caring throughout the period.

Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Acknowledgements

This thesis would have been far from completion, if his support and guidance was not there throughout the research. I'm heartily thanking my supervisor Prof. Asoka S. Karunananda who is the Dean of Faculty of Information Technology of University of Moratuwa, for being my supervisor and guiding me patiently in all the times.

I would also like to thank my dear colleagues, in providing invaluable assistance and support during the hard and tough times of the research while they were also going through the same. Shihan Merino Silva specially remembered for being there to discuss and help on technical matters from the beginning.

Last but not least I would like to thank the researchers who have done their research work related to Revenue Management and various Artificial Intelligence approaches for revenue management.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Abstract

Enterprises today, specially performing online sales face huge challenge to respond to very dynamic market changes and to manage their revenues. This is due to the complex nature of the businesses and huge amounts of data being required to process to make generate correct forecasts. Complexity further increases when it comes to travel and tourism industry where mainly the hotel and flight prices face great competition and demand fluctuation. From the literature it can be seen that this area of research has already been studied in different angles. Examples are agent oriented supply chain management, multi agent mediated internet market places, dynamic re-contracting and re-negotiation in online market places ...etc. However, there is no readily available solution to address this complexity and manage revenues from Tour Operation point of view.

This thesis presents the work carried out to address the tour operator business complexity by building a multi agent technology based model. Inputs to the system are customer purchase requests for flight seats, relevant inventory with the seat allocation criteria. System outputs the decision if to accept customer purchase request at the requested prices, autonomously adjust listed prices which can be above or below the minimum price and most appropriate allocation of the inventory which generates the optimal revenue. In transforming input to the output, agents act autonomously trying to negotiate the best price for the customer and optimal inventory allocation. Features of the system are adaptive negotiation, adaptive price adjustments and generating forecasts for customer bid price and patterns. Design of the system consists of few types of agents. Namely, Global Manager, Local Manager, Sales, Customer, Inventory, Demand forecasting, Competitor price monitoring and Pricing agents. Ontology has been defined in two levels. One is to store global travel ontology and the other to store local Ontology for the tour operator. MADKit has been used to implement the agent model and to wrap existing services. Evaluation has been performed based four cases defined with agent features in each. Results from the evaluation clearly shows, if the supplier closely analyzes and adapts to the market behavior in terms of negotiation, price adjustments and forecasting, he can earn considerable more revenue out of the same market.

Contents

	Page
Chapter 1 - Introduction	1
1.1 Introduction	1
1.2 Agent Approach	1
1.3 Aim and Objectives	2
1.4 Resource Requirement	2
1.5 Structure of the thesis	2
1.6 Summary	3
Chapter 2 - Revenue Management – State of the Art	4
2.1 Introduction	4
2.2 Supply Chain Management (SCM) – Agents in action	4
2.3 Agent Negotiation in competitive environments	5
2.4 Online Market places and Multi Agent Systems	6
2.5 Problem in brief	8
2.6 Summary	8
Chapter 3 - Theoretical Basis for Managing Complexity	9
3.1 Introduction	9
3.2 Multi agent technology and business process complexity	9
3.3 Summary	10
Chapter 4 - Multi Agent Approach for Revenue Management	12
4.1 Introduction	12
4.2 Inputs	12
4.3 Outputs	12
4.4 Process	12
4.5 Users	13
4.6 Features	13
4.7 Summary	13

Chapter 5 - Agent Oriented Analysis and Design	14
5.1 Introduction	14
5.2 Functional Requirements	14
5.3 Agent oriented analysis	15
5.4 Architecture of agent oriented market place for tour operation	15
5.5 Architecture inside Tour Operator	17
5.6 Tour operator – Agents	17
5.6.1 Individual Component Details	18
5.7 Detailed designs	19
5.8 Summary	19
Chapter 6 - Implementation	20
6.1 Introduction	20
6.2 Hardware for agents to operate	20
6.3 Choice of the simulation framework and other software	20
6.4 Implementing individual Agents	20
6.5 Implementing the ontology	21
6.6 Implementation of algorithms	21
6.6.1 Demand Simulation (Customer side)	21
6.6.2 Bargaining	22
6.6.3 Autonomous price adjustment (Supplier/Tour Operator)	24
6.6.4 Generating forecasts	25
6.7 Implementing the simulation software	26
6.8 Summary	26
Chapter 7 - Evaluation	27
7.1 Introduction	27
7.2 Evaluation Strategy	27
7.3 Experimental Setup	27
7.4 Choice of participants	28
7.5 Obtaining Responses	30
7.6 Results	30
7.7 Summary	34

Chapter 8 - Conclusion and Further Work	35
8.1 Introduction	35
8.2 Conclusion	35
8.3 Problems encountered	37
8.4 Future work	37
8.5 Summary	38
References	39
Appendix A	42
Appendix B	44
Appendix C	46



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Figures

	Page
Figure 5.1 - Agent Oriented Marketplace for tour operation – Architecture	16
Figure 5.2 - Architectural components inside a tour operator	17
Figure 5.3 - Agents inside a tour operator	18
Figure 6.1 - Bargain handling flow chart	23
Figure 6.2 - Demand Curve for Tour Operator/Supplier Items	24
Figure 6.3 - Price adjustment flow chart	25
Figure 6.4 - Flow chart for forecast calculation	26
Figure 7.1 - Revenue per cycle with increasing Bid price and above average Bid count	30
Figure 7.2 - Revenue per cycle when Bid price is increasing and Bid count is marginal	31
Figure 7.3 - Revenue per cycle when Bid price is increasing and Bid count is below average	31
Figure 7.4 - Revenue per cycle when Bid price is decreasing and Bid count is above average	32
Figure 7.5 - Revenue per cycle with decreasing Bid price and marginal Bid count	32
Figure 7.6 - Revenue per cycle when Bid price is decreasing and Bid count is below average	33
Figure 7.7 - Revenue per cycle with arbitrary Bid price and arbitrary Bid count	33
Figure A.1 - UML Component diagram of agents inside a tour operator	42
Figure A.2 - UML Sequence chart for bid handling inside a tour operator	43
Figure B.1 - Customer Agent User Interface	44
Figure B.2 - Sales Agent User Interface	44
Figure B.3 - Sales summary after a cycle completed	45
Figure B.4 - Sales status after few cycles	45

List of Tables

	Page
Table 7.1 - Customer side parameter table	29
Table 7.2 - Functions for Bid Price Variation	29
Table 7.3 - Functions for Number of bids calculation	29
Table C.1 - Test Data	46



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk