

Association for Information Systems AIS Electronic Library (AISeL)

AMCIS 2009 Proceedings

Americas Conference on Information Systems
(AMCIS)

2009

Logistics Projects: How to Assess the Right System? The Case of RFID Solutions in Healthcare

Yannick Meiller

NOVAPTEN, yannick.miller@novapten.com

Sylvain Bureau

ESCP Europe, sylvain.bureau@escp-eap.net

Follow this and additional works at: <http://aisel.aisnet.org/amcis2009>

Recommended Citation

Meiller, Yannick and Bureau, Sylvain, "Logistics Projects: How to Assess the Right System? The Case of RFID Solutions in Healthcare" (2009). *AMCIS 2009 Proceedings*. 547.
<http://aisel.aisnet.org/amcis2009/547>

This material is brought to you by the Americas Conference on Information Systems (AMCIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in AMCIS 2009 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

Logistics Projects: How to assess the Right System?

The Case of RFID Solutions in Healthcare

Yannick Meiller

CEO

NOVAPTEN

14 rue Charles V

75004 Paris, France

yannick.meiller@novapten.com

Sylvain Bureau

Assistant Professor

Dpt. of Information Technology and Modelling

ESCP Europe

79, avenue de la République

75011 Paris, France

Sylvain.Bureau@escp-eap.net

Affiliate Professor

Dpt. of Information Technology and Modelling

ESCP Europe

Associate Researcher

Management Research Center

Ecole polytechnique, France

ABSTRACT

RFID is very promising for the healthcare industry. However, RFID solutions and contexts of use vary a lot from one place to another and as a consequence its impact on performance can vary as well. Moreover, it can be complex to assess its potential benefits relatively to other solutions before its implementation.

We analyze a real project which gathers 18 partners working together to implement RFID solutions and/or datamatrix in health related processes in hospitals. We show the complexity of assessing such a project: diversity of the domains involved, interdependencies between them and impact of representation of the project on its assessment. Instead of providing an evaluation tool ready to use, we suggest a meta-evaluation tool which determines what the appropriate scope and abstraction level are to represent and grasp what has to be assessed. Practitioners could then use it to design their own customized evaluation tool on the field.

Keywords

IT adoption, RFID, meta-evaluation tool, assessment, healthcare

INTRODUCTION

Many RFID specialists claim that this technology can enable healthcare to overcome existing technological and workflow limitations (Corea, Gil and Redin 2007). Among other advantages, RFID should “reduce drastically or entirely eliminate the time the nurses spend on non-patient care, to ensure correct materials are ordered by the procurement department, and to reduce storage, transport, and support costs” (Myerson 2007). But these results could vary on the field depending on several contingencies (size of the hospital, age of the information systems, type of applications...). Moreover, benefits might not be the same for the different stakeholders (patients, medical professionals, IT companies, pharmaceutical industry...) involved in an RFID project. As for other supply chain projects involving RFID, assessment – including beforehand assessment – is important. If RFID solutions could enable a better information visibility to improve the supply chain management (Zhou 2009), information needs also to be gathered to evaluate the potential benefits of an RFID project. The problem is that many analyses are focused on one single dimension of the issue: technical, managerial, economical, or legal. Moreover, the evaluation tools used do not always take into account the specificities of the situation on the field. Eventually, it does not consider the various stakeholders involved in a project and does not evaluate the sharing of the value created by this kind of projects.

In this paper, we address these issues by analyzing a major project – labeled DTC – partly funded by the French ministry of economy. Eighteen partners (hospitals, industrials, scientific research institutions) have joined this project to develop various experiments which consist in the use of different electronic tracking systems in hospital. The applications enable the tracking of three types of devices and containers:

1. bottles of medical gases (such as oxygen for instance);
2. surgical instruments (especially during their sterilization);
3. ancillaries (set of instruments necessary to implant or extract a prosthesis).

Setting up a project with 18 partners and public funding required beforehand assessment taking into account the specific decision criteria of each potential partner. Assessing such a project is a complex task. We show that the choice of the project description, the choice of the variables and of others elements have a strong impact on the results of the assessment and are not straightforward.

Our paper proceeds as follows: firstly, we describe the project, secondly, we show that its assessment involves elements which are very diverse. With three examples, we highlight dependencies between elements and the impact of the representation of the project on its assessment. Thirdly, we discuss the complexity of assessment and more particularly the relationship between the representation of the project and the result of its evaluation.

We conclude by presenting the limitations of our study and directions for future research, including possibilities of cross fertilization with fields such as that of artificial intelligence.

GENERIC PROBLEM: TRACKING HEALTHCARE ITEMS IN HOSPITALS

Here is the generic problematic to be addressed:

- Medical devices and medical containers have a cost for hospital;
- The ones we are concerned with are mobile and circulate within the hospital, between different services;
- Their use is submitted to several constraints :
 - specific processes including mandatory treatments (such as sterilization);
 - tracking obligations;
 - respect of good practices by healthcare practitioners;
- managing them, using them, storing them, applying treatments to them, involve different responsibilities within a hospital;
- with no tracking, a hospital may not know whether a specific device or container can be used neither where it is (while supporting its cost);
- as a consequence, other devices may be ordered and additional treatments may be carried out, to guaranty the continuity of medical service – whereas this may not be necessary;
- to reduce this gap between the information state and the physical state of a hospital, healthcare staff is asked to manage more closely devices and containers – but doing so the hospital reduces its healthcare qualified staff resources and therefore reduces its medical care capacity.

Our project's goal is twofold:

- getting a better management of devices and containers for hospital;
- while optimizing the involvement of healthcare qualified staff in management tasks.

Electronic tracking of devices and containers can bring a valuable contribution to these issues (Nagy, George, Bernstein, Caban, Klein, Mezrich and Park 2006).

DTC PROJECT: THREE PILOTS, EACH ONE FOCUSING ON A SPECIFIC TYPE OF ITEMS

The project focuses on tracking three types of devices and containers, all related to medical care:

1. bottles of medical gases (such as oxygen for instance);
2. surgical instruments (especially during their sterilization);
3. ancillaries (set of instruments necessary to implant or extract a prosthesis).

Three sub-projects have been designed, each one dedicated to a specific type of device or container. Each one will lead to a large scale pilot in one or several hospitals.

Sub-project 1: Tracking medical gas bottles within the hospital

Hospital issues addressed by this sub-project

A hospital's pharmacy is in charge of providing bottles of medical gas to the services needing them. Each supplier charges a hospital:

- for the volume of gas sold to it;
- for the renting of the containers it provides to it.

The pharmacy faces two main issues:

1. it pays for renting bottles it does not use anymore;
2. it buys more gas than actually needed.

The first issue can be explained by several reasons, among them these three explanations are the most often given:

- when a patient using a bottle of oxygen is transferred to another hospital, the bottle follows him and is likely not to be returned by the destination hospital;
- it happens that an ambulance team borrows bottles from the emergency service of the hospital without asking for it;
- once emptied, some bottles are not returned to the pharmacy by the hospital's services.

The second issue is mainly due to the fact that some services ask for more bottles than they actually need, so that they can manage their own stock. Then, they do not communicate to the pharmacy timely information about the state of their stock (how many empty bottles? etc.). In order to guaranty that the hospital will be able to face any urgent need for medical gas, the pharmacy keeps its own stock sufficient by buying more gas, whereas the actual (but unknown) stock within the hospital may be sufficient.

These difficulties lead to a twofold wasting:

1. the direct expenses for paying medical gas suppliers are higher than what is needed;
2. the pharmacy's staff spends a lot of time inventorying medical gas bottles. An internal study conducted by pharmacists of a 475 bed hospital estimates to about 77 hours the time needed each month by the pharmacy's staff to complete this task. It expects this work load to be reduced to about 36 hours a month by using the proper tracking technology and organization.

Solutions proposed by this sub-project

The solution studied by this project is:

- to tag every bottle of medical gas when it is provided to the hospital;
- to scan its tag as soon as a bottle enters or exits the pharmacy or any other service;
- to scan and update the state of a bottle when it is relevant (for instance when the bottle is emptied);
- to integrate the so-collected information in an information system managed by the pharmacy.

Pilot description

In two different hospitals, all the bottles of medical gas are going to be tagged. About 500 tags and 15 readers will be used in each hospital.

Sub-project 2: Tracking surgical instruments during the sterilization process*Hospital issues addressed by this sub-project*

Surgical instruments are grouped together in specific sets. Each set is stored in a box which keeps it sterile for a given duration. When an instrument is used, the whole set it comes from has to be sterilized.

During the sterilization process, the surgical instruments can be treated together – no matter whether they come from the same set or even whether they were used during the same operation. At the end of this process, the original sets have to be reconstituted. Errors occur frequently during this step.

That's why the sterilization unit staff is helped by nurses from the surgical block. In France, these nurses have a specific diploma. They are highly qualified and their wage is higher. They are required in the surgical block when a surgical operation is conducted. Therefore, the time they spend grouping the instruments in proper sets is as much resource which cannot be allocated to the medical activity they have been trained for: surgery.

In addition, knowing how an instrument has been used so far is extremely important:

- for its maintenance;
- for compliance with risk management rules and regulation (for instance: a surgical instrument used with a patient contaminated by the Creutzfeld-Jacob disease has to be taken out from the usable instruments).

Such a tracking is not easy as it is quite difficult to identify each instrument.

Solution proposed by this sub-project

This sub-project proposes to tag each surgical instrument. This way, every single instrument could be identified. This would make possible:

- to keep track of the instrument's history;
- to indicate with a specific device or software which set it should be stored in.

Pilot description

In order for the experimentation to be valuable, it has to be large enough to encompass a homogenous activity. In the hospital hosting the pilot, the solution to be tested will be applied to the whole activity of cardiac surgery. 7000 surgical instruments will be tagged. These represent about 8% of the total number of surgical instruments in this hospital. Major attention will be paid to the positioning of the transponder on the instrument so that it does not disturb the surgical gesture. Specific software will be developed.

Sub-project 3: Tracking ancillaries from hospital to hospital*Hospital issues addressed by this sub-project*

The issues addressed here are similar to the ones related to surgical instruments.

The specificity of ancillaries is that they often circulate from hospital to hospital. Indeed, an ancillary is specific to the type of prosthesis being considered (hip, knee...) but also to the exact model of prosthesis. Actually, when a provider designs a prosthesis, it designs also the ancillary to implant or extract this prosthesis. A prosthesis from a competitor, for the same body part, will come along with its own ancillary.

Because of the high level of specialization of an ancillary, its use frequency can be low. That's why prosthesis providers lend (or rent) ancillaries to hospitals when they are required for a specific operation. Thus, an ancillary can be used by a hospital in Paris on Monday and then by another hospital, in Lyon, on Tuesday, and so on.

As a consequence, keeping track of the history of the ancillary is very difficult, all the more as there is no centralized dedicated information system.

Solution proposed by this sub-project

We propose to tag ancillaries.

Pilot description

For the pilot we designed, some ancillaries will be tagged. They will circulate between four different hospitals. Each hospital will append data related to its use of the ancillary to prior data written by the same hospital or by other hospitals. Once again, the positioning of the tag is very sensitive as it must not disturb the surgical gesture.

Collaborative project

This project involves 18 partners:

- 6 major hospitals in France;
- 8 companies (one large, one major cluster and several small and medium sized businesses);
- 1 non profit group gathering experts in tracking management;
- 3 research institutions working on supply chain management, risk management and the diffusion of RFID solutions.

It is partly funded by DGCIS (the General Directorate for Competitiveness Industry and Services, part of the French Ministry of the Economy, Industry and Employment).

METHODOLOGY

The approach is qualitative and interpretative, using case examples to illustrate the potential benefits of our meta-evaluation framework. One of the authors adopts a participant observation methodology as he is completely involved in the DTC project. He was involved since the beginning as a project manager and its major role is to coordinate the 18 partners. The other author has no operational role in the project and conducted several interviews with some of the medical professionals to better understand their motives. This duo enables to be both close to the empirical data but also to have a certain distance with the visions and interpretations of the practitioners involved.

HOW TO EVALUATE SUCH A PROJECT?

The main purpose of this research is to discuss the way we assess such an innovative project. We would like to design a meta-evaluation tool which could help the practitioners on the field to build their own evaluation tool, based on a good understanding of how and why RFID solutions could have positive impacts.

One of the main issues to assess these impacts is the need for a cross disciplinary approach as this project is related to as many fields as innovation, information systems, logistics, inter-organizational systems, and so on. This need for global and multidisciplinary assessment approaches is not specific to the DTC project. More generally, it is pointed out for IS projects – (Hallikainen and Chen 2005) (Barclay and Osei-Bryson 2008) (Fitzgerald 1998). Within each field of study, we can find specific tools of assessment. However, each of these approaches leads only to partial assessment for a project like DTC. Moreover, many evaluation methodologies adopt a single actor perspective which cannot be relevant in the case of the DTC project which gathers 18 institutions. Eventually, the evaluation criteria suggested in the literature are very often imposed. There is no proposition of a sort of a maieutics process which leads the practitioners to find the right questions to ask before to choose and to apply a standardized evaluation tool.

