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THE IMPACT OF IMPLEMENTATION PROCESS ON THE PERCEPTION OF ENTERPRISE RESOURCE PLANNING SUCCESS

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Abstract

Purpose

The purpose of this paper is to investigate the impact of the implementation process on the ERP's success in the post-adoption stage, measured as system's acceptance, reliability and utility perceived by users, inside the organizations.

Design/methodology/approach

The authors adopted a multiple case study research design. The data collected, provided by IT managers and 120 key-users from four companies, has been used to investigate the impact of the Enterprise Resource Planning (ERP) implementation phases on selected constructs of the Task-Technology Fit (TTF) and Technology Acceptance Model (TAM). The empirical evidences highlight a direct relation between the effectiveness of the implementation phases and the ERP's success.

Findings

The research results emphasize the importance of the quality of the software, but especially the importance of the implementation phases' management, which require technical and managerial ability of the team made up of people from the system integrator and the company's key-users. Evidences suggest that the higher will be the organizational diffusion of an ERP implemented during a successful implementation project, the higher will be the perception of ERP success in the post-adoption stage. Moreover, the users' perception of ERP quality will be maintained over time.

Research limitations/implications

The research has some limits due to its exploratory nature and to the chosen research approach, so the results may lack generalizability; consequently future research will concern with enlargement of the sample that will allow a better generalization of the results.

Practical implications

This exploratory study suggest that companies' managers should be aware that a correct methodology of implementation, strongly influenced by the team, impacts on the technology consistency and therefore, on the ERP system success. So an appropriate choice is to invest more in the creation and development of internal and external project team than in the ERP's brand.

Originality/value

This paper fulfils an identified need to clarify the explicit relationship between the quality of implementation phases and the subsequent ERP success in the post-adoption stage measured in terms of users' perception of information system quality.

Introduction

Enterprise Resource Planning (ERP) are management information systems (IS) that optimize the distribution of enterprise resources and help a business to integrate all its resources for fast and effective application to improve its operational performance and enhance its competitiveness (Hsiao et al., 2007).

The benefits generally attributed to ERP are an increase in productivity, better warehouse management, a higher efficiency in the information flow, costs reduction and so on (Nonino and Panizzolo, 2007). Nevertheless, ERPs have high implementation costs; as a matter of fact, the cost range is about 2 to 6 per cent of annual sales with the cost of the software being just a tip of the iceberg, as reported by Mabert et al. (2001). In large companies, the average cost of an ERP system implementation is approximately equal to 1 per cent of the firm's turnover and the average lead time (from business process analysis to the go live) is about 20 months (PPRA, 2003). However, the huge capital investments in Information and Communication Technology (ICT) do not always determine a clear-cut link to the expected benefits and even, in some cases, the ERP projects end in failure (PPRA, 2003; Legris et al., 2003; Zhang et al., 2005).

A recent research conducted on more than 5,400 IT projects by McKinsey and University of Oxford (Bloch et al., 2012) shows that half IT projects with budgets of over $15 million dollars run, on average, 45 per cent over budget, 7 per cent are behind schedule and deliver 56 per cent less value than predicted. Furthermore, 17 per cent of IT projects go so badly as to threaten the very existence of the company. ERPs are usually implemented in a top-down style, and the organization generally has to adjust its processes to the system in a short period of time (Baroni de Carvalho and Tavares Ferreira, 2001). Furthermore, implementations of ERP projects most often require dramatic redesigns of business processes (Walsh and Schneider, 2002). So a successful implementation of an ERP system is an important factor for future company's competitiveness (Ehie and Madsen, 2005) and market value (Bharadwaj et al., 2009).

More than ten years ago Standish Group (2000) found that among the causes of IT project failures only 14 per cent was due to incompetence of technologies whereas management deficiencies, due to the complexity of the business and of implementation processes, accounts for the remaining 86 per cent. The difficulties of ERP implementations have been widely cited in the literature but, since ten years ago, research on the critical factors for initial and ongoing ERP implementation success was rare and fragmented (Fui-Hoon Nah et al., 2001). Past researches has identified the critical success factors that affect the ERP implementation effectiveness (e.g. Kumar and Hillegersberg, 2000; Esteves and Pastor, 2001; Al-Mudimigh et al., 2001; Dong, 2001; Zhang et al., 2002; Walsh and Schneider, 2002; Al-Mashari, 2003; DeLone and McLean, 2003; Umble et al., 2003; Bloch et al., 2012) like project management, top management influence, building effective and aligned teams, user training, technological infrastructure, alignment of requirements with software potentiality, etc.

A complete understanding of the ICT investment effectiveness cannot ignore the analysis of the ERP success so, in this regard, the literature provides different methods to evaluate it both ex-ante (during the selection process of the ERP software – e.g. Stefanou, 2001) and both ex-post (after the go live of the ERP).

Quality of ERP software regards the pre-implementation phase, the project and the implementation phase while perception concerns the post-adoption stage. The pre-adoption stage predominantly takes a value-based perspective (Venkatesh et al., 2003). Since the pre-adoption stage, one of the necessary conditions for IS success is the user acceptance of the technology (DeLone and McLean, 1992).

In the course of the pre-enterprise system adoption and implementation stages, key-users (i.e. end-user involved in the business process analysis and customization of the ERP system) are influenced by initial perceptions, expectations and by the performance of the implementation project. But, during the post-adoption stage, the direct interaction with ERP and the usage outcome can change the users' perception of the IS based on those initial cognitions. Nevertheless the IS research has given relatively less attention to post-adoption usage outcome and users' behaviour (Jasperson et al., 2005). The existing literature seems to lack research that clarify the explicit relationship between the quality of implementation phases and the subsequent ERP success in the post-adoption stage measured in terms of users' perception of ERP quality. In our opinion this relationship is plausible and, if exists, the comprehension of which phases of the implementation project impact more on these factors of future success of ERP system could lead to significant academic and managerial implications. Consequently, the question, which has driven our research activities, is:

> RQ1. Does implementation process impact on perception of ERP success during the post-adoption stage?

Taking off from this research question, we aimed to investigate if the implementation process (project phases) impacts on the ERP's perceived success in the organizations during the post-adoption stage, also considering other variables which could provide an explanation of its variation. Consequently, we adopted a multiple case study research design with the objective to explore some variables and to offer a contingent view on how there is such an impact and in which type of setting it is more likely to occur.

Literature propose numerous models and theories for the determination of success of generic ISs. Two suitable models for our research purpose are Task-Technology Fit (TTF) and Technology acceptance Model (TAM). In fact, some items of the two models allow the measurement of system's acceptance, reliability and utility perceived by users.

The paper begins analyzing the main features of TTF and TAMs. Afterwards the methods (research sites, data collection, dependent and independent variables) are described. Subsequently, the results of the regression analysis are presented. Finally, we discuss the results of the research and we provide some academic and managerial remarks.

Theoretical background

Evaluating the user's disposition and perception of IS quality is important for assessing IS success (Brown et al., 2002). In this direction, the TTF model studies the relationship between the use of the IS and its performances, through a consistent analysis of the software functions and the users' perceived needs (Dishaw and Strong, 1998). Another model, the TAM (Davis, 1989) evaluates ERP success through the perceived ease of use and perceived usefulness of the final users (e.g. Hwang, 2005).

TTF model

TTF is a model that studies the coherence of the software features with user needs that is the degree of consistency of the systems features with task needs. Specifically, the model aims at providing the basis for the analysis of those factors that explain the employment of an IS and the interactions with the users' performances through the study of the relationship between the clients' tasks needs and the system functionalities. Goodhue and Thompson (1995) demonstrate that TTF is a useful indicator of IS implementation success. The basic hypothesis of TTF is that better technology coherence brings better performances; in fact, TTF is based on the cost/benefit framework propositions (Payne, 1982; Smith et al., 1982; Creyer et al., 1990) that are:

1. user performances, that result from the use of technology, depend on technology itself and its coherence with task needs;
2. coherence influences users' task processes; and
3. users are able to evaluate coherence, therefore they choose the right technology.

The organizational structural contingency theories (Galbraith, 1973) state that better organizational performances are the results of the fit between organization structure and the organization context. Both contingency theories and TTF model are referred to the fit concept. Nevertheless, the two theories differ in the different level of analysis: the first one refers to the organizational level, while TTF refers to the individual level.

