

BUSINESS INTELLIGENCE SYSTEM FOR STRATEGIC DECISION MAKING IN MACHINE-TOOL SME-S

Dipl. Ing. Juan Antonio Arrieta, Dr. Itziar Ricondo,
Dipl. Ing. Nerea Aranguren
IDEKO Technology Center, Spain
{jarrieta, iricondo, naranguren}@ideko.es

The aim of this paper is to highlight the importance of Business Intelligence (BI) for optimal strategic decision making and, on the long term, for business innovation and competitive advantage. The Business Intelligence System aims at identifying and gathering strategic information from outside and inside the company and communicating it to key stakeholders. It will be oriented to Machine-Tool industry, but it could be applied to other industries characterised by tight competitiveness. The implementation of a BI system will be explained through the development of two competences: component competence and architectural competence.

1. INTRODUCTION

Scarce information on concurrent technology solutions, false estimation of customer requirements, ignorance on global market situation and future perspectives are some of the issues to which SMEs have to face. Furthermore, machine-tool industry and the whole manufacturing industry operate in a tight competitive environment. Manufacturing industry faces the following external uncertainties (Monostori *et al.*, 2003):

- increasing and diversified customer demands,
- enhancing role of the one-of-a-kind production, fast sequences of new tasks,
- increasing number and speed of communication channels,
- appearance of new technologies,
- frequently changing partnership (suppliers, distributors, customers, purchasers),
- instability of market circumstances.

An adequate information retrieval and capture system is required in order to provide organisations, particularly SMEs, with the most updated information regarding these issues. Companies need to be really aware of their business environment in order to survive.

Valuable business intelligence involves more than the systematic collection of information. Based on the resource-based theory, the ability of Business Intelligence

(BI) to have an effect on performance will depend upon the development of two competences (Hughes, 2005): component competence (resources) and architectural competence (capability).

Two similar concepts appear in the literature: Competitive Intelligence (CI) and Business Intelligence (BI). BI has a broader strategic orientation than mere analysis of competitors. In some cases, CI has been reduced to the analysis of competitors. Along this work it will be used the BI concept, understood as “targeting any information in the business universe that affects a firm’s ability to compete” (Sharp 2000), but oriented to New Product Development (NPD) decision-making. Some other decisions for BI application are strategy formulation, market entry or exit, corporate restructuring, etc.

Business Intelligence (BI) is related to the concepts of Digital Enterprise Technology (DET) and Engineering as Collaborative Negotiation (ECN). Digital Enterprise Technology (DET) can be defined as ‘the collection of systems and methods for the digital modelling of the global product development and realization process, in the context of lifecycle management’ (Maropoulos & Reiter 2002). Engineering as Collaborative Negotiation (ECN) can be defined ‘as a socio-technical decision-making activity, where a team of stakeholders with different expertise and mixed motives engage in interactive and joint conflict resolutions to co-construct consensual agreements of some engineering matter’ (Lu, 2004). Business Intelligence (BI) is a system for the identification, gathering, storage and diffusion of information for decisions in the early stages of life cycle management, such as the NPD conceptual stage. The BI system establishes the framework for collaborative decision-making in the conceptual stage, when design alternatives are evaluated and configuration decisions made attending to technical and market requirements.

The paper will explain BI methodology and technologies. The implementation of a BI system will be explained through the development of two competences: component competence and architectural competence. Finally, the most relevant milestones will be exposed regarding the development and implementation of the BI system.

2. BI METHODOLOGY AND TECHNOLOGIES

Several authors (Bernhardt, 1994; Kahaner, 1997) propose an “intelligence cycle,” composed of four stages: (1) Planning & Direction, (2) Collection, (3) Analysis, and (4) Dissemination. In the Planning&Direction stage the BI needs are established. Collection involves the identification of sources of information and also the access and retrieval of information. The Analysis stage is the most value-adding activity of the BI system,

BI is supported by a suitable ICT toolkit. Table 1 shows a classification of different technologies according to Hohhof (2000) and Bouthillier and Shearer (2003).

Table 1 – BI technologies. Source: Hohhof (2000) and Bouthillier and Shearer (2003)

Hohhof	Bouthillier and Shearer
E-mail	Profiling/push technology
Text searching software	Filtering/intelligent agent
Profiling/push technology	Web searching
Filtering/agent technology	Text mining
Groupware	Text summarizing
Document management	Text discovering
Imaging software	Groupware
Analysis-oriented software	Document and content management
Portals	Text analysis and structuring
	Multipurpose portals
	Business intelligence/e-business applications
	Analyzing/reporting data
	Information services/vendors