The structure given by many of the grids given by this literature on the evaluation of IS projects are useful but nevertheless, it has some limitations to understand the DTC project:

- on the one hand it focuses on one type of potential adopter at a time, which is only part of the problem when considering the opportunity of a collaborative project ;
- on the other hand it mixes up all types of considerations (technical, economical, regulatory, etc.): this requires to handle multiple competences and raises the difficulty of compounding the results.
- Considering a supply chain innovation, is there any other aspect to consider in addition to evaluating effects on the supply chain itself?

We are now going to list different aspects, point of views and parameters which have come up during the project engineering of our healthcare case. We will show then how considering some of them or not, and combining them or not, change dramatically the vision of the project.

Different evaluation topics

Technology

Technology - for electronic tracking - plays a major role in this project. There are three main possibilities: RFID, barcode and datamatrix. In order to evaluate this aspect we consider capabilities of a given technology and of course the technical feasibility.

All works about the relevance of a given technology for healthcare or works about characteristics of a given technology are usefull. For example, (Bureau, Prabhu and Gadh, 2008) studies the “myths” going along with RFID and contributing to the decision to adopt this technology.

Organization

Our project is going to change organizational processes. Are these changes acceptable by the hospital and by the users of the new system? In (Dowling 1980) a survey of 40 randomly selected hospitals is presented in which 45% of the information systems failed due to user resistance and staff interference despite the fact that they were technologically sound.

What is the impact on the performance and the robustness of the organization?

In the DTC project, assessment of the organizational aspects is closely related to technological assessment since technology enables these new organizational processes. This is often the case with electronic tracking and supply chain – see for instance (Housseman, Absi and Dauzère-Pérès 2009) or (Fosso Wamba, Lefebvre and Lefebvre 2007).

Economy

Even if the return on investment (ROI) has to be questioned, other aspects have to be addressed especially to understand a project with several stakeholders which do not have the same perspective and expectations on the project (Benghozi, Bureau and Massit-Folléa, 2008):

- Impact on the value chain;
- Business interest for this new market;
- Competition.
- ...

Regulation compliance

In healthcare, numerous regulations apply. The ability to track devices and container enables a better compliance with obligations such as being able to identify and remove surgical instruments used with a patient contaminated by the Creutzfeld-Jacob disease.

Also, regulations apply in the provider side: for instance, bottles of medical gas - as a product submitted to drug approval - will have to get tagged with a datamatrix by 2010 - see (*République Française* 2007).

Risk management

All healthcare processes in hospitals have a risk management dimension. Therefore, this project impacts risk management as well. In addition, the process will be changed which may also introduce new risks (Bertrand and Schlatter 2008).

Different points of view

Hospitals: An organizational perspective

The added value that hospitals expect from this project is the design of tailor made new processes. The new organizational processes will be co-designed by hospital staff and other partners before being tested during pilots. On the one hand, this

should make it easy to focus on hospital's actual needs. On the other hand, this should contribute to a better adoption of the innovation by hospital staff.

Industrials: A durable growth perspective

The industrial partners of this project expect to develop and validate new solutions which can be sold to numerous clients. Their objective is to open large consistent new markets for them. Cooperation with hospitals and large scale experimentation are expected to facilitate later selling process.

Hidden information

There is some information which plays a role in adoption but which will hardly ever be said by protagonists. This "hidden information" can be related to personal interest: for instance, in hospitals, leading a successful innovation project is likely to be good for a practitioner's career.

Information may also be hidden because the institution cannot make it public or cannot acknowledge it. For example, industrial partners may have their own industrial constraints and have some competition interests to protect. It may happen that these are different from their clients' needs. During the negotiation, a part of the information has to be kept hidden.

Decision making is different when considering a pilot or an operational adoption

A pilot is an experimentation. As such, hospitals and industrials are partners more than clients and providers. Hospitals have the opportunity to have the system being tested partly paid by others (here, industrials and public funding by DGCIS). This can trigger decisions which usually would require much more time to be made. For example, two technologies seemed to be equivalent for the project manager of one hospital and therefore the cost was the only variable of decision: the technology proposed by the partners supporting most of the costs of the pilot was chosen.