TTF is based on the following constructs: task, technology, relationship between task and technology, effective use of the instrument (Goodhue and Thompson, 1995). The first one refers to the procedures followed by users to transform input in output; the second one refers to the instruments used to complete the user's tasks; the third one refers to the degree of assistance that technology gives to a user to help him doing a part of his own tasks; the fourth one refers to the behaviour in using technology while completing tasks.

The measurement of the coherence of technology and tasks is extremely difficult and many researches faced this argument. Nevertheless if it is difficult to measure performances obtained through the utilization of an IS, we can assume that if users positively evaluate a system, this probably can help increase their performances. So these researches (e.g. Goodhue, 1994, 1998; Goodhue and Thompson, 1995; Goodhue et al., 2000) consider the user's evaluation to measure the IS success. This will be the criterion chosen also for the present study. The measurement of the coherence with tasks, according to Goodhue and Thompson (1995), is structured in eight components (Table III). The first five components (data quality, localizability of data, authorization to access data, data compatibility, training and ease of use) focused on the alignment of task needs for using data in decision making; the second two (production timeliness and systems reliability) focused on daily operational needs and the last component (IS relationship with users) focused on relationship among people.

The model is the basis to study the factors that explain the use of ERP systems and the relations with user's performances, observing the relationship between the users' needs and the functionalities offered by the system. TTF is characterized by:

- the explicit focalization that explains the relationship between system and performances is based on the importance of TTF;
- the purpose of a detailed base for constructs finalized to:
  - compensation of the user impact involving on performances; and
  - development of diagnosis instruments for ISs.

TAM

When implementing an ERP system, top management commonly faces an unwanted attitude from potential users who resist the implementation process (Aladwani, 2001).

The success of an ERP system can be explained by another model, the TAM proposed by Fred Davis (1989) and widely developed in following years, e.g. in the so-called TAM2 by Venkatesh and Davis (2000) and TAM3 by Venkatesh and Bala (2008). The TAM framework, and more generally, IT acceptance literature resulted in the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003). TAM framework was the most widely utilized theory to study IT adoption (Dwivedi et al., 2009; Williams et al., 2009) and has been applied in a wide range of IS researches dealing with behavioural intentions and usage of IT (see Turner et al., 2010 for a systematic literature review).

TAM was conceived starting from Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) developed inside the branch of social psychology during the 1970s. TRA affirm that the individual behaviour is determined by behavioural intention and it is composed by the attitude of the individual and the subject norms of the group. Consequently, TAM aims to evaluate how the acceptance of a technology influences the use of the technology itself and finds its foundation on the idea that perceived ease of use and perceived usefulness finally determine the attitude towards the technology and its actual use. The TAM model shows connections among prior ICT experiences, attitudes with affective components, planned and actual behaviour and attempts to understand and to measure computer anxiety.

According to Davis (1989), the model of the technology acceptance, which explain the actual IT use, is structured in four components (Table III):

1. perceived usefulness: the individual's perception that using an IT system will enhance job performance;
2. perceived ease of use: the individual's perception that using an IT system will be free of effort;
3. attitude towards using IT: the individual's evaluative judgment of the IT system; and
4. behavioural intentions to use: the individual's motivation or willingness to use the IT system.

The TAM postulates that IS usage is triggered by behavioural intention to use a system jointly determined by individual attitude towards the technology and perceptions of its usefulness. Therefore, perceived usefulness and perceived ease of use are fundamental for predicting the technology acceptance of users, i.e. technology success within an organization. Venkatesh and Davis (1996) studied the antecedents of the perceived ease of use and found that computer self-efficacy and usability act as determinants of perceived ease. Amoako-Gyampah and Salam (2004) developed an extension of the TAM in an ERP implementation environment. Amoako-Gyampah (2007) examined the influence of perceived usefulness and user involvement on the behavioural intention of ERP system usage.

Methods

To address our question we adopted the multiple case study research design, as suggested by Yin (1994) and McCutcheon and Meredith (1993). This methodology is widely accepted in management ISs studies for the formulation and building of theory (Lee, 1989).

