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Rethinking Business Intelligence

The business organizations are looking BI as an integrated, agile, customizable, operational, real-time and automated spanning across various functional areas at enterprise level, enabling actionable intelligence to offer personalised experiences and manage resources optimally. It should possibly look into each and every opportunity or risk on continuous basis, analyse it and facilitate or decide on its own to take appropriate action by utilizing available data, information and knowledge within and outside the organization. With increasing service orientation in software industry, BI also needs to be delivered through services. Using conventional intelligent techniques and database management systems is one of the possible options to achieve such kind of intelligence.

Business Intelligence!

The term intelligence is used to express the ability to think, reason and understand things automatically or by instinct [1]. It means an ability to acquire and apply knowledge and skills [2]. Extending the later definition to businesses (business intelligence!) means the ability of the organization to *acquire knowledge and skills* about products, services, business processes, external and internal resources including people, customers, suppliers, other entities like business partners, regulators, etc. and to *apply* that to take the informed and right decisions. Smart organizations look for opportunities and insights on continuous basis by performing 360 degree analyses of on-going activities (e.g. transactions) and interactions (e.g. feedback); take actionable decisions and immediately act upon. Only episodic and ad-hoc or craft-based analysis [3] done in off-line mode will not suffice. Delays in recognizing, interpreting and acting on insights and changes are critical emerging impediments to competitiveness [4]. Ultimately this kind of on-going analysis should be aimed to *do everything right*. Right means: *the right thing* at the *right place* and the *right time* at the *right cost* using the *right resource(s)*. At the same time fulfilling and adhering to compliance, organizational business rules and policies, social and ethical obligations along with individual stakeholder's objectives, constraints, preferences and changing tastes and requirements. For example, selecting an appropriate customer executive (*resource: person*) to make a phone call (*resource: channel/mode/interface*) to a customer (*compliance*: who has given consent to call) at his or her home (*place*) on Saturday evening (*time, preference*) for a campaign (*thing*). Data, information and knowledge required achieve all this needs to be collected and constantly updated from various internal and external sources including people.

Intelligence for personalised experiences

Many retail domain areas like telecom, banking, insurance, finance, e-tailing, customer products, media, travel are experiencing increasing heat of competition and a downtrend in margins or have to manage within thin margins. Because of open markets, availability and accessibility of information about products and services, variable prices, extensive product promotions and advertisements, the bargaining power has shifted from providers to customers. For instance in telecom, increasing numbers of operators are entering into the market with reduced prices and generous offers, so the other existing players have no option but to slash prices. Number compatibility and negligible switching cost makes it easier for subscribers to move from one to another. The customers have been pampered. They demand and expect more and better products and services. Changes in job profiles, income levels, locations, family status, life styles along with availability of various new options and choices, the tastes and requirements of the customers keep changing. What they did few years back may not be relevant today. This challenges the retail players, and they need to tailor-make, workout competitive pricing, customize or bundle products or services to satisfy the customer's needs uniquely, in order to retain and get the best possible value out of the products and services and to offer better value to the customer. On risk side, one bad experience at one of the touch points is enough to trigger the customer to switch to competitor. This requires the retail firms to know and understand each and every customer better and subsequently offer each one personalised experiences. In short, even if the firm has millions of customers, it has to deal with one customer at a time and offer unique personalized experience (N=1: one customer at a time [4]). By knowing and understanding each and every customer, their experiences of buying and spending patterns, acceptance and response to various offers, feedbacks and reviews the firm can co-create and innovate products and services along with better customer intimacy. Filtering techniques like content, collaborative, knowledge-based and demographic filtering play important roles in offering personalised experiences by recommending relevant products [5], good examples are websites like Amazon and Netflix.

Intelligence for resource management

People in the firm are considered as valuable assets of the firm. They are the back-bone and face of the firm. They possess precious tacit knowledge about systems, processes, workflows, culture, experiences of dealing with customers and so on. Just like customers have issues with the firm, people in the firm also have issues. They need to be taken care of well in order to achieve productivity. Each individual is different in the firm. Everyone has his or own experiences, technical skill-sets, personal agenda, family conditions, temperament and soft-skills. The bottom line is, as the firm has to treat one customer at a time, the firm needs to deal with one employee at a time to offer every employee personalised and unique experiences. For example, offering a *job profile* to the *right employee* (based on his or her experience, skills and various other factors) at the *right place* (e.g. his/her preferred/convenient office location) at *right cost* (e.g. salary he/she deserves) using the *right resources* (e.g. office

space, equipments and support staff etc.). Employees should feel that the firm does take care and understands them. When any employee leaves the firm, a lot of knowledge which he or she has accumulated through years of experience goes with him or her. Retention of valuable employees is far more important than retention of customers because a loyal and productive employee can handle many customers well to bring value to the firm. So similar to analytics CRM, there is greater scope for analytical HRM (human resource management).

Firms procure, consume, process and distribute various resources. The term resource is used here in a generic way, referring to raw material, finished product, equipment, money, vehicle, stationary, office space, etc. In a typical manufacturing firm, the suppliers (providers) supply raw materials through in-bound logistics. The firm manufactures the finished goods. The finished goods are pushed through the distribution channel to customers using outbound logistics. However, many firms other than typically manufacturing ones use various kinds of resources to carry out their activities. In today's world, a lot of firms outsource the requirement of their resources such as office space, machines, vehicles, printing, etc. Using resources optimally becomes imperative to reduce waste and save cost. Some examples are: (a) printing and sending the hard copies of HR circulars to only relevant employees, (b) booking appropriate office room for meeting/function based on the number and type of people attending, (c) using the right type of vehicle, based on the number of people travelling together, (d) sharing resources like vehicle whenever possible, (e) connecting to the right help-desk person to the customer based on the type of complaint etc.

Enterprise and integrated intelligence

Intelligence should be integrated, all-encompassing at enterprise level like enterprise resource planning systems, routine and part and parcel of all business processes, interfaces and workflows of the organization as shown in figure 1. For example, intelligence can be incorporated into inventory management system to automatically acquire knowledge about what to reorder, when to reorder, which supplier(s) to order from without waiting

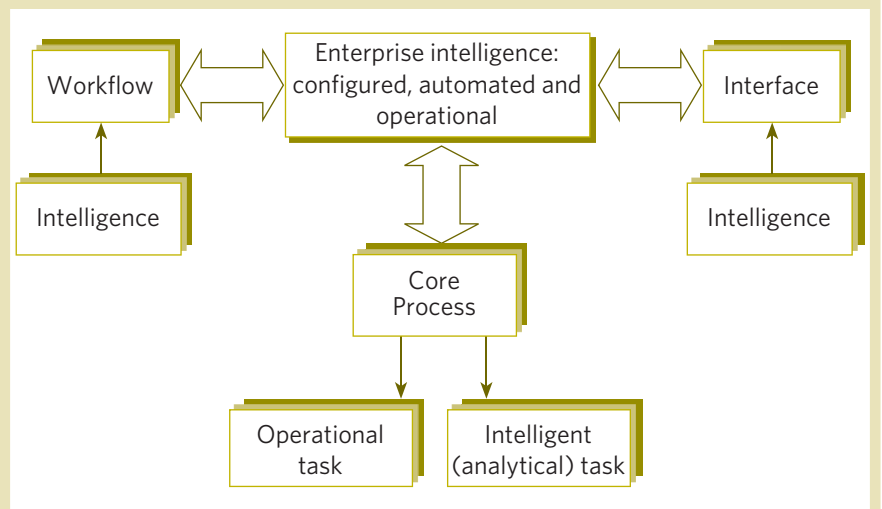

Fig. 1 : Integrating intelligence into business processes, workflows and interfaces.

for explicit manual instructions from human decision makers. Knowledge about the suppliers makes it easy to send order to the right supplier, at the right time in supply-chain, based on various parameters and factors like urgency, quality and location of delivery, profitability, supplier's capacities, capabilities, costs, skills and distances. This is real-time configuration of resources. Similarly, in-built intelligence in transaction processing system that automates an ATM transactions can decide (and send alert) how much cash to replenish at what time by acquiring knowledge out of past experiences. This means every core business process can become smarter if it has its own intelligence. Similarly workflows and interfaces can have their own intelligence. A core manual business process here we mean execution of set of related core activities or tasks to accomplish that business process. Work-flow facilitates simple sequencing and routing of tasks or activities. Interfaces are used to interact or communicate with the system such as SMS, IVR (interactive voice recognition), etc. Automation and complexity of implementing enterprise intelligence can depend upon various factors some of them are:

- Level automation of business processes, workflows and interfaces. More automation ensures availability of data, information and knowledge in real-time.
- Granularity, structuredness and standardization (common vocabulary with proper syntax and semantics) across the organization in collecting, sharing, representing, storing and disseminating data, formation and knowledge about customers, products, services, resources, employees and so on.
- Culture of creating, sharing and disseminating knowledge and using automated business processes, workflows and interfaces as much as possible.
- Ability to recognize, capture and integrate as much as information possible from various touch points, internal and external sources.
- Integration with outside world (such as web 2.0 sources) and adoption to widely accepted standards and technologies (such as XML: eXtensible markup language, semantic web).
- Use of appropriate methodologies, techniques, tools, and technologies to build intelligence capabilities.

Continuous and event-based intelligence

Opportunities as well as possible risks such as losing out customers to competitor can be found by tracking ongoing activities and interactions within or outside the organization. The intelligence should be constantly evolving and business should have the ability to continuously acquire and apply it to look into every opportunity and risk, and decide to take action on it based on certain *criteria*

within *time-frame* (refer figure 2). Such opportunities and risks can be mapped to *events*. Some practical examples of events are: (a) *bill is ready*: customer can be offered discount coupons immediately when bill is getting ready based on items just bought, (b) *add to cart*: when an item is added to cart using 'add-to-cart' option, other relevant items can be recommended with exclusive pricing, (c) *statement date is due*: personalised discounts or relevant coupons can be printed along with credit card statement based on past purchases, (d) *recharge*: to check whether there is sudden drop in recharge amount as well as frequency, this may be an indication of possible churn out.

Action should be initiated in response to the event only when certain *criteria* is met in order to use computing resources optimally. For example, in case of *recharge* event, a criteria can be *recharge amount < 50% average of last 3 recharge amounts*. Based upon the type of event, decision to take appropriate action needs to be taken in real-time or within specific time period. There is no point in taking action or chasing it when opportunity is lost. For example, in *bill is ready* event, the personalised discount coupons should be immediately printed (or handed over) when bill is prepared (printed); so that customer can have a look at it and make a mind to redeem them. There is no point sending him or her offers through SMS/ email once he or she leaves the super store. However, events such as *recharge,* the customer need not be immediately called for understanding reasons for dip in usage but have sufficient time, may be within a day or so.

Database systems

Today, many organizations are moving to centralized enterprise solutions like ERP (enterprise resource planning), CRM and CBS (core banking solutions) from distributed and heterogeneous setups. These solutions sit on top of, and, use common corporate or organizational level databases. Since data is stored in databases, it remains in consistent and integrated fashion once integrity constraints are properly set in databases. Database systems like Oracle, MySQL and MS-SQL can handle huge amount of data (e.g. entire bank's) and capable of performing transactions in real time. Same database systems can be used to store data, information and knowledge to build real-time intelligence. Snapshots of the operational data from such databases can be extracted and moved into a separate database (referred here as BI.DB) meant for the purpose of solving specific analytical tasks instead of building data warehouses and data marts etc.

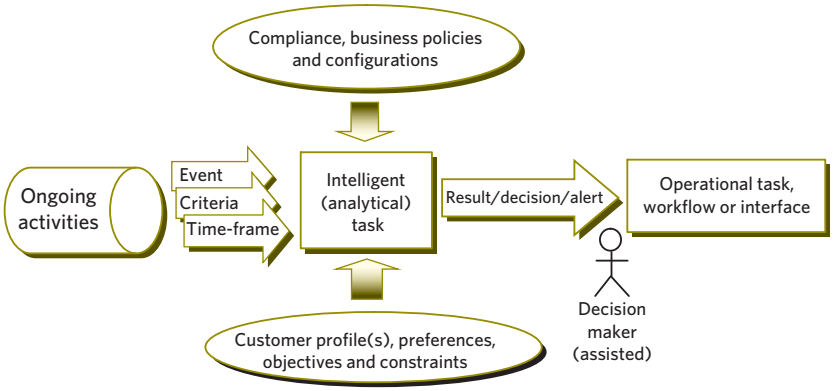

Fig. 2 : Monitoring on-going activities

Intelligent techniques

Humans acquire knowledge and skills in a variety of ways, e.g., by practicing, reading, experimenting, observing, solving problems and so on. Machines can be made intelligent either by feeding explicit knowledge (like business rules) in a format they can easily interpret or by letting them learn on their own. Intelligent techniques are modelled on biological systems and attempt to mimic intelligent behaviour. For example, neural networks simulate the working of nervous system using mathematical models and have learning capabilities, while case-based reasoning models how humans tackle new problems by taking inferences from past experiences. Popular intelligent techniques used in business domains include rule-based reasoning (RBR), case-based reasoning (CBR), genetic algorithms (GA), model-based reasoning (MBR), neural networks and fuzzy logic. They are often classified under artificial intelligence (AI) discipline. All these techniques together can solve various types of problems. They can work on smaller datasets. Some of the intelligent techniques like CBR [6] can address wide range of applications from diagnostics, personalization and recommendations [7] to knowledge management.

Hybrid intelligent systems

All intelligent techniques do not have all the capabilities, for example expert systems do not learn, they need explicit knowledge. Use of an appropriate technique also depends upon kind of knowledge source available. When intelligence is to be built at enterprise level it would not suffice to use only a single technique. In such a scenario, it is appropriate to use combinations of various intelligent techniques. This also helps to balance the weaknesses of one technique by the strengths of the other. Combinations of some of the techniques are complementary in nature. For example, integration of RBR and CBR facilitates combination of human (explicit knowledge) + experience based intelligence. RBR, CBR, GA & MBR put together offers blend of explicit domain knowledge + experience + optimization + quantitative modelling which can possibly model many kinds of problems to build intelligence capabilities. There exist many ways to integrate the intelligent techniques. Various models, mechanisms and architectures have been suggested and implemented to build hybrid intelligent systems [8].

A possible approach using intelligent techniques and database management systems

Following steps describe (refer figure 3) an approach to implement BI functionality (service) using intelligent techniques [9]. These steps are followed for each functionality (service

driven approach) required such as up-selling, cross-selling, credit scoring, personalization, recommendation, churn analysis, forwarding, supplier selection, loan monitoring, job profile matching etc. Intelligent systems are configured to analyse one entity at a time with current context such as *location*, *time* and *item category*. For examples, (a) configuring CBR to select the right supplier(s) for an item reorder based on their past behaviour and current contexts, (b) modelling individual borrower's expected repayment patterns and comparing it with actual ones on regular basis (e.g. on every *repayment due date*) by configuring MBR to detect deviations and take precautionary measures.

1. Select appropriate knowledge sources (most of them may be from operational data stores, content management systems, human experts, documented sources, RSS feeds etc.), they can be: (a) *explicit knowledge sources*: domain knowledge to implement intelligent system(s), (b) *implicit knowledge sources*: data and meta-data about items, users, features, attributes, demographics, transactions, feedbacks, ratings, etc. (c) *meta-knowledge sources*: keywords, tags, taxonomies, ontologies, folksonomies (folks' taxonomies), etc.
2. Once knowledge sources are available, the next task is to acquire knowledge e.g. building set of rules to build expert system, domain knowledge for case-based reasoning, etc.
3. Data, information and meta-knowledge extracted from some of the knowledge sources would be stored in BI.DB. Schema is designed based on concept of universal data models [9] to accommodate various types of products, contents, users, transactions, etc. Figure 4 shows basic entities and examples are given in table I.
4. Development of intelligent system(s) based on required functionality. For example, if the functionality (*recommending right resource*) is to suggest a right job profile(s) for prospective employee; it can be implemented using CBR. In case, the functionality is complex or require multi-functionality hybrid systems can be used.
5. Once the intelligent system(s) is developed, it is configured and deployed in run-time environment.
6. After intelligent system(s) is deployed, the next task is to develop interface to wrap its functionality to be accessed externally using API (application programmer interface), web service or HTTP (hyper text transfer protocol) interface with appropriate required inputs. The interface would do the mapping and transformation of input and output parameters between operational system and intelligent system(s).
7. The last task is to loosely integrate intelligent system(s) with operational system(s) wherever respective functionality is required. For example, integrating service that pushes personalized offers into SMS interface.