For industrials, the pilot enables:

- to lower the cost of experiment thanks to co-funding;
- to get higher visibility for their work;
- to open a new market.

As a consequence, a same entity may have different approaches when deciding to participate to a pilot and when deciding to adopt an innovation. Generalizing what happened when setting up a pilot to decision making related to the considered innovation in the rest of the market is not straightforward.

System

What we call system is the entity being evaluated. All the aspects we have been talking about are applied to the system at hand. For the same project, different systems can be considered.

We focus on two parameters differentiating these various systems (for a same project):

1. abstraction level, i.e. the level of details of the system;
2. scope, i.e. what is included within the system.

EXAMPLES

Evaluation of technology relevance: impact of abstraction level and scope

We consider two abstraction levels:

1. the generic problem: the problem is exactly the same whatever the context of use;
2. the detailed project with three types of devices and containers.

We consider three different scopes:

1. the narrowest scope– the circuit of one given device or container within a hospital (either ancillaries, or surgical instruments, or else bottles of medical gases);
2. a larger scope – a hospital, possibly dealing with one, two or three types of devices and containers among the ones we are interested in;
3. the largest scope– a hospital and its suppliers.

Six couples (abstraction level, scope) are possible. Below, a table summarizes for each of them the evaluation of technology relevance among RFID, datamatrix and bar code. Each cell is numbered, from 1 to 6.

decreasing abstraction level →		
	Generic problem	Detailed project with 3 types of devices and containers
One particular device or container within a hospital	1 (not applicable)	2 Ancillaries : RFID only Surgical instruments: RFID preferred for resistance and readability Bottles of medical gases : RFID vs. datamatrix
Hospital	3 RFID or datamatrix or barcode	4 idem cell 2 in addition: consistency between applications in a same hospital (if hospital deploys RFID for ancillaries and surgical instruments, then RFID becomes preferred for bottles of medical gases)
Hospital and its providers	5 idem cell 3 in addition : <ul style="list-style-type: none"> • check compatibility with regulation applying to providers; • check compatibility with industrial tracking used by providers . 	6 idem cell 4 in addition: check compatibility with providers constraints and tools. Ancillaries: if there exists a national file integrating information, datamatrix may be sufficient Bottles of medical gas: <ul style="list-style-type: none"> • Can we use same tags for industrial and in-hospital tracking • Regulation demands providers to engrave datamatrix

↓ increasing scope

Figure 1 Summary of relevance analysis for technologies for six systems defined by the couple (abstraction level, scope).

Comments related to abstraction level

At the highest level of abstraction, all tracking technologies seem to be as valuable. However, when you lower the level of abstraction, considering the three specific types of devices and containers selected for the project, sensible differences appear.

Considering ancillaries, if there exists centralized file gathering information about all ancillaries in use, then a tagging technology providing each ancillary with a single ID is sufficient. In France, there is not such a file. RFID is then the unique valuable technology. Indeed, the relevant data will be stored within the RFID memory so that it will always be with the ancillary, traveling from hospital to hospital.

Considering the surgical instruments, the choice of RFID has been driven by the chemical, temperature and mechanical constraints of the sterilization process. Barcode tags are quickly destroyed in such environment. A known alternative is to engrave the barcode or data-matrix on the instrument. However, the medical staff designing the project found this solution inappropriate because the engraving can be difficult to read, especially when the instrument is dirty. In addition, the use of RFID technology allows applications such as checking at once a whole set. This could be useful to detect errors afterward.

On the contrary, as far as it concerns tracking bottles of medical gas, choosing between RFID and datamatrix technologies is not an easy decision. A datamatrix solution is cheaper than a RFID one. Nevertheless, reading a tag with RFID technology is expected to be faster and easier. Is this difference big enough here to be relevant? Moreover, part of the information could be held by the tag itself, so that it can be read anywhere, even when the operator is far from an access to a centralized information system. How frequently is this useful?

To get clear answers to these questions, we decided to experiment both types of solutions. Two pilots are going to be conducted in two hospitals, in similar conditions and with the same evaluation referential.

