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A Multi-Agent Business Intelligence Framework for the Travel Sector

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Abstract

Business Intelligence in the travel sector includes dimensions such as market intelligence, customer relationship management, yield management, employee scheduling, over/ under booking, tour management, and security management. Each of these dimensions is elaborated on and put in an overarching framework to enable better business intelligence management for the travel sector, identifying both internal and external partners in an increasingly complex industry with ongoing customization of product / service offerings, detailed customer segmentation, and data integration requirements. A multi-agent business intelligence framework is used for the customer interface and customization, linked to a corporate business intelligence system displaying the dimensions above.

Keywords: business intelligence, tourism, travel, competitiveness

1. Introduction

Business intelligence can be defined as the set of concepts that involves technologies, applications and practices which are used to collect and analyze business information to enable organizations improve their decision making process. It mostly uses data previously stored in a data warehouse or a data mort, and includes the business operations' historical, current views and future outlook (predictions). Examples in the tourism travel sector include market intelligence, customer relationship management, yield management, employee scheduling, over/ under booking, tour management, and security management.

New on-line travel agencies play an increasingly central role in the travel and tourism sector; by combining an agency merchant model with dynamic packaging, resulting in a radical change in terms of organizational processes, strategies and underlying IT infrastructures.

Hinton and Mieczkowska [11] identified three main issues in this context: process integration (consisting of the deconstruction of the package tour and the adoption of dynamic packaging technologies), business intelligence tools integration, and the operating context. Dynamic packaging technologies are opted for by most tour operators to meet customer demand and expectations, and manage inventory and yields more effectively and accurately. Information gathered can be classified into 2 two groups; static information and dynamic information. Static information consists of elements like furnishings or location of a hotel, whereas dynamic information changes dynamically over time, such as the capacity of hotels or seasonal trends. In the travel sector, we can also distinguish pre-trip information, which tourists use prior to taking the tour/trip, and in-trip information which is used throughout the trip, and which is becoming increasingly important. Business intelligence tools are very helpful in not only reducing information gaps among suppliers and customers by providing accurate information about the products on offer, but may also include software and hardware devices like speech dialog systems for in-trip information services, which provide information via a mobile phone at the destination related to sights to visit, accommodation, opening hours, entrance fees, the weather, and other queries on demand. Such emerging systems use artificial intelligence coupled with computer technology and voice commands, and can be found in air and rail booking services, airport, traffic information or weather reports, as well as in tourist offices, shops, museums, and information on timetables of public transport.

Websites used in this sector are mostly customized, maintaining independence and assuring a personalized style in communicating with customers [3]. A new trend in this area is the ongoing development of search engines and recommendation systems based on dynamic agents [7]. Such internet enabled developments will continue to change travel related information gathering and the purchasing of a wide range of travel related goods and services. Business intelligence tools enable merchant brokering by comparing different suppliers and pricing information, service delivery modes and times, providing customers with increased flexibility in travel time scheduling. For example, once customers have selected their travel destination, a selection of flights, arrangements for travel to and

from the airport, and activities to engage in at the destination, are presented. Customers can then perform a cost-benefit analysis of the choices offered, and finalize their selection. Such data can be used to organize a 'trip', conduct internal and external searches, manage search criteria as well as mutual constraints, form a choice set, evaluate and compare alternatives based on price calculations and brokering between multiple merchants, handle affective and intangible attributes, filter stimuli, reduce perceived risk, develop conceptual frameworks, and define assumptions. Such business intelligence tools can be further developed to address some or all of these elements.

Business Intelligence Tools in the travel sector can be subdivided into:
1. Market intelligence applications
2. CRM
3. Yield Management
4. Over/underbooking
5. Employee scheduling
6. Tour Management
7. Security Management [6]
Each of the listed BI-tools is briefly explained below.