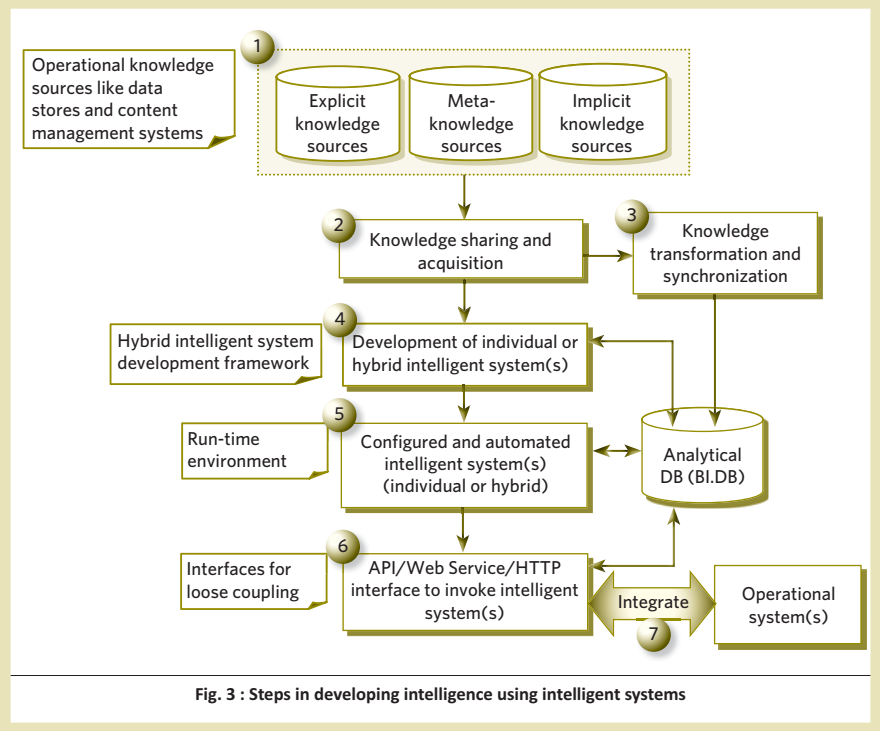

Fig. 3 : Steps in developing intelligence using intelligent systems

Discussion and conclusion

Conventionally, data warehousing kind of technologies play role in BI. Data

Table I : Description of generic entities

Base entity	Sub-type	Examples
Party (who)	Consumer	customer, client, user, subscriber, borrower, visitor, student
	Provider	supplier, agent, firm, expert, business partner, lender
Item (what)	Product	electronic gadget, banking product, telecom product, plan, book, movie
	Content	article, news, review, document, email, blog, video clip
	Resource	office space, money, job profile
	Service	courier service, web service, subscription service, car on rent
	Promotion	campaign, discount offers, advertisement , deal
Transaction (activity and when)		buy, sell, call, message, add-to-cart, read, listen, watch, click, download, visit, review, rate item, preview
Location (where)	Physical	area, city, state, country
	Online	website, WAP, URL, TV channel, IPTV
	Contact	phone no, email, fax
	Mobile	train, flight, bus, ship