The multiple case studies allows researchers to do a holistic and contextualized analysis, to observe the phenomenon in its complexity, to collect a wide array of data and to identify the crucial variables (Yin, 1994). The use of multicase sampling enhances the validity and generalizability of the findings through replication logic (Miles and Huberman, 1994). In total, two replication criteria should be set for the case selection: one being that they could produce similar result (literal replication) and one being that they could produce contrary results because represent a diversity of the population (theoretical replication) (Eisenhardt, 1989).

We chose case studies both for literal and both for theoretical replication purposes. The unit of analysis is the ERP’s user. Therefore, for the literal replication purpose, we selected four companies where there was a substantial number of users (at least 10 per cent) and which implemented a ERP in all the principal functional areas: finance, human resources, manufacturing, marketing, procurement, R&D, sales, after-sales service and IT management. Moreover, for theoretical replication purpose, we selected four companies because they show different market approaches and/or type of ERP implemented, number of years since its implementation, different investment as compared to total turnover and are heterogeneous in terms of turnover, number of employees and business sector (see Table I).

From June of 2010, during a 12 months research time scale, multiple sources of evidence were used in the data collection phase to enhance both validity and reliability. The data used in the case study were obtained from a combination of secondary and primary sources. Primary data gathering involved the four IT managers from the organizations through semi-structured interviews, to enhance the understanding of the processes and to deeply analyze all the potential relevant variables affecting the ERP implementation and its success. A survey to collect data from key-users was used to investigate the quality of the ERP implementation phases on the factors and dimensions of TAM and TTF that represent the ERP success in the post-adoption stage measured in terms of users’ acceptance, reliability and utility perceived. We used a multiple regression analysis in which ERP implementation phases were the independent variables and selected TTF and TAM items were the dependent ones.

Secondary sources (company database) were used to enhance the validity of the research through triangulation with multiple means of data collection (Voss et al., 2002).

Research sites

Each selected company operates in a different market (respectively, high technology, manufacturing, toys and food). The turnover of the enterprises is between 23,000,000 and 240,000,000 and the ERP end-users are between 50 and 250. In all, two companies implemented EnterpriseOne (J.D. Edwards) while the other two, respectively, adopted Seven (Solgenia) and Sap/R3 (SAP Ag).

Company A designs, develops and markets nano and high performance computers and its revenues amounted to 91 million euros. This company owns different branches working in Europe, America and Asia. It adopted the Seven ERP produced by the Italian company Solgenia and implemented three years before our research.

Company B produces medium density fibreboard (Mdf. wooden floors and office furniture. It accounted revenues of 233 million euros. It owns branches in Italy and Slovenia. The ERP adopted is SAP/3 produced by the German company SAP plus others application package implemented eight years before our research.

Company C designs and sells stuffed animals, but in the last years it differentiated into apparel, sun glasses and jewellery sectors. Its revenues accounted for 23 million euros. It has several offices in the Far East, Germany and Spain. The ERP system, adopted five years before our research, is EnterpriseOne by J.D. Edwards.

Company D is a leading company in the coffee sector with four European branches and an American one. The corporate revenues were 240 million euros. The ERP system, implemented four years before our research, is EnterpriseOne by J.D. Edwards.

Data collection

The research has been carried out through interviews with the four IT managers, a data collection using the companies' database and a survey to the ERP key-users of each company. To assure the coherence and the consistency among interviews, a standard protocol was developed to be checked and to guide our interviews, which aimed at understanding the main features of the ERP system and the implementation dynamics. During two interviews (the first lasting three hours and the second lasting one hour), the four IT managers were asked to describe the evolution of the ERP in their company and the several ERP modules implemented. The analysis then focused on the implementation phases of the system; each phase was accurately described and the problems arisen highlighted. Moreover, a questionnaire was submitted to gather information on ERP characteristics such as initial investment, maintenance costs, etc. Finally, the IT managers and key-users (described below) provided a judgment of the quality of ten ERP implementation phase using a five-point likert scale from 1 (poor) to 5 (excellent).

