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Information technology at IKEA: an "open sesame" solution or just another type of facility?

Enrico Baraldi[a,*], Alexandra Waluszewski[b,1]

[a]Department of Business Studies, Uppsala University, Box 513, SE-751 20 Uppsala, Sweden
[b]Department of Business Studies, Uppsala University, Box 513, SE-751 20 Uppsala, Sweden

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Abstract

Information technology and such business applications as IT systems create great expectations to solve most problems a company faces. However, these expectations are seldom fulfilled. This article treats IT and IT systems simply as a facility among many other resources (products, facilities, business units and relationships) in business networks. By making use of a case study centred around Product Information Assistance (PIA), one of IKEA's key IT systems for product information administration, the analytical part extracts a series of interactions patterns between IT facilities and the surrounding resources. Being IT systems also embedded into other resources implies that their effects seldom turn out to be as expected or simply defined by their technical potentials.

Keywords: Information technology; Resources; Business network; IKEA

1. Introduction

Few industrial applications have been enveloped with so many expectations as IT systems have been. The implementation of IT systems is claimed to be the most widely used class of process innovations in the past 40 years (Tidd et al., 2001, p. 267). First, IT is seen as a tool to redesign and sustain more efficient processes (Davenport and Short, 1990). Such IT applications as enterprise resource planning systems (ERPs) are expected to increase efficiency as they "promise the seamless integration of all information flows flowing through a company" (Davenport, 1998). Second, IT promises to improve performance in technological and product development, through project management systems and large-scale computer simulation and modelling. They are expected to speed up development projects and save money in the building and testing of prototypes and pilot plants (Tidd et al., 2001, pp. 113–114). The realm of IT possibilities seems boundless. In the words of Bessant and Buckingham (1993, p. 219), "benefits include dramatically shorter response times, better customer service, materials savings, improved design and quality and the opportunity to introduce new products more frequently".

Such high expectations often lead to disappointment. This seems to be what is happening with IT and its role as facilitator of firms' performances in technological and product development. According to Bessant and Buckingham (1993, p. 219), "...there is a disturbingly high level of dissatisfaction and failure associated with the implementation of CIM (computer integrated manufacturing) and its derivatives". Or, as Tidd et al. (2001, p. 57) put it, "many IT systems, whilst technically capable, fail to contribute to improved performance because of inadequate consideration of current working patterns which they will disrupt, lack of skills development amongst those who will be using them, inadequately specified user needs, and so on."

However, what happens if we change perspective and treat IT systems as just one type of facility among many others? Then, the above citation would become "Many *facilities,* whilst technically capable, fail to contribute to improved performance because of...". Considering IT as just one facility out of many can perhaps offer a greater understanding of the different roles that it can have in technological and product development. Certainly an IT facility can have the role of supporting development pro-

* Corresponding author. Tel.: +46-18-471-14-95.
E-mail addresses: Enrico.Baraldi@fek.uu.se (E. Baraldi), Alexandra.Waluszewski@fek.uu.se (A. Waluszewski).
[1] Tel.: +46-18-471-14-95.

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cesses, if its interaction with other involved resource constellations increases the possibilities to create certain solutions. If not, the IT facility can be useless or, at worst, a hindrance in the development process. Using this as a starting point, this article searches the "because of..." a specific IT system is not fully used and, consequently, does not contribute as expected to a large company's product development efforts. This happens despite our focal company, IKEA, the worldwide leader in furniture retailing, having a reputation of being very skilled in handling these issues.

1.1. An analytical toolbox

To explore how one of IKEA's IT facilities is related to other resources within and outside this company, we used a model developed to map resource interaction in industrial networks (Håkansson and Waluszewski, 2002). The underlying assumption of this toolbox is that the features of resources are developed and embedded into each other through interaction. Through this interaction, a resource is systematically related to a specific set of other resources, hence, certain features emerge and become prominent in each resource. One effect is that the utilisation of a certain resource in connection to some resources will increase, which, then, might decrease the possibility of easily combining it with other different resources.

The focal type of resource in this investigation, a facility, is defined as any equipment used to create or transform products and information. IT systems are, more precisely, facilities that process data by means of complex hardware and software. IT systems manipulate signals and symbols (Winograd and Flores, 1986, pp. 85–90) and produce, by means of internal hierarchical layers of symbols, messages that individuals use as information in making decisions (Simon, 1977, pp. 39–62). According to our analytical toolbox, all types of facilities are seen as involved in interaction processes, something that affects them and embeds their current use in other resources. Interaction processes and embeddedness concern both an *activated* structure, i.e., the connections between different parts of a facility and other resources, and an *idea* structure, i.e., actors' underlying knowledge, ideas and goals on the facility and other resources, which can be much wider and deeper than the currently activated structure. Some features of a focal facility can be discovered, or rediscovered, and brought forward while it interacts with other facilities (Håkansson and Waluszewski, 2002).

Furthermore, this toolbox analyses how facilities are related to three other types of resources involved in technical development processes. The other, mainly physical, resource that interacts with facilities is the product, i.e., any artefact exchanged between economic actors. Products, in the same way as facilities, are seen as a result of interaction processes. The toolbox also includes two types of resources that are mainly social: *business units* and *business relationships*. A business unit is seen as the result of interaction processes, during which, such features as knowledge and the ability to cooperate with different counterparts are embedded. Business relationships connect exchange and interaction episodes, between the buying and selling units, over time. Thus, a relationship connects interaction patterns where the other three types of resources (facilities, products and business units) are involved. Therefore, relationships imply both opportunities and restrictions to the actors involved (ibid).

Considering these assumptions, how much an IT facility can contribute in technological development becomes a question of how much its features can be utilised in such resource combining processes. We will discuss this issue by taking a closer look at one of IKEA's central IT systems called Product Information Assistance (PIA) and its role in a certain product development. The product in focus is one of IKEA's biggest sales successes, the table "Lack". The scope of this study is therefore limited to how PIA is used for development projects, about only one among IKEA's many products. The ambition is not to attain a fully representative picture of the use of IT, in general, and of PIA, in particular, in all IKEA's development work. The way PIA is used in Lack's product development reflects nonetheless the way it is used also for other many product development projects. The following material is based on a total of 34 interviews conducted between March 2001 and February 2002 at IKEA and at all the other firms mentioned in the case study. Informants were PIA users at various IKEA units (product developers, order managers, supply planners, retail store salesmen), IT support personnel at IKEA and, finally, production managers and technicians at the external units involved in the product development. Besides, access to PIA was granted on several occasions. Guided visits to production plants were also arranged. A limitation of this study is that the described product development process was not followed as it unfolded, but in retrospective.

2. IKEA's way of handling product development

The empirical material is organised by first giving a general picture of IKEA and of the business unit in charge of developing Lack (Section 2.1). To illustrate the context for IKEA's product development efforts, the product and its connections to other resources are introduced later (Sections 2.2, 2.3 and 2.4). Next, IKEA's IT system PIA is reviewed (Sections 2.5 and 2.6). Finally, an account is given of how concretely PIA is used in a specific Lack project (Sections 2.7 and 2.8).

2.1. IKEA of Sweden

IKEA manages a worldwide organisation of 65 000 employees, more than 550 directly controlled business units and 165 retail outlets. In 2000, sales reached 80 billion SEK through a product range including 12 000 product items. Developing, producing and distributing all these products with the necessary precision and timeliness implies that IKEA has to collect, process and disseminate a vast amount of information. Considering this, it is easy to understand IKEA's desire to use IT systems to facilitate activities ranging from order management to product development.

The IKEA of Sweden (IKEA-oS) is a central business unit in IKEA's universe that is responsible for designing, developing, procuring and preparing all products for distribution. As a production-lead retailer, IKEA does not simply buy what is available in the suppliers' inventory or design a product just to be produced by an external production facility. IKEA's products are developed and designed for manufacturing, logistics, warehousing and retail exhibition. Thus, IKEA-oS is required to orchestrate the whole system of internal and external resources that interact behind each product. To perform product development, IKEA-oS is obliged to integrate many more competences and activities than simply creation and design; hence, it is a large organization with more than 600 employees.

IKEA-oS created Lack in the late 1970s and is still involved in its continuous development. Because Lack is currently produced in Poland, IKEA-oS procures it by interacting with IKEA's Polish purchase office, while it is produced in a facility owned by Swedwood, IKEA's production arm. Physical distribution is handled between the Polish supplier and IKEA's 25 distribution centres (DCs) that store Lack and deliver it to IKEA's local retail stores.

2.2. Lack: a product under constant development

Lack is both a simple sofa table and a series of shelves. The table version is one of IKEA's best sellers. Approximately 2.5 million pieces are sold annually worldwide. The key design feature of today's Lack table is the unusually thick flat surface and the fact that the table legs have the same thickness as the flat surface does. The original and basic Lack table, squared and laminated, is sold in Sweden for a retail price of 99 SEK. Actually, Lack's price was designed before the product was ready, i.e., already at the idea and project definition stage. In this way, Lack has been treated as a typical IKEA project: A project group was appointed to develop the product project and idea. The price issue is an important part of Lack's development. First, it is used to give the product its identity. Second, a final price fixed at 99 SEK strongly influences which resources can be combined and how, to transform each new idea about Lack into a physical solution.

In the early 1980s, IKEA-oS decided that Lack should become the table produced and distributed at a cost allowing a price that no competitor could ever beat. Moreover, its price should remain as constant as possible in the years to come. The target production cost and the retail price set at 99 SEK appeared, at first, unrealistic and impossible to attain and maintain. Nevertheless, today, 20 years later, it can be said that IKEA actually managed to do it. The price for Lack's basic version has been kept constant or even reduced occasionally.

How can the miracle behind Lack's constant price over 20 years—a period during which prices for several kinds of input materials increased significantly—be explained? If IKEA-oS had treated Lack as a given product, a constant price over 20 years would certainly have been something extraordinary. However, continuous development work at IKEA-oS made the difference. This work can be characterised as a continuous struggle to combine and recombine different internal and external resources, which together can create the appearance of a Lack table. Thus, IKEA-oS is engaged in creating a product that, to the naked eye, looks like this table always has, but which, under the surface, from year to year, can be the result of different resource combinations.

For the last 10 years, Lack has been produced with a technique called "board-on-frame". This production technique allows IKEA to make very strong and resistant furniture that is simultaneously low weight because it is mostly empty inside and built on "honeycomb" paper structures. A typical Lack table includes veneers, chipboards, honeycomb paper, high-density fibreboard (HDF) and lacquers. Some of these materials are transformed into the table's legs, while others into the table surface. Lack has been produced, for the last 10 years, in three Swedwood plants located in Poland. They account for 100% of this product's worldwide sales. These three business units perform the following activities: (1) production of table legs, (2) filling the chipboard-made surface frame with honeycomb paper, (3) covering and gluing of the filled frame with HDF, (4) all surface treatment, (5) packaging and (6) storing.

2.3. Technological development around lack

The technological development of IKEA-oS can be characterised as a combination process that includes parallel creation of new and demolition of old resource constellations. This endeavour includes price, costs, quality, design and technology issues. Furthermore, these issues are often tightly connected, as illustrated by a recent technical project aimed at substituting veneers with printed surfaces.

The project was carried out to eliminate the most expensive input in the veneered and lacquered version of Lack. To achieve the potential cost reduction of eliminating veneers, it was necessary to create new combinations, both in terms of products and production facilities. For example, products like lacquers were specially developed in cooperation with Akzo–Nobel and Becker–Acroma. The production facility was complemented with special surface treatment lines. Similar examples of production processes development at the three Polish Swedwood plants can be traced back to the emergence of the Lack concept. When the board-on-frame technique was first applied to Lack tables (in the end of the 1980s), it immediately became apparent that it could not be used to produce its legs. IKEA-oS worked toward finding an equally economical solution for Lack's legs. IKEA's experts launched a specific project involving technicians from Swedwood and Wicoma, a small machine supplier located just a few meters away from the Polish units. The result was a special production line, based on particular production facilities that were able to mill and bend very thin HDF boards into the external leg structures and to fill them with chipboards placed a few centimeters apart. Thus, the basic idea of "air-filled" furniture could also be kept for Lack's legs, with all the related cost advantages.

To keep a product like Lack's price and visible identity constant, IKEA-oS is bound to go on experimenting with combining and recombining resources. In this way, IKEA's is a "never ending story". Any new solution, no matter how beneficial it may appear at any time, must be treated as just a temporary one. Fig. 1 presents a few of the resources that are usually involved in these combination endeavours. The resource items in Fig. 1 are categorised according to our analytical toolbox (see Section 1.1) into products, facilities, business units and relationships. The dotted arrows indicate Lack's logistic flow. The solid lines indicate how IKEA-oS interacts with other units during development projects. Along with manufacturing machines, other facilities are also involved with Lack, such as transportation equipment and warehousing facilities, at DCs and at retail stores.

The development efforts of the resources of IKEA-oS, in Fig. 1, are reflected in its internal organization. Product developers at IKEA-oS play a central role in this process, being in charge of initiating and managing all Lack development projects. They are assisted in their work by product supports. Product development teams also include technical specialists, contributing their expertise in material and production technology (e.g., how to handle and develop suppliers' production facilities and materials). ISTRAs, i.e., purchase strategists, handle contacts with IKEA's local purchase offices and specific suppliers.

2.4. Possibilities and restrictions in development work

IKEA usually handles development projects such as Lack by restricting them to the "resource network" directly related to the production sites. It is these resources that are considered as *nongiven*. Restrictions and possibilities created for Lack by other resources are nonetheless considered. But these other resources are treated as *given*, rather than changeable resources that can be adapted to Lack. For example, in developing the Lack table, IKEA-oS product developers take into account the whole IKEA system, as they call it, which stretches from raw materials to consumers' homes and includes a series of connected value-creating activities and resources. DCs, transportation equipment, local sales organisations and specific retail stores are thus always explicitly considered. However, with 12 000 items to handle, this larger resource constellation is adapted to the product assortment as a whole—not to the demands of a single product.

2.5. IKEA's IT system PIA: a facility for product development

IKEA also expects its IT systems to offer support for development projects that require large amounts of information and data to be collected, processed and diffused both inside and outside the organisation. During such projects,

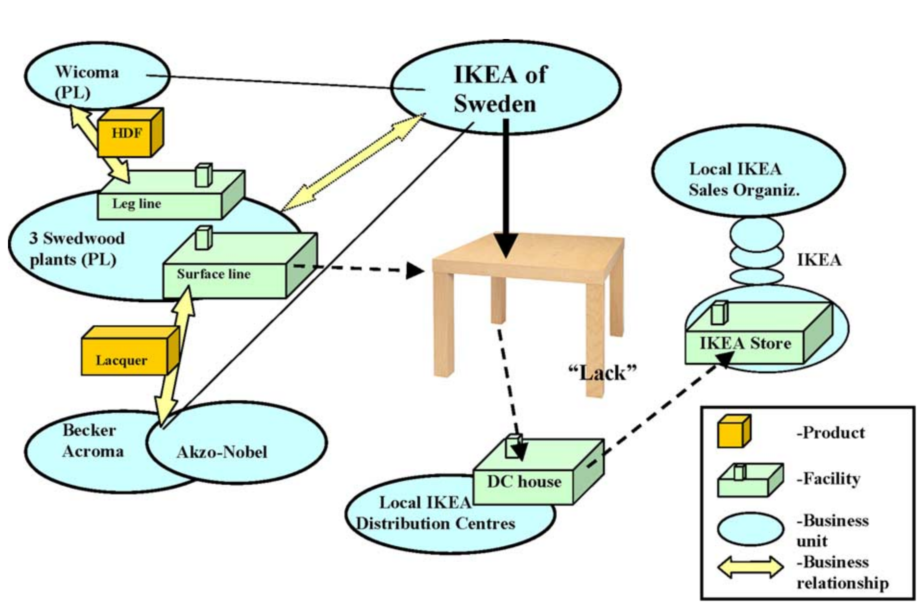

Fig. 1. The resource network involved in Lack's development.

information is extracted by the product developers of IKEA-oS and is exchanged with both internal and external units.

Among IKEA's many IT systems, PIA is particularly relevant for development activities. The four central functions of this information facility are:

1. administration of product information,
2. administration of product documentation,
3. administration of the product range structure and
4. administration of development projects.

From a technical point of view, PIA is composed of a series of databases, a graphic user interface (GUI) and a series of applications that allow calculations and other operations on the input data. This production facility is made of various databases that are both internally connected, inside PIA, and externally connected to other IKEA databases and IT systems (IKEA's Website, IKEA's Intranet, the "Pricetag" retail system, etc.).

When PIA was introduced in 1998, it was meant to take a central role in the management of relevant product-related information, from supplying units to components, from technical descriptions (TEDs) to prices, from measures to materials, from photo-pictures to product drawings. As a consequence, PIA is the central source from which a number of information bearers (some of which are directly attached to products) can be generated: price tags, product descriptions, label drawings, the IKEA catalogue and IKEA's pricelists. Making PIA into a key information source for a number of business units, both inside and outside IKEA, such issues as how input is created and under whose responsibility became crucial. To handle them, IKEA has specified a series of routines that require product developers to provide PIA with input data.

Product developers and their project teams can therefore be considered as central in the provider–user interface of PIA. They not only provide the IT facility with input data, but they are also expected to be the main users of the outcome, the processed data, during their development assignments. A wealth of other "passive users" (up to all of IKEA's 65 000 employees) can also access the system via IKEA's Intranet interface to PIA. Passive users (including all visitors to IKEA's Website) can access different levels of PIA's databases, via other connected IT systems, to either simply browse for information or create specific documents (e.g., internal reports, price tags, TEDs and supplier indexes). Individuals outside IKEA are not granted direct access to PIA-borne information.

2.6. PIA as a tool for managing development projects

The fourth PIA function, administration of development projects, clearly indicates its role in the management of development projects, i.e., of how resources are combined and recombined. Interacting with PIA is considered the most information-rich task that project developers are required to perform during development projects. Every development project that is launched at IKEA-oS is supposed to be registered, "inscribed" and constantly updated into PIA. For this purpose, PIA literally mimics a product development guide that IKEA-oS introduced in 1994 as a template to sustain project planning and management. In fact, PIA includes a particular series of applications and databases that represent the seven milestones in this project guide:

1. *Project assignment* to a specific product developer and his project team, who set broad requirements and specifications for the project to be translated into a product prototype.
2. *Presentation to the product council* who assesses the match with the original project goals, e.g., economic calculations and required investments in production facilities.
3. *First buy* requiring (1) technical specifications for the involved suppliers, (2) complete product information for consumers and (3) detailed forecasts of local markets' expected needs.
4. *Contract review* with supplying units to formalise, among other issues, technical requirements into documents called TEDs.
5. *News* about the developed product is produced and communicated to all of IKEA's retail stores before they can place any order. This must happen six weeks before product launch.
6. *Sale start* after orders from retail stores have been collected and fulfilled.
7. *Follow-up* on the new or improved product in retailing, distribution and production.

The administration of development projects is done by input and retrieval of data in a series of "flaps" inside PIA that resemble a paper archive. A "planning" flap prompts product developers to input the detailed time planning of each project, including all the scheduled activities (to be selected from a menu of 160 items). Product developers are also expected to input data about the project team composition, the expected costs and sale price for the project object, explicit strategic goals and the distribution aspects for the project. The level of detail of the data increases as one compiles the flaps of PIA dedicated to the "item level", where the specific article number (e.g., for Lack 55×55 cm, veneered in birch), each single component, machine and tool involved must be specified. At the item level of PIA, TEDs, a very important documentation, are created. The amount of information that is supposed to be fed into PIA for each development project is overwhelming. Product developers are responsible for the information that is to be found inside PIA, but they are not alone in the task of "feeding the system". Other IKEA-oS specialists intervene in development projects, and their role is also supposed to be mirrored by PIA and by routines that make them responsible for filling in specific flaps of this IT-system.

For instance, technical specialists are required to compile TEDs, while ISTRAs are responsible to input "cost/price" and "supplier" information into PIA.

The objective with PIA is to create a rudimentary communication facility that allows coordination between actors participating in development projects. There are also a great variety of individuals who simultaneously use PIA, either while inputting data in the various project-related flaps or while retrieving information from PIA or other connected IT systems. Thus, PIA produces and spreads a wealth of information about products that becomes highly relevant for many more individuals in the rest of the IKEA organization, all the way to retail stores (as implied by the administration of product information and documentation functions attributed to PIA). News, TEDs and all information bearers at the store level (such as price tags and assembly instructions) depend on the regular and precise inclusion of data into PIA by product developers and other actors at IKEA-oS. However, most of the interaction between the individuals involved in development projects happens outside the PIA system through face-to-face meetings, discussions, etc. To illustrate the difference between the objective behind PIA and how it is actually used by product developers, we will take a closer look at a specific development project.

2.7. Using PIA in product development projects: the "printed veneer" example

In 1999, IKEA-oS started a large and extensive project addressing the problem of veneers in Lack. In veneered versions of both tables and shelves, veneers account for almost one third of total costs. No wonder, then, that a large cost reduction could be obtained by eliminating them. IKEA wanted though to offer consumers the "veneer feeling" with comparably good aesthetic results. Consultations between technologists from IKEA-oS, production managers at the Polish plants and suppliers of varnishing lines and lacquers directed the attention of the product developers to a new technique. This new technique would allow them to eliminate *real* veneer and substitute a *printed* veneer obtained by impressing an artificial veneer profile on the table surface.

A project was then launched to introduce this new process technology in Swedwood's Polish units. The production facilities that were installed and tested are completely different from traditional lacquering lines: Printed veneer is obtained in a process similar with offset printing, performed in production facilities that resemble printing presses. Lacquering technology suppliers such as Becker–Acroma and, especially, Akzo–Nobel were directly involved in the development work from the very beginning, including the many tests performed at Swedwood production plants. After two years of development work, the production system succeeded in printing a veneer-like film directly on HDF surfaces that gave substantially the same aesthetic result as real veneer does. The first products with printed veneers were then launched.

What role did the PIA system play in the printed veneer project? IKEA's product development guide, on which PIA's project management function is based, explicitly prompts product developers to begin a project by setting requirements and specifications for technical variables and specific goals for economical variables about the products to be developed. But in the printed veneer project, many specifications and requirements were still highly unclear in the advanced phases of the project because tests were still being performed. Not even the project's original idea and specifications are attributable exclusively to IKEA-oS. They emerged from interaction between specialists representing at least six different business units and several different resource constellations: IKEA-oS, Swedwood, Akzo–Nobel, Becker–Acroma, lacquering lines suppliers and IKEA's Polish purchase office.

Later on, key decisions during the project were not made individually by Lack product developers but were the result of a high degree of collegiality. Participation of all the above individuals was necessary to bring different capabilities and resources together for each new solution. The printed veneer project witnessed fully negotiated technical specifications and choices of applicable solutions. These were frozen on paper only when all the involved actors agreed on them and on their respective roles in their accomplishment. Much later in the project, they were provided to PIA. The product developer's ability to directly control this process was explicitly recognised as limited, especially when units outside IKEA were involved. Control was even limited in the original choice of cooperative partners: Akzo–Nobel and Becker–Acroma were constantly present in a wide range of parallel and nonformalised development projects. The Polish Swedwood units had produced Lack for over 10 years, thus, these business units are almost mandatory choices for Lack-related development projects. Despite limited control by IKEA-oS, a satisfactory solution to the original problem was identified and introduced.

With just a general idea for the project, the product developer and the others involved in the project were challenged to further reduce the production costs for Lack so the constant price miracle could continue. Moreover, all the individuals taking part in this Lack project (ISTRAs, technicians and product developers, designers, production specialists, machine and lacquer experts) regularly met face-to-face to jointly find a solution to the problem of keeping down production costs. According to the IKEA style, these meetings were held on the shop floor, where all the various people's different competencies and experiences could also be directly tested.

2.8. The different logic behind PIA and "real" development projects

When the project management guide was adapted to the contingencies faced during creation and implementation of the printed veneer project, it no longer corresponded to the utilisation pattern built into the PIA system. Instead of using PIA as an active support in the development work, product developers postponed interaction with the IT systems' project management function as much as possible. The product developers used PIA only in the late stages, when they were obliged to "input", in very concrete and detailed terms, the results of the project into the system. These results must be stated in very concrete and detailed terms because the modification of the underlying production technology for Lack, like printed veneer, must be formalised into the IT systems. In turn, this type of formalisation is imposed by the institution of routines for creating documents that must be detailed, unequivocal and even binding for the supplier, IKEA-oS and IKEA's retailing organisation.