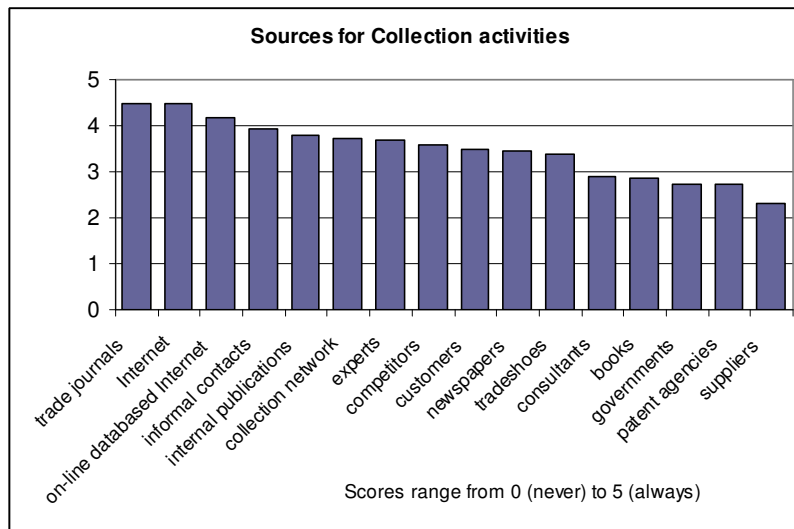


Figure 1 –Sources Used by Large Organizations in The Netherlands for Collection Activities. Source: Lammers and Siegmund (2001)

The most relevant ICT technologies following the stages of the “intelligence cycle” are:

- **Collection:** searchers and metasearchers, intelligent agents, technological alerts, syndication, additional alerts from specialised databases (such as Derwent worldwide patent database) and trade organisations...

- **Analysis:** data miners, text miners, OLAP techniques, data warehouse, summarizers, ontologies, Semantic Web, natural language...
- **Dissemination:** information repositories within I*Net (intranet, extranet), customised portals, electronic bulletins or newsletters, visualisation and monitorisation tools, graphical representation of key evolution metrics.

The first step in the Collection stage involves the identification of information sources. Figure 1 exhibits the nature and frequency of use of several sources, based on Lammers and Siegmund (2001). ICT tools are then used for information capture and retrieval.

Within these ICT tools, Analysis software programs have a substantial gap for improvement, since many of analysis tools only provide visualisation alternatives to collected information (Bouhilier and Jin, 2005). Indeed, analysis is mainly based on human effort, and it is argued that 'it is almost impossible to build intuition into software' (Nikkel, 2003). On the other hand, the value of automatic analysis depends on the technology and industry specialisation (Figure 1). The more specialised (less generic) the technology or industry niches are, the less useful current ICT tools are for analysis.

Accordingly, BI external consultants (without technology know-how) are most valuable when broad and generic BI studies are required, such as the analysis of the whole manufacturing sector, providing generic information from multiple sources. On the other hand, when the BI study area is very focused, topic know-how (component competence) is required, so it is preferable and more valuable that BI be carried out by the company BI team or a third party with technology and industry know-how. Furthermore, external consultants may also support company BI team, providing BI methodology and tools.

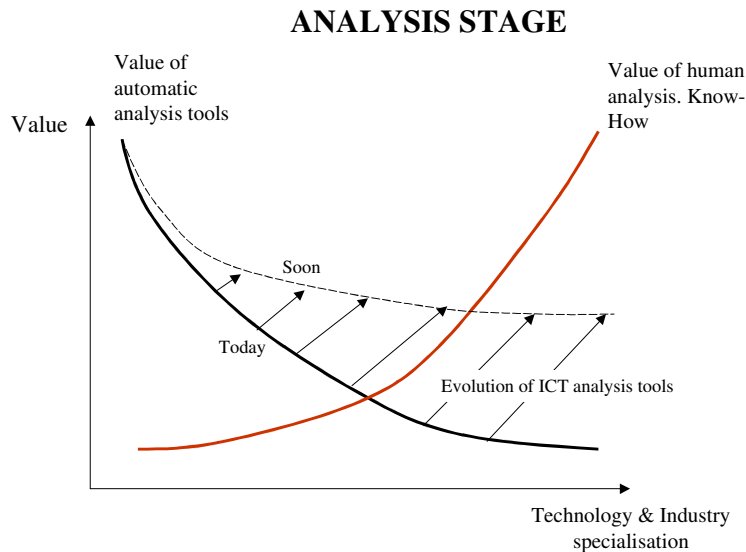


Figure 2 – Analysis stage in BI

Several techniques are usually applied in the Analysis stage (Fleisher & Besoussan), which is the main value-adding stage of BI: Strategic analysis techniques (SWOT, BCG portfolio matrix, value chain analysis), Competitive and Customer analysis (competitor analysis, customer segmentation), Environmental analysis techniques (scenario analysis, macro environmental analysis), Evolutionary analysis (technology life cycle analysis, patent analysis) and Financial analysis techniques. The application of these techniques involves human thinking and reflection, which goes beyond the capability of any software. However, the application of these techniques can be supported by software, involving different levels of intelligence: from simple applications to intelligent software, such as patent analysis software.