The data gathering concerning the TAM and TTF selected dimensions was carried out through a survey. The sample dimension was defined on the basis of the total number of ERP end-users and on the basis of the IT managers' awareness of the end-users' level of competence. Consequently, the questionnaire was sent only to the company key-users. As suggested by Hirt and Swanson (1999) the key-users have been selected because they belong to operating departments, generally familiar with business processes and having domain knowledge of their areas. In contrast to key-users, end-users are the final users of the ERP system. They have only very specific knowledge of the parts of the system they need for their work. In order to have a representative and homogeneous sample among the four cases, key-users have been selected according to the following features:

- functional unit: this first driver in the sample selection aimed at selecting key-users from all the company functions allowing us to conduct a comprehensive analysis of all the ERP modules implemented;
- duration of use: the users with more experience in the ERP utilization have been selected starting on the assumption that the best evaluators are those employees that use it more time; and
- participation during ERP implementation project: the third driver is the end-user involvement in the business process analysis and customization of the ERP system.

The questionnaire provided to each key-user contained a first part concerning the general information (age, gender, functional unit, time lag of use, etc.) and a second one regarding the TAM and TTF selected items. Out of 135 possible respondents, 120 completed the survey for a response rate of 89 per cent (Table II).

Independent variables

The independent variables are the phases for an ERP implementation. We proceeded in two stages:

- we analyzed existing research and selected some models of the implementation process; and
- we collected and analyzed empirical data from case studies and we identified common phases in line with literature.

Ross (1998) developed a five-phase model for ERP implementation: design, implementation, stabilization, continuous improvement and transformation. Parr and Shanks (2000) proposed the project phase model (PPM) based on the following implementation processes: planning, set-up, re-engineer, design, configuring and testing, installation and enhancement. Rajagopal (2002) applied a six-stage model (initiation, adoption, adaptation, acceptance, routinization and infusion) to the ERP context and conducted six case studies. Klee (2005) proposed the following phases: product evaluation, implement - phase I, implement - phase II and beyond, extending value, maintaining value and declining value.

Starting also from other ERP implementation phases described in literature (Markus and Tanis, 2000; Berchet and Habchi, 2005; Ehie and Madsen, 2005) and carrying out a comparative analysis of the four case studies, we identified ten common phases for the ERP implementation:

1. software installation quality: the ERP installation phase in standard configuration with an initial set of modules;
2. business process analysis: the As-Is and To-Be processes' analysis and the check of the compatibility of ERP modules with the involvement of the key-users (usually one person for each functional unit);
3. set-up and prototype development: starting from the previous phase, the ERP system is parameterized and key-users feedbacks are gathered for the customizations;
4. customization: additional development of customized ERP modules based on the information gathered in the previous phase;
5. data recovery: set-up of the data alignment and transfer interfaces and uploading of the previous database in the new ERP system;
6. system test: all the previous phases converge in the test of all the business processes as formalized at the beginning of the project;
7. training: in each functional unit a focused training has done to end-users, while every key-user participates to the prototype development; the key-users get an informal training due to the active participation in the ERP system customization and implementation phases;
8. system delivery: all the ERP-customized packages implemented in the set-up phase are tested with a fist run in a simulated environment to avoid system crashes;
9. go live: the final assessment and the refinement; the old ERP system (if exist) is interrupted and the new one starts to run; and
10. after delivery assistance: the support to end-users in the first period of the ERP utilization; in particular the deadline is usually associated with the first drafting of the VAT journal report; from this moment the ERP implementation project is considered delivered.

The quality of the ERP implementation phases have been evaluated by IT managers and key-users using a five-point likert scale from 1 (poor) to 5 (excellent).

Dependent variables

We initially selected the TAM and TTF items starting from previous studies (Zanutto, 2005; De Toni and Zanutto, 2006a, b) which investigated the most important variables that represent the success of ERP and ISs. De Toni and Zanutto (2006b) found the main constructs through an empirical study based on a survey with a sample of 300 employees belonging to six large companies. Subsequently we organized a focus group lasting four hours, which involved three professors of computer science, three IT consultants and four IT managers in order to suggest us the best dimensions representing ERP's success as we defined it. Table III shows the final six dimensions selected at the end of the process.