The two most important documents that must be created are TEDs and *news*, which are generated by the retail-oriented part of PIA and transmitted to IKEA's retailing organization. The moment in a project when these two documents must appear in PIA is connected to Milestones 4 (contract review) and 5 (news) in the project guide reviewed in Section 2.6. This gives product developers plenty of time to avoid PIA, but eventually, they must face this IT system. Before launching the modified product it is necessary (1) to have perfectly defined TEDs that will bind suppliers and (2) to inform retail stores about the modified product by means of the PIA-based internal *news* system. Without *news*, nothing can be officially and concretely sold to retail stores, and the project would come to a halt. TEDs have also a sort of higher order responsibility because they offer the informational support on which the *news* about the new or modified product is generated.

Such an arrangement of TEDs and *news* requires product developers to compile PIA's various flaps. But do they really perform this duty? Product developers are usually too busy working on the project: Their task is actually *managing* the project, which requires for them to meet the network, as highlighted above. If they want their projects to progress, they need to closely interact with those actors that represent the many resources involved in such a development project as printed veneer. The natural result is that they seldom have time available to sit in front of a computer screen and input data into PIA, hence, they delegate the task of feeding PIA with information to product supports.

Product developers and all the other actors concretely involved in the project have nonetheless already made an important contribution to the freezing and formalisation of the information that will later be fed into PIA. TEDs may well have appeared for the first time in PIA just a few weeks before launching, but they were discussed for a long time and later agreed upon by the many involved actors. Product developers knew about the agreed upon technical specifications and requirements well in advance of their inclusion into the PIA system. The duty of including them into formalised TEDs appearing in PIA is attributed to technical specialists. When they approach PIA's item flaps, they simply feed the results of a wealth of actions into the IT system: tests, trials, errors and decisions that were made during the whole project by a variety of actors.

To summarise, IKEA-oS personnel involved in product development interact quite sparingly with PIA during a project's unfolding. Product developers substantially avoid PIA until they must produce the documents required for them to launch production and sales related to their projects. At that stage, the more detailed item flaps must be filled in, which is done both by technical specialists and product supports. For instance, in the printed veneer project, product developers and technical specialists did not interact with PIA for more than a year from the project's start. Thus, product developers at IKEA-oS consider PIA more of a restraining and superfluous factor than an enabler of creativity and new ideas. This attitude can be understood by considering the nature of their tasks, i.e., managing projects by travelling and meeting all the involved actors face-to-face, often on the shop floor. They feel that this concrete type of solution enormously speeds up project execution and is directly connected to project results, while feeding PIA certainly does not.

3. Case analysis: PIA, a network-embedded or disembedded IT facility?

In the words of (Tidd et al., 2001, pp. 113–115) IKEA is a typical example of "information-intensive" technological trajectory. In fact, IKEA is populated by many company-wide IT systems that vary in function and extension. The underlying logic is that these IT systems should be able to track data and information on all the central processes and activities that involve both internal and external resources in the IKEA system (Section 2.4), from development to production, from transportation to warehousing, from ordering to retailing. PIA has a central role in IKEA's IT infrastructure (Ciborra and Hanseth, 1998) but, quite surprisingly, IKEA's product developers use PIA only sparingly for the most important of their tasks, i.e., to set into motion and manage specific development projects.

Let us now try to analyse why IKEA's central IT system for product management is so underused in product development work. In the empirical account, we reviewed *how* PIA is actually used, by *whom* and *when*, during product development projects. By applying our analytical toolbox presented in Section 1.1, we can now identify which factors hinder PIA's full use in product development. Rather than merely questioning PIA's internal technical functionality, we take into account the resource network, both *inside* and especially *outside* IKEA, where product development unfolds and where the PIA system is used. How can we make sense of PIA's pattern of utilisation and only marginal contribution to development projects? Let us try to do it by highlighting how the facility PIA is embedded (or possibly disembedded) in the network of resources where it is supposed to stimulate, facilitate or speed up development.

Which possibilities and limitations for PIA are derived from its direct and indirect connections, from close or distant and active or passive users, from conflicting and sustaining functions attributed to this facility? In pointing at these possibilities and limitations, we should not however forget that PIA is constantly evolving, hence, its features and patterns of use are likely to change in the near future. Moreover, there was no possibility to follow actively and directly how PIA is used throughout a whole development project. This analysis suffers, therefore, from a retrospective and time-compression bias.