2. Business Intelligence Tools for the Travel Sector

2.1 Market Intelligence
Market intelligence (MI) is the process of acquiring and analyzing information in order to understand the market (both existing and potential customers); to determine the current and future needs and preferences, attitudes and behavior of the market; and to assess changes in the business environment that may affect the size and nature of the market in the future [5]. Market Intelligence performs both a market analysis and competitor analysis role, and it involves assessment of strategies, competitor perceptions, effectiveness of current operations, competitor capabilities, and long-term market prospects. In the travel sector, market intelligence may refer to demand forecasts, competitor promotions, and the like.

2.2 Customer Relationship Management
 "Customer Relationship Management (CRM) was recently defined as an enterprise business strategy designed to improve corporate profitability by building and maintaining better relationships with customers" [9]. CRM Systems provide information to companies that help them coordinate all the business processes that deal with customers in sales, marketing and service in order to optimize revenue, achieve customer satisfaction, and customer retention. The information obtained helps firms identify, attract, and retain the most profitable customers, provide better service to existing customers, add others and hopefully increase sales. CRM as a business intelligence tool answers questions such as "What is the value of a particular customer to the firm on a lifetime basis?", "Who are our most loyal customers?", "Who are our most profitable customers?", "What are the specific products and services that these most profitable customers buy?" Different types of CRM systems can be grouped under: Operational CRM, Sales Force Automation, Analytical CRM, Sales Intelligence CRM, Campaign Management and Collaborative CRM.

Operational CRM provides support to "front office" business processes, including sales, marketing and service. Each interaction with a customer is generally added to a customer's contact history, and staff can retrieve information on customers from the database when necessary. The major benefit of Operational CRM for companies is that customers can interact with different people or different contact channels in a company over time without having to describe the history of their interaction each time. This data processes by operational CRM can be used in some operational purposes like; managing campaigns, achieving enterprise marketing automation and sales force automation.

Sales Force Automation (SFA) on the other hand is a type of Operational CRM that is designed to achieve automation in sales-force-related activities, such as lead tracking. Software products perform such tasks like keeping lists of leads, assigning the segments to salespeople, tracking responses, generating reports, and allowing list contacts to be dialed by telephone or e-mailed.

Analytical CRM analyzes customer data for using in several functions like; design and execution of targeted

marketing campaigns to optimize marketing effectiveness, design and execution of specific customer campaigns, including customer acquisition, cross-selling, up-selling, retention, analysis of customer behavior to aid product and service decision making (pricing, new product development etc). Also Analytical CRM analyzes data for management decisions such as market positioning, financial decision making and forecasting, and customer profitability assessment.

Sales Intelligence CRM is very similar to Analytical CRM, but it is generally used as a more direct sales tool. Sales Intelligence CRM has features including the use of "alerts" to sales people based on analysis of such factors as: Cross-sell/Up-sell/Switch-sell opportunities, sales performance, good or bad, customer margins and customer trends within the segments.

Campaign management software is a tool with a marketing orientation. It combines elements of Operational and Analytical CRM and allows campaigns to be run on an existing client base. Campaign Management is also used while choosing campaign recipients from the client base according to selected criteria, development of a campaign offer, assigning specific campaign offers to selected recipients, automatically sending offers to the selected clients via selected channels; either directly, via channels such as e-mail, or indirectly, by creating lists for use in channels such as direct mail, as well as gathering, storing, and analyzing campaign results.

Collaborative Customer Relationship Management coordinates the multi-channel service and customer support by providing the infrastructure for faster, more responsive and effective support to customer issues, questions, complaints, etc. Collaborative CRM aims to get various departments within a business (sales, technical support and marketing) to share useful customer information from different customer contact points throughout the company. Collaborative CRM's ultimate goal is to use information collected from all departments to improve the quality of customer service. We now turn to yield management as another business intelligence tool for the travel sector.