BI SOFTWARE TECHNOLOGY ROADMAP

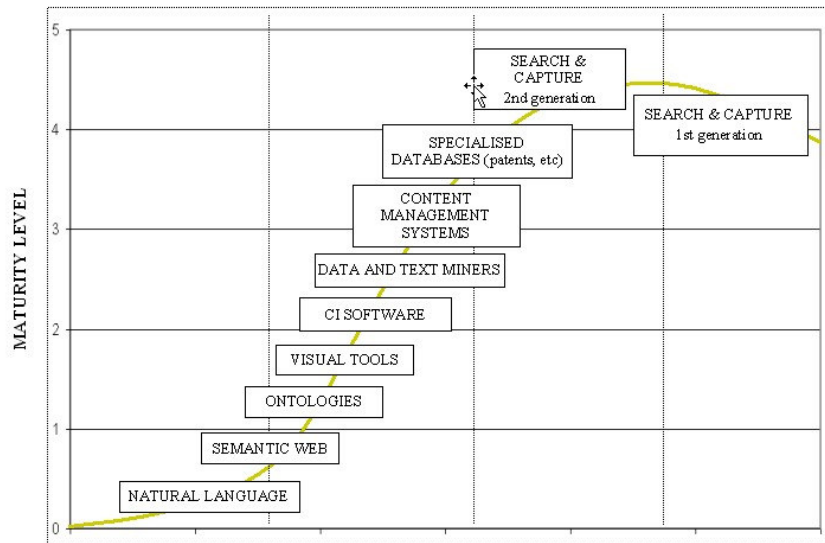


Figure 3 – BI software Technology Roadmap

Figure 3 shows the BI software technology roadmap, which sheds light on ICT development needs for researchers and implementation challenges for companies.

3. BI SYSTEM DEVELOPMENT: ARCHITECTURAL AND COMPONENT COMPETENCES

Based on the resource-based theory (Henderson & Cockburn, 1994), the ability of Business Intelligence to have an effect on performance will depend upon the development of two competences: component competence (resources) and architectural competence (capability) (Hughes, 2005). Architectural competence will be gained through the development of information systems, communication channels and information technologies in order to make the best use of the

information and build competitive products. Component competence is related to the expertise and tacit knowledge, so related work for gaining this competence will be oriented to the adequate identification of knowledge sources (e.g.: technologies and markets) and qualification of people. This section will explain how architectural and component competences have been developed to implement BI within a machine-tool manufacturing group.

3.1. Architectural competence

BI is supported by a suitable ICT toolkit. These tools (meta-searchers, meta-crawlers, data processing tools, web watchers, file repositories, specific-purpose developed software...) are especially useful for the identification, filtering and gathering of information. However, the analysis of information depends heavily on human labour. The machine-tool know-how is wisely applied in this stage.

The main developed information system for communication has been the Business Intelligence Platform (BIP), a Content Management System with the following functionalities (Figure 4):

- Document & Content management,
- Personalised portals attending to user,
- Integration with external systems, allowing searches on own databases (e.g.: patents, catalogues, articles, proceedings, books...),
- Subscription service,
- Event manager & calendar,
- RSS Syndication,
- Administration.

The BI users may get their information in several ways. On the one hand, users can easily access the platform in order to perform specific document searches, get the latest industry news and search databases (e.g.: patents, books, scientific articles...). On the other hand, special templates and procedures have been developed in order to communicate and present the information to the customer. This standardisation of the outcome makes easier for the users to gather and understand the suitable data, establishing some regular information channels: the BI platform, periodic bulletins, periodic face-to-face meetings with BI users, etc.



Figure 4 – Business Intelligence Platform

3.2. Component Competence

BI component competence is gained by the BI service provider through expertise and specialisation in a certain technology, such as turning, milling or grinding. For that purpose, they access state-of-the-art sources regarding specialised journals, patents, trademarks, general business information and publications.

Every BI Project Team is composed of a main skilled engineer and some other novice assistants. Machine tool knowledge (technology and market) and competence are gained among assistants through socialisation and internalisation (Nonaka & Takeuchi, 1995).

The following Business Intelligence Organisational Model (Figure 5) has been established to gather company needs and target BI efforts. The model is based on the close relationship among the BI Project Team (BI service provider) and the Key Company Contact (KCC). Knowledge sharing is two-fold. On the one hand, different BI project teams may enrich from each others' experiences. On the other hand, the information sharing among companies depend on the relationship among them. For example, the sharing of external information among a single industrial group is really valuable, in terms of shared knowledge and economical efficiency.