3.1. The interaction between IT systems and resources in business networks

IT facilities have had an important role in the development of new solutions in such areas as the graphic and printing industry, biotechnology, bio-informatics, etc. In these areas, the IT system features are exploited and embedded in a favourable way in other resources, each one somehow using IT. To understand PIA's role in IKEA's product development work, we have to consider the types of interactions between this IT system and the other resources we encountered in Section 2. Before doing this, we must introduce a general categorisation of how an IT system can interact with the other four resource items populating business networks, i.e., products, facilities, business units and relationships (Håkansson and Waluszewski, 2002). Interact means how an IT system is combined with, thereby (positively or negatively) affecting and being affected by, other resources. Which features and functions of the IT system are then used or unused, and, reciprocally, which features and functions of the other resources does the IT system stimulate to be used or unused (or even blocked)?

The potential features and functions of an IT system are suggested by the disciplines and practices of Informatics and Computer Sciences (for a general review, see Bocij et al., 1999). But, of course, unexpected features and functions can emerge when the IT system interacts with other resources located in the business network context (Håkansson and Snehota, 1995), and, therefore, outside the restricted domains of Informatics and Computer Sciences. IT systems are facilities that perform data processing to provide meaningful information to actors. The technical solutions used include hardware, i.e., physical equipment, and software, i.e., programs and data repositories. IT and its various applications are used to generate and manage information for users, who need information to make a wide range of decisions (Simon, 1977). This is also recognised in the concept of "information systems", introduced in the 1960s by Langefors (1973, 1995). A business network analysis of an IT system usually reveals that there are many more users than the intended and explicitly recognised ones, where some are direct users, while others use the system-borne information only indirectly, some are active users, involved also in inputting data into the system, while others are only passive users. Usually, they are all spread across many business units and will express highly differentiated and, often, unexpected information needs.

By bringing together a few basic insights from Informatics and our analytical toolbox inspired by studies on business networks, we identified the following eight interaction patterns between an IT system and the resources surrounding it:

1. All IT systems somehow represent resources (Winograd and Flores, 1986, p. 89). In the case of business units, representing also includes simply mimicking their behaviour by means of procedures and routines (Nelson and Winter, 1982, p. 97) inscribed into IT systems. These IT-based representations of resources can become relevant for the IT system users for such purposes as decision making or learning.
2. Some IT systems can be a precondition for a particular behaviour of a business unit. This is the case with IT systems that are the only available tool to perform certain routines and procedures at a business unit, such as ordering, production planning and document generation.
3. IT systems automatically monitor (i.e., passively control) and emit signals about products, facilities, business units and relationships.
4. Most IT systems make calculations about products, facilities, units and relationships.
5. Some IT systems directly steer the operations of computerised production facilities.
6. IT systems can offer a bridge for information and data flows between units and between other IT systems, even if they were not originally conceived as "communication tools".
7. IT systems require data input from a business unit that codifies relevant information, or from another IT system. In addition, data input from other IT systems usually imply codification of information and time-consuming manual feeding performed elsewhere.
8. IT systems offer some form of data output to a business unit or to another IT system, thereby offering valuable information or a necessary input for their further activities (decision making, immediate automatic operations or human action etc.).

Because of the possible emergence of unexpected features and functions, the above list of interaction patterns between IT systems and other types of resources in business networks is just provisional, but it offers basic guidelines to frame how IT interacts with other resources.

3.2. Interaction patterns between PIA and the surrounding resources

Let us now identify how PIA interacts with the other resources presented in the IKEA case, according to the above eight patterns of interaction. PIA interactions are structured around the four resource items in the analytical toolbox presented in Section 1.1: (a) products, (b) facilities, (c) business units and (d) relationships:

(a) *PIA products*: PIA simply represents products (Point 1 above), but does not monitor, make calculations or directly steer them. Thus PIA, in itself is not a fundamental resource for the emergence of products, such as the table Lack, and for their subsequent development.

(b) *PIA facilities*: PIA simply represents production facilities (Point 1 above) but does not monitor, make calculations about or directly steer them. PIA has connections to other IT facilities, such as IKEA Intranet, IKEA Internet, the P-tag system (Point 6 above). Moreover, PIA offers important data output for these other IT systems (Point 7 above). Hence, PIA is an important resource only for a restricted group of other IKEA IT facilities.

(c.1) *PIA–IKEA-oS*: PIA simply mimics (Point 1 above) the behaviour and routines of the unit IKEA-oS, such as the product development guide. Only PIA-based *news* is a precondition (Point 2 above) for launching products to retail stores. Here, a stronger embedding factor for PIA in the business unit IKEA-oS can be seen. Only for this specific task does PIA become a very important tool for the focal business unit. PIA also requires data input from IKEA-oS' personnel (Point 7 above). But, in turn, PIA does not offer much useful data output to IKEA-oS product developers, at least not for conducting development projects (Point 8 above). PIA is much more dependent on the IKEA-oS unit than vice versa.

(c.2) *PIA–other IKEA business units*: retail units use PIA-borne TEDs and *news* to obtain information about the products they are about to order or are already selling (Points 6 and 8 above). PIA is also, indirectly, a precondition (Point 2 above) for producing point-of-sale information material, such as store displays, price tags, via the P-tag system. Updated and clear information material is fundamental to guide customers through retail stores and enable the IKEA self-service concept. Thanks to PIA and the way it is embedded in other resources, IKEA-oS product developers and technicians participate, thus, to producing sales material and information for points of sales. IN addition, the IKEA catalogue is produced by using PIA-based information. PIA is therefore important for these units, who use it passively but are not essential for its functioning.