2.3 Yield Management
When planes, trains, or ships depart, for example, unused seats are lost forever. Similar problems occur for vacant hotel rooms, unsold concert tickets, idle tables at restaurants, and many other fixed-capacity services [8]. Linked to the perishability problem is a capacity-constraint problem. To profitably fill capacity, many service providers use complex pricing systems administered by a computer. Such systems, referred to as yield management systems (YMS), employ techniques such as discounting early purchases, limiting early sales at these discounted prices, and overbooking capacity [12]. The basic idea behind yield management is that different customers are willing to pay different amounts for the service [2]. In fact, yield management is not truly a new concept nor is it an innovation in the service industry. Yet, information technology is now regarded as the main factor enabling the effective implementation of yield management in service firms. It is claimed that service organizations that efficiently employ computerized yield management techniques can achieve increases in revenue of between two and five per cent and gain a competitive advantage over their competitors [4].

2.4 Over/ Under Booking
As an example, it is possible for a customer to book a ticket on an airline flight and not show up for the departure. If that is the case, the airline may end up flying an empty seat resulting in lost revenue for the company. In order to account for such no-shows, airlines routinely overbook their flights: based on the historical rate of no-shows the firm books more customers than available seats. If, by chance, an unusually large proportion of the customers show up, then the firm will be forced to 'bump' some customers to another flight. Hotels and rental car agencies also overbook. When determining the optimal level of overbooking, the calculation is similar to the calculation used for yield management. The optimal overbooking level balances (i) lost revenue due to empty seats and (ii) penalties (financial compensation to bumped customers) and loss of customer goodwill when the firm is faced with more demand than available capacity [15]. Finally, we note that when different service providers offer one service at different times, the overbooking penalty also may involve the additional penalty of shifting customers to competitors, as well as the opportunity cost of losing future customer loyalty.

2.5 Employee Scheduling
"The employee schedule is a list of employees who are working on any given day, week, or month in a workplace. Scheduling software is used to allow organizations to better manage staff scheduling. Such software will usually track vacation time, sick time, compensation time, and alert when there are conflicts. As databases of schedules are accumulated over time, it may analyze past activity and prepare data for payroll. Some of the benefits are listed

below:
- Better achievement of contracted service level agreements
- Field workers completing more jobs per day
- Improved worker, equipment and vehicle utilization
- Increases transparency of field operations
- Minimizes job administration cost.

2.6 Tour Management

Business intelligence tools relating to tour management help handle all aspects of tour management, including streamlined booking and invoicing, effective vendor and traveler communications, robust marketing segmentation and tracking, in-dept operations analysis and reporting, and much more. An example is ViaTour software systems (http://verticals.botw.org/Software/Hospitality-and-Travel/Tour-Operator/).

For example, product creation may involve a wide variety of holiday products including: charter and scheduled flights, hotels, villas, car rental, transfers, excursions, ski packs and insurance. Holiday offers can be made available for sale via different sales channels, websites or call centers. Product flexibility offers a service of quickly creating specific date-related offers utilizing existing inventory and allocations. Such service enables tour operators to compete more effectively with companies that specialize in these kinds of date-specific offerings. The financial dimension of tour management business intelligence includes sales and purchase ledgers, general ledger, and bank account management including check, cash and credit card batching for bank reconciliation. Such purchase ledger can be automatically changed using standard costing when bookings are made, facilitating subsequent cost authorization and supplier invoice reconciliation.

2.7 Security Management

Nowadays pro-active dealing with potential security threats is becoming a part of the international travel scene. Security management in this context relates to identification requirements such as passport and visa requirements. Examples include the interfacing with homeland security in the US for travelers of different nationalities, or the passport requirements in the Schengen Area in Europe (the most prominent passport free travel zone in the world) [10]. Another example is the "common travel area" between the UK and Ireland. Other future passport free travel zones are being planned, including the Caribbean Community and Common Market (CARICOM), South American Community of Nations (CSN), or Economic Community of West African States (ECOWAS) (ibid). In addition, linking security to international tourism may require alternative forms of identification pending the nature of the traveler. As these security and identification issues evolve content wise and technologically, they create another dimension of business intelligence that travel agents will have to cope with successfully.