Comments related to scope

The preceding analysis applies when considering each type of item individually (cell 2 – smallest scope). Now, considering a hospital tracking all three types of devices and containers (cell 4 – larger scope), it appears that it would be easier for the pharmacy to use the same technology for all of its tracking efforts. Thus, if the RFID technology is used for tracking other devices, then RFID seems to be more relevant to track bottles of medical gas. Of course, this argument makes no sense in pharmacies where only bottles of medical gas are tracked. Note that this last remark requires a level of abstraction which allows differentiating different types of hospitals.

Finally, when considering the largest scope (cell 6), we can notice that some suppliers prefer datamatrix or barcodes for their industrial tracking. However, the industrial constraints of suppliers do not apply within a hospital. In addition, by 2010, it will be mandatory for providers in France to engrave a datamatrix on every bottle of medical gas (regulation imposes the presence of datamatrix but it does not prevent from adding a RFID transponder).

Economy: the different points of view of actors lead to different and sometimes independent decision variables

Considering the project, one is likely to think of the ROI for hospitals. However, if you consider also industrial partners (larger scope), the computation of global ROI differs from the computation of ROI for hospitals.

ROI for hospitals: a matter of staff allocation and better purchasing management

We will not go into a detailed calculation of the ROI for hospitals. Roughly, tracking of devices and containers should save management time of highly qualified healthcare staff, so that this time resource can be allocated to medical care. Also, in the case of bottles of medical gas:

- the quantity of medical gas available in the hospital should be known more accurately, and therefore less gas shall be bought;
- the number of lost bottles is likely to decrease, and consequently the amount of money spent for renting “phantom bottles” should also decrease.

Information system industrials expect opening a large new market

Industrial partners dealing with information systems development and deployment consider that the market of information systems for sterilization is larger than others in the healthcare sector such as managing digital medical records for instance. Indeed, the issues and regulations related to sterilization seem to be more uniform within Europe than the issues and regulations related to medical record. This analysis requires expanding the scope of our study up to other European countries.

Industrials tagging surgical instruments fight against low cost off shore competition

Part of the production of surgical instruments used in France is nowadays completed in Asia. However, tagging surgical instruments with RFID transponders requires skills which raise a new temporary technological barrier. Moreover, tagging surgical instruments requires to work with only a few instruments at a time and to keep them out of the hospital as little time as possible. Otherwise, it would be difficult for the hospital to maintain open its surgery service. For these reasons it seems to be difficult to offshore this activity as far as in Asia.

Impact of hidden information on solution design

Organizational dysfunctions in hospitals

Some of the problems addressed by this project could be solved through an organizational change – without technology. For instance, the fact that some services build up their own stock of medical gas, or that they do not return every emptied bottle, is not a matter of technology. This is a matter of relation between a given service within the hospital and the pharmacy. This is a matter of priorities in this service. This might be a matter of human resources in this service.

Tagging bottles makes it possible and easier to track bottles up to the entrance of non cooperative services. It could show explicitly that these services do not play their part of the process. In this case, technology could highlight responsibilities and then cause an organizational change.

Within non cooperative services, tags on bottles are likely not to be scanned. For this reason, automatic scanning may be sought. In this case, RFID technology and readers positioned at strategic places, are preferred to datamatrix. However, this is difficult for a hospital to admit that some of its services do not cooperate properly with pharmacy.

Suppliers of medical gas

Considering electronic tracking of bottles of medical gas, providers have to handle two sets of constraints which are mainly hidden to other partners:

1. constraints related to industrial tracking;
2. constraints related to competition with other providers.

The industrial environment is very different from the one of hospitals. For example, it is much more metallic. Indeed, stored bottles are numerous and they are not handled one by one as in a hospital. Therefore, the environment is more hostile to RFID.

As far as it concerns competition, it is common for a hospital to have several suppliers at the same time (for different medical gases). This raises the question of tracking together items provided by different industrials. Should a given supplier propose a proprietary tracking solution and use it as a competitive advantage? Instead, should-it propose a solution working with bottles from any supplier and this way become also a tracking solution provider (independently of the gas providing)?

This type of question is crucial in supply chain management as a better fluidity of a whole system may imply a higher dependency among partners. Indeed, setting up a very specific tracking system in a supply chain is likely to make the replacement of one of this supply chain's protagonists more difficult for competitors. This effect benefits to current protagonists of the supply chain.

DISCUSSION

These examples highlight several characteristics of the evaluation of such a project. In this section, we discuss them and show different tracks to explore.