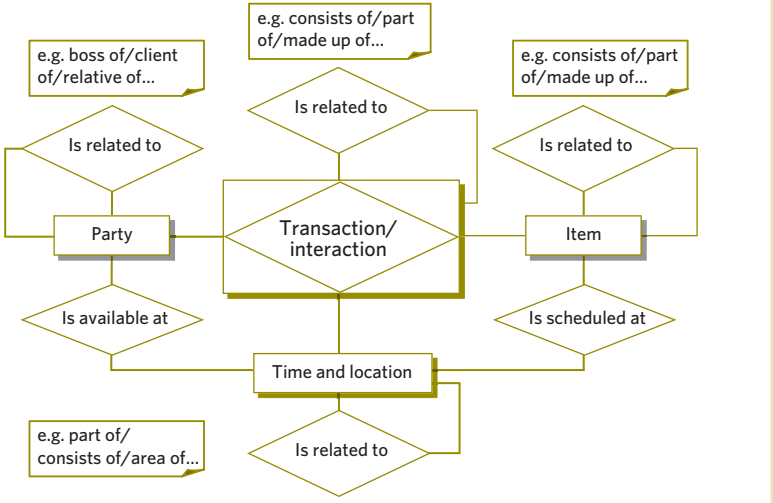

Fig. 4 : Basic entities for analytical data model

from different sources is extracted, transformed and mapped into it. However, for SMEs (small and medium enterprises) and big ones those have centralised databases at enterprise level, it is possible to use conventional database systems which are capable of managing huge amount of data by designing data model specifically required for analytical tasks. Services approach can be followed where each service corresponds to a well defined analytical functionality implemented through intelligent technique(s). Each service is separate and modular, analyses and focuses on one entity such as one customer or one item. The outcome of one service can be used by other, for example the service that does personalization uses the results generated by the service that implement collaborative filtering. Based on the type of application, requirement or business policies, only certain kind of recent data can be considered. For example, while executing personalisation service, only last five relevant transactions of active customers in each item category visited can be pulled from operational data store into BI.DB. All these factors reduce the volume of data required by individual service, and database management systems like MySQL can manage that.

Since the services are invoked when events happen subject to fulfilling specific criteria, they can be automated without requiring explicit invocation. The advantages of intelligent techniques like RBR, CBR: (a) models are easier to understand, (b) they can be configured (e.g. changing rules in expert system, selecting appropriate features and their weights) externally without changing the services that wrap and invoke them, (c) advantages of lazy learning (deferring learning as late as possible) that takes latest activities (for example, the very last download done by the user) into consideration: it is better fit for on-the-fly intelligence, (d) flexibility in search space (like searching the relevant contents), it can be restricted to the case in hand (like a customer profile) or task in hand using various indexing schemes supported by databases.

Once the intelligent systems are wrapped under web services, they can be loosely integrated or even embedded into operational systems to deliver intelligence through services. Some of the services can run in off-line mode or execution can be deferred depending upon time-frame availability. This makes it possible to use such approaches in distributed fashion using service based bottom up approach thereby achieving better modularity and scalability.

1. http://dictionary.reverso.net/english-cobuild/intelligence accessed on 13 May 2011.
2. http://www.oxforddictionaries.com/definition/intelligence accessed on 13 May 11.
3. Davenport, T., Harris, J., & Morison, R. (2010). *Analytics at work: smarter decisions, better results,* Harvard Business Press.
4. Prahalad, C.K., & Krishnan, M.S. (2008). *The new age of innovation: Driving Cocreated Value Through Global Networks*, Tata McGraw Hill, New Delhi.
5. Adomavicius, G., & Tuzhilin, A. (2005). Toward the next generation of recommender systems: a survey of the state-of-the-art and possible extensions. *IEEE Transactions on Knowledge and Data Engineering,* 17(6), 734-749.
6. Aamodt, A., & Plaza, E. (1994). Case-based reasoning: foundational issues, methodological variations and system approaches. *Artificial Intelligence Communications,* 7(1), 39–59.
7. Lorenzi, F., & Ricci, F. (2005). Case-Based recommender systems: a unifying view. *Lecture Notes In Computer Science*, 3169, 89-113.
8. Medsker, L. (1995). *Hybrid intelligent systems.* Kluwer Academic Publishers, Boston.
9. Sonar, R.M. (2011). *Next Generation Business Intelligence: A knowledge-based approach*, Vikas Publishing House, New Delhi.
10. http://www.univdata.com accessed on 13 May 2011.