3. A Multi-Agent Business Intelligence Framework

The previous discussion summarizes the different dimensions of today's business intelligence framework for the travel industry. While application of such business intelligence tools will vary greatly across customer segments and/or product/service offerings, they will become increasingly complex as customer travel internationalizes and intensifies further.

A multi-agent business intelligence framework is proposed to canvas this complexity in producing elevated service offerings with greater customization for the customer, based on the multi-agent system approach by Wickramasinghe, Amarasisi and Alahakoon [16].

Multi-agents systems offer specialized problem solution pathways that incorporate mathematical techniques, generic algorithms, and clustering techniques, and deliver more customized solutions to the customer [14]. This multi-agent approach is built around a knapsack mathematical problem formulation that optimizes item selection, or resource allocations, in a constrained environment (size of the knapsack) [13].

Within a travel sector, solving a business problem like booking a hotel, multiple knapsacks, working across multiple dimensions, contribute to, and so build, the component solutions to the business problem. These dimensions may refer to, for example, time, cost, location, room size, room quality, transport, logistics, and dining requests and constraints, all to be potentially sought by the customer in building a customized solution. To add to this complexity,

other constraining factors may apply, such as time of year, facilities availability, and payment methods. Here, the distributed agent builds multi dimensional knapsack problems based on the total customer request, and subsequently solves (optimizes) these using generic algorithms.

The central administrator agent then collects requests from the distributed agent components, and looks for additional contributions to the optimized distributed agent interim solution. It may draw comparisons from available similar data which it has available as clustered similarities (or differences). It may then offer this additional complimentary information to the distributed agent interim solution. For example, to determine hotel preferences in terms of value for money, budget, cost, and time may be assigned to an unattached distributed agent, and re-formulated as a knapsack problem and solved using generic algorithms. As such, the customer may revisit, and iteratively re-run the program seeking to optimize their specific requirement mix – such as different booking time, different value level accepted, or working off a different budget. The distributed agent then checks for constraints like being well within budget, and sources alternatives within budget that complement the initial preferences expressed by the customer, using a neural network system incorporating hierarchical structures similar to those explained by Alahakoon, and Halgamuge [1]. Hotels with near matching solutions to neural determined targets are hierarchically prioritized with additional knowledge or information drawn from the central administrator system, such as restaurant dining locations, or from partnering external database systems like specific restaurant menu options, and 'next tour' booking availabilities. This solution is then relayed to the customer across the business-customer encounter interface as the best current solution to his/her request.

Aside from relating the multi-agent business intelligence approach to the travel sector, we propose to extend this methodology of Wickramasinghe, Amarasisi and Alahakoon [15] to also include information from partnering external database systems in the deployment of central administration agents. For example, specific restaurant menu options, 'next tour' booking availabilities, and bus-to-airport pickup may be included in the multi-agent framework. The multi-agent customer business intelligence framework is illustrated in Figure 1.
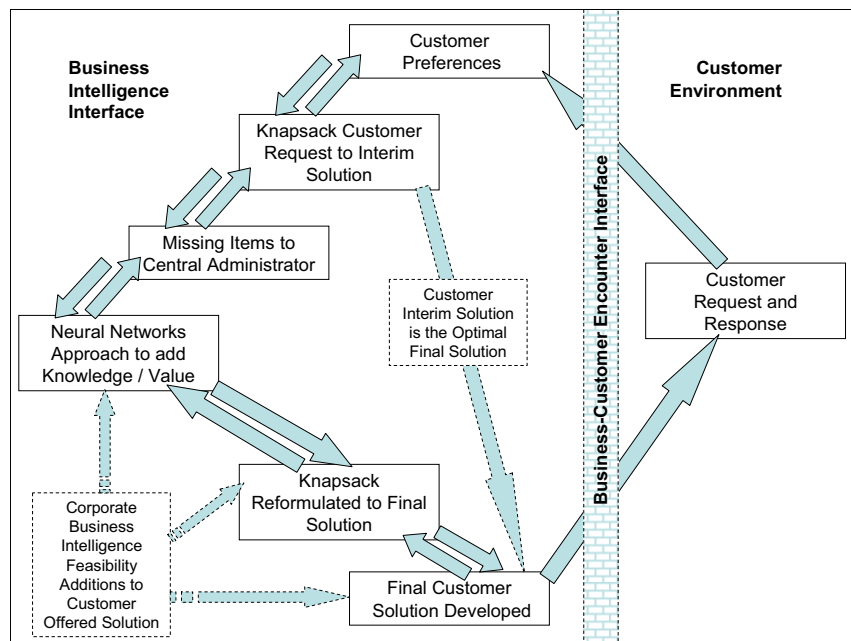
Figure 1. Multi-agent Customer Business Intelligence Framework, adapted from Wickramasinghe, Amarasisi & Alahakoon [15]