Assessment: Diversity of the elements to take into account and sensibility

The elements used in the three examples are very diverse. An assessment approach is necessarily composed of many specific sub-field which contribute to the general assessments. One could believe that adding another field specific analysis would not change the results of the global evaluation but would bring additional results, specific to this particular field. This is not always the case.

Indeed, all these field-specific analysis are not independent. For instance, regulation impacts technology relevance. Technology and economic analysis are related. Therefore, these analyses cannot be conducted independently from each other.

Choosing a given abstraction level and a given scope does not impact only these two dimensions. It shows different things. It is obvious when comparing cells 2 and 4 in

Figure 1. In cell 2 the scope of the study is focused on one tracking application only. For example, considering tracking bottles of medical gas, there is no clear reason to prefer Datamatrix or RFID over the other one (both have advantages and drawbacks – as discussed earlier). In cell 4, the scope is larger, including a whole hospital, with the three types of tracking being studied. This new level of analysis changes the assessment for the tracking of bottles of medical gas: in this study RFID is preferred to datamatrix because it is consistent with the technology in use for other applications.

Therefore, the choice of the system to study, the choice of the fields to analyze and the way to combine field specific approaches, are determinant. The quality of analysis and simulation tools cannot compensate the mistakes done in these choices.

Relevant systems

As shown in

Figure 1 (see cell 1), some combinations of abstraction level and scope are not relevant. Scope cannot be smaller than details distinguished by the abstraction level.

Some couples (scope, abstraction level), although different from each other, lead to similar results. They cannot discriminate the situations in a decision making perspective. In other words, in the space of representations of the project at hand (the space of what we called “systems”), these two representations are equivalent, for the conducted analysis. Depending on the goal and the methodology of the analysis, the groups of equivalent representations are different.

Here is an example. We noticed that RFID would be preferred for tracking bottles of medical gas in hospital where RFID is also used for ancillaries and surgical instruments. For this tracking application it is relevant to use an abstraction level which allows distinguishing appropriate categories of hospitals. On the contrary, for the ancillary tracking application, all hospitals are equivalent: only RFID is valuable (as long as there is no national ancillary database). The distinction between hospitals can be abstracted.

In the perspective of tools or methodologies to help finding the most appropriate system to study, exploiting this structure of equivalency groups allows to search the whole space without handling each single case. This is similar to the notion of splitting of the search space in action planning – in artificial intelligence – (Meiller 2003) (Meiller and Fabiani 2001): in order to find a solution plan (appropriate sequence of actions for a given planning problem), the space is split in sub spaces so that the search manipulates sub spaces. The appropriate way of splitting the search space depends on the planning goal: finding any plan, finding a plan maximizing a given criteria, handling uncertainty, etc. Structure of the search space is also studied in the fields of dynamic programming and Markov decision problems - see for instance (Teichteil Königsbuch and Fabiani 2006) and (Boutilier, Dearden and Goldszmidt 2000).

Cross fertilization between these works about automatic decision and assessment issues could be interesting.

Modeling and representation

The evaluation is complex and involves diverse elements. These elements can involve different aspects, different scopes, and different abstraction levels. This raises modeling issues and representation issues:

- How to connect different models (particularly when they correspond to different levels of abstraction)?
 - Model compatibility
 - Model synchronization
- How to represent information in order to help the analyst?
 - Links between elements
 - Diversity of information involved
 - Different levels of abstraction

Dedicated browsers (in the information space specific to the project) as well as graphical representation could be an interesting tool. Once again, works from knowledge management, and from knowledge representation and reasoning may be valuable.

CONCLUSION

A large experimental project has been set up in the field of applying RFID and/or datamatrix to healthcare. It encompasses three pilots, in order to test tracking bottles of medical gas, tracking surgical instruments in the sterilization process, and tracking ancillaries from hospital to hospital.

This large project gives us the opportunity to work on methodologies for evaluating new processes involving RFID. We have shown the complexity of such a task. We have shown the risks of conducting a useless analysis because of a bad

representation of the project. We point out the potential of working on tools helping the assessment – either by helping finding the right system to analyze or helping representing the information.

We focus on the work preceding actual assessment: determining what are the appropriate scope and level of abstraction to represent and grasp what has to be assessed. After mapping the different elements and relations involved in our prototype – the DTC project – future work will aim at working on methodologies and tools. We could build on previous works conducted on similar subjects, in domains such as artificial intelligence (planning, knowledge representation and reasoning...).