(c.3) *PIA–external business units*: the interaction pattern between PIA and units outside IKEA does not even provide "representations" (Point 1 above), but is limited to mentioning the names of relevant suppliers, such as Becker–Acroma, Akzo–Nobel and Swedwood. PIA does not address the information flows towards these suppliers (Point 6 above). For these units, PIA is thus absolutely unimportant. Instead, it can be argued that, as highly knowledgeable active users, these units could supply relevant technical information to PIA.

(d) *PIA relationships*: PIA reports contracts to suppliers, with reference only to technical specifications, but this does not even qualify for representing these relationships. PIA and IKEA's business relationships do not affect each other on any substantial dimension.

Where do the aforementioned interaction patterns between PIA and the surrounding resources lead, in terms of how PIA is used and of the related outcomes? The way PIA interacts and is embedded implies that PIA is *used by* and *useful for* a limited set of resources in the surrounding network. This situation is to be related to the overwhelming burden of compiling project-related data into the PIA system. IKEA-oS product developers gain only mere representations of resources (Point 1 in Section 3.1) from time-consuming data input. Moreover, these representations are not useful for IKEA-oS because relevant product development decisions are taken outside PIA, without the support of its information. These representations become useful for sales material at retail units and for the product launch routine, involving IKEA-oS and the retail units. That is where it makes sense to fill data into PIA, not during product development, where PIA does not add any value to the involved resources. The important contribution to product development from other business units, such as lacquering technology suppliers, has been pointed out in Section 2, but they are only mentioned in PIA. These external units, given their extensive technical knowledge, could be very important active users and feeders of the PIA system for technical issues, but they are not interacting with it. No wonder that, instead of an active management tool PIA, remains, for development projects, simply an ex post "document administration system".

For product development, PIA is certainly not an enabling factor but, at most, a neutral resource. No substantial improvements in speed or commercial and economic success for development projects can be attributed to PIA's project management function because these outcomes depend on much wider dynamics in IKEA's whole business network (Håkansson, 1987; Håkansson and Lundgren, 1995). Rather, we can point out that *routinisation* and *tight control*, ensuing from absolute respect of PIA's requirements, can have harmful effects on IKEA development projects' flexibility and creativity.

The goals of IKEA-oS in using PIA are also changing accordingly. Using PIA as a complete tool to comprehensively manage every development project showed its substantial rigidity and insufficient anchoring in the context where product development unfolds. From 2002, IKEA-oS will apply a different approach to PIA: its central role will be as a document administrator. To have product developers use PIA more actively during projects, the burden of sheer data feeding is being reduced. Product developers will no longer have to inscribe all the hundreds of projects and subprojects they simultaneously manage and each single detail about them inside PIA. Until now, the risk was that for each innovative idea, PIA required a formal project to be launched and registered. This is a burden rather than an enabler for innovation.

4. Conclusion

The possibilities of IT systems highlighted in the Introduction are nonetheless still there. The implicit goal with this article was to bring IT somehow ''down to earth'', but certainly not to deny the possibilities these types of solutions can offer. It cannot, however, be forgotten that there is also a huge difference between having possibilities and delivering the expected outcomes. Calls such as ''the new Intranet enables information sharing 10 times faster'' do not mean that information sharing actually became 10 times faster, as often is implicitly assumed in such statements. That information is actually shared 10 times faster depends on much more than just the new Intranet. This new solution simply removed one of the many limits to how fast information can be shared, but it usually cannot actively do much to speed information sharing. This article attacked the deterministic position that it is possible to forecast that state-of-the-art information technologies necessarily lead to positive outcomes or, generally speaking, to the expected outcomes.

IT solutions, even those with excellent technical and functional features, are therefore not panaceas. This also holds true when personnel's competence and commitment to the new technology supports them. Accusing technology itself of being incomplete or ''innocent'' users of being incompetent or of lacking motivation in using it still misses the point. Wider factors, both technological and social that embed IT, must be accounted for on a case-by-case basis. While enormous possibilities are still there, they are often not fully exploited. As we saw in the IKEA and PIA cases, given the context where IT is embedded, these possibilities are not easy at all to exploit. How they will, if ever, be exploited is also very difficult to say. Gadde (1997) also points to the difficulty in estimating the way IT will be used, as soon as a business network perspective is assumed. In this citation from *Business Week* praising collaboration software on the Net: ''*If* this stuff delivers to *its promise*, it *could* help drive productivity growth for years'' (Keenan and Ante, 2002). The stress should be on both the *if* and the *could*, but, unfortunately, so far, most scientific and business press publications have stressed too much ''its promise'', which has certainly not helped an objective evaluation of IT and, ultimately, not even its reputation.

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