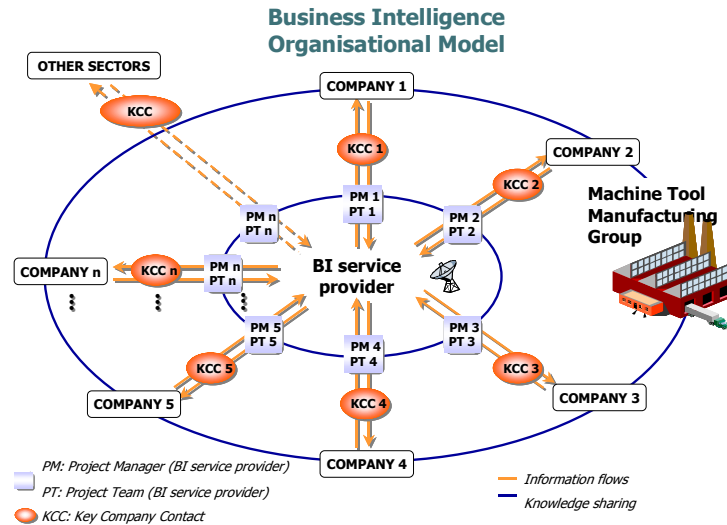


Figure 5: Business Intelligence Organisational Model

4. IMPLEMENTATION

This section summarises the implementation process of BI activities from year 2000 on. It is worth pointing out the broadening in scope of these activities. In the beginning, competitive intelligence was focused on mere analysis of competitors' products. The first important milestone took place in 2002, when it was decided to spread the scope out in order to analyse other competitors' areas, such as their financial situation, market orientation and strategic evolution. This approach would fit within the Competitive Intelligence concept. Finally, from year 2004 on, it can be said that Business Intelligence has been implemented, which considers more information inputs regarding market (geographical and sector), technology trends, and other relevant information for company competitiveness and product strategy.

In the beginning, the use of ICT tools was focused mainly on collection, to be used by BI service provider. The tools for collection have been tuned, through periodical updates to more advanced commercial tools. On the other hand, incremental steps have been taken in order to improve the diffusion of BI. The exposed BI platform is the final result, a Web platform which allows BI users to search and gather information attending to their profile.

The next milestones and research areas in BI will aim to:

- Exploit the capabilities of internal BI, through a deeper analysis of some internal key departments, such as sales, technical office, production and assembly, technical assistance service or purchasing.
- Strengthen the use of software tools in Analysis stage.
- Adapt visual and graphical tools in order to improve diffusion stage, so that decision-makers can have the most relevant information in a user-friendly interface.

- Measure and quantify BI activity, i.e., to set key indicators that should clearly show both the external evolution in market, competitors and technology, as well as the internal evolution in the different departments within the company.

Consistent with the main components of the BI system, the main success factors are (Figure 6):

- Existence of a target sector and activity for BI application. Fluent communication between the BI service provider and the BI user is necessary.
- Establishment of a BI method, both considering the information transformation process and the organisational aspects, such as communication channels.
- Experience and know-how about the technology and market demands.
- Application of ICT technologies for collection, analysis and dissemination activities for BI efficiency.

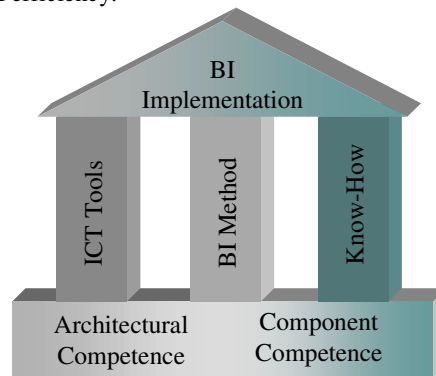


Figure 6 – Pillars for successful BI implementation

4. CONCLUSIONS

This paper has outlined the main elements of a Business Intelligence (BI) system. It enhances the need of such a system in the machine-tool industry and the whole manufacturing industry, characterised by a tight competitive environment. The NPD oriented Business Intelligence system supports decisions made in early design, providing accurate and well-oriented information regarding technological aspects, competitors' evolution, customers and market trends.

The development of the BI system has been explained through the development of two competences: component competence and architectural competence. ICT tools have made available for companies to index, store and spread out plenty of information in several ways. The critical stage between collection and diffusion is the analysis stage. Analysis involves the extraction of valuable information and knowledge from rough data and heterogeneous sources. Even though there are some ICT tools which support human analysis, this stage remains highly manual, where know-how is wisely applied.

Future activities and challenges in Business Intelligence will be oriented to a higher use of ICT analysis tools through text miners and ontologies, visualisation of results and better use of internal information.

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