ACKNOWLEDGEMENT

This project exists thanks to the joint works of:

- hospitals Antoine Bécclère, Bîchat Claude Bernard, André Grégoire, Henri Mondor, CHU de Reims and Verdier;
- companies Aegle, Air Liquide Santé France, Axyome, IS Medical, Sedia, Sferic Stellite and companies grouped within Nogentech;
- the expert group about tracking Pôle Traçabilité
- scientific laboratories in Ecole polytechnique, ESCP Europe and Ecole Centrale Paris.
- NOVAPTEN, specialized in innovation management, is in charge of the project engineering and management.

REFERENCES

1. Barclay, C. and Osei-Bryson, K.-M. (2008) The Project Objectives Measurement Model (POMM): an Alternative View to Information Systems Project Management, *The Electronic Journal Information Systems Evaluation*, vol. 11, Issue 3, pp. 139-154.
2. Benghozi, P.J., Bureau, S. and Massit-Folléa, F. (2008) The Internet of Things: What are the Challenges for Europe? French Research Ministry, 65 p.
3. Bertrand, E and Schlatter, J. (2008) Cartography of risks for the implementation of RFID solution: Application to ancillaries in University Hospital Jean Verdier, « RFID Projects: a case for healthcare » - ICIS'08 (International Conference on Information Systems) – Paris (France).
4. Boutilier, C, Dearden R and Goldszmidt, M (2000) Stochastic Dynamic Programming with Factored Representations, *Artificial Intelligence* 121(1), pp.49-107.
5. Bureau, S. Prabhu, B. and Gadh, R. (2008) Radio Frequency Identification: Beyond the Myths - a case for Health Care, paper presented at the Academy of Management, Anaheim, California, USA.
6. Correa, F. A., Gil, M. J., & Redin, L. B. (2007) RFID and Health management: is it a Good Tool against System Inefficiencies? *International Journal of Healthcare Technology and Management*, 8(3-4): 268-297.
7. Dowling, A. F. (1980), Do hospital staff interfere with computer system implementation? *Healthcare Management Review*(5): 23-32.
8. Fitzgerald Guy (1998), Evaluating information systems projects: a multidimensional approach, *Journal of Information Technology*, 13, pp 15-27.
9. Fosso Wamba, S. Lefebvre, L. and Lefebvre E. (2007) Integrating RFID technology and EPC network into a B2B retail supply chain: a step toward intelligent business processes, *Journal of Technology Management and Innovation*, vol.2, issue 2.
10. Hallikainen, P. and Chen, L. (2005) A Holistic Framework on Information Systems Evaluation with a Case Analysis, *The Electronic Journal Information Systems Evaluation*, Vol. 9 Issue 2, pp 57-64.
11. Housseman, S. Absi, N. and Dauzère-Rérès, S. (2009) Simulation as a decision support tool – Estimating the Impacts of using RFID technologies within Biobanks, *Proceeding of HealthInf'09*, pp.337-342, Porto, Portugal.
12. Kleijnen, J (2005) Supply chain simulation tools and techniques: a survey, *International Journal of Simulation & Process Modelling*, vol.1, No1/2.
13. Meiller, Y. (2003) Du morcellement de l'espace de recherché en planification d'actions, PhD thesis, Ecole Nationale Supérieure de l'Aéronautique et de l'Espace.

14. Meiller, Y. and Fabiani, P. (2001) Tokenplan – a planner for both satisfaction and optimization problems, *AI magazine*.
15. Myerson, J. M. (2007). *RFID in the Supply Chain. A Guide to Selection and Implementation*, New York: Auerbach Publications.
16. Nagy, P., George, I., Bernstein, W., Caban, J., Klein, R., Mezrich, R., and Park, A. (2006) Radio Frequency Identification Systems Technology in the Surgical Setting. *Surgical Innovation*, 13(1): 61-67.
17. République Française (2007) *J.O. de la république française* n°64 du 16mars 2007 page 4950 texte N°107.
18. Teichteil Königsbuch, F. and Fabiani, P. (2006) Influence of modeling structure in probabilistic sequential decision problems, *RAIRO - Operations Research*, 40 no. 2, p. 195-234.
19. Zhou, W. (2009) RFID and item-level information visibility, *European Journal of Operational Research*, 198(1):252-258.