In addition, we propose to link the multi-agent business intelligence customer interface with an overarching corporate business intelligence system that integrates the business intelligence system dimensions discussed earlier. For example, particular corporate partnerships with participating hotels may yield additional information on pricing

structure using a yield management program, feasible packaged deals using its tour management interface, and customer preference dealing using a CRM package, all of which check the feasibility of the proposed multi-agent solutions before these are presented to the customer. As such, more holistic customer solutions are presented that are still customized to customer needs, but also fit well within the set parameters of the corporate business intelligence system. Both the multi-agent system and the corporate business intelligence system make up the total business intelligence framework of a particular travel business. The overall business intelligence framework is displayed in Figure 2.
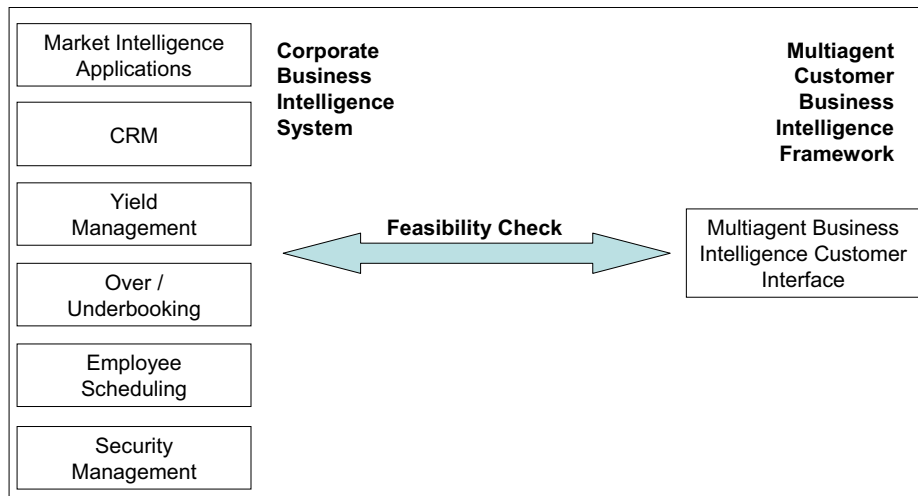

Figure 2. Overall Business Intelligence Framework

4. Conclusion

Business Intelligence in the travel sector is illustrated along dimensions of market intelligence, customer relationship management, yield management, employee scheduling, over/ under booking, tour management, security management, making up the corporate business intelligence framework. This in turn is linked to a multi-agent business intelligence framework for the customer interface which is conceptually enlarged and illustrated to include partnering external database systems. The resulting overarching business intelligence system produces more customized solutions to customer needs, while also meeting set parameters of the corporate business intelligence system such as price setting, capacity management, customer preference management, tour profitability management, and the like.

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