The TTF and TAM factors selected have been measured through representative items found in literature (see Appendix). These ones are the dependent variables of our statistical model, in particular:

- production timeliness: quickness of the ERP end-users to gather information thanks to interfaces and rapidity of the system response (Bailey and Pearson, 1983; Bruno et al., 2004);
- data compatibility: level of completeness, accuracy and effectiveness of the information processed by ERP system (Saarinen, 1996);

- systems reliability: probability that the ERP system continue to run under certain conditions for a defined period of time (Lucas and Spitler, 1999);
- ease of use: employees' perception of easiness in the use of the ERP system without efforts (Davis, 1989; Goodhue and Thompson, 1995);
- perceived usefulness: employees' perception of usefulness of the ERP system's use (Legris et al., 2003); and
- behavioural intentions to use: employees' intention of use of the ERP system (Venkatesh and Davis, 2000).

Data analysis and results

The data collected, provided by IT managers during the interviews and gathered through the 120 key-user questionnaires, has been analyzed to evaluate the impact of the ERP implementation phases on the single selected constructs of the TAM and TTF. The dependent and independent variables of the models have been analyzed using a correlation analysis and a multiple regression analysis.

First of all, we studied the ten independent variables using the correlation analysis with the aim to identify a potential multicollinearity. The correlation analysis showed that ten ERP implementation phases are strongly correlated among themselves (Table IV); for this reason, we conducted a principal component analysis (Table V) which shows that the first component maintains the 77 per cent of the information enclosed in the ten selected variables. Consequently, we decided to use only two variables in the regression analysis:

- software installation quality (var1) represented by the first implementation phase; and
- implementation quality (var2 the mean of the second to tenth implementation phases value (the first component).
- A subsequent analysis has demonstrated no correlation (0.071) between software installation (var1) and implementation quality (var2).

The regression analysis confirmed the causal relation among software and implementation quality and the six constructs representing ERP system's acceptance, reliability and utility perceived by users (Table VI).

First, we found that the implementation quality influences the ERP system's reliability and utility perceived by users more than the software quality. As a matter of fact, the software installation quality impacts on the production timeliness, data compatibility, ease of use and perceived usefulness a behavioural intention of use; instead the software installation quality does not seem to influence the system reliability. However, the more interesting results come from the implementation quality as defined by the remaining nine implementation phases. It impacts on all the dependent variables and, consequently, on the ERP success. Furthermore, the 30 per cent of the variance in the production timeliness of the ERP, the 22 per cent of its perceived usefulness and intention of use are explained by the software and implementation quality. The variance of the other three dimensions seems to be less explained in the model.

Discussion, managerial implications and further research

The literature recognizes the implementation project as important for achieving the efficient and efficacy functioning of ERP systems, but little is known about its impact in the subsequent ERP success in the post-adoption stage. We have therefore conducted this study in order to obtain a better understanding of this relation by measuring the ERP success in terms of users' acceptance and reliability and utility perceived.

The results of the statistical analysis on the empirical data collected support the idea of a causal relation between the quality of implementing an ERP system and its future success within an enterprise, so the answer to our initial research question is affirmative. Nevertheless, the cross-case analysis allows us to give further results and deepen the result of statistical analysis by considering other variables affecting perception of ERP quality.

Discussion

The first result of our research comes from the correlation analysis after the principal component analysis: the ERP's implementation quality seems to be not correlated (or influenced) with the installation quality, a proxy of the software quality. However, the ERP's implementation phases are strongly correlated each other (and surely influenced by the antecedent one) so we considered that every implementation phase impacts on ERP system's reliability and utility perceived by users. Unfortunately, the dimension of our sample has not allowed us to identify the most important phase clearly.

If our analysis highlights the importance of a high-quality ERP system and the importance of a correct implementation in a company, we found that the most important is the second one. The results of our analysis suggest that implementation quality influences the ERP system's reliability and utility perceived by users more than the software quality. If the first variable is representative of the intrinsic quality of the ERP system, the other depends on the ability of the team composed by people from the system integrator (typically the consulting firm) and the key-users of the company.

After interviews, we conducted a search for cross-case patterns. We compared two and two cases searching for similarities and differences, and we finally compared all four cases. We chose a number of cases, which clearly does not support generalizability, but allows for comparison and contrast between the cases as well as a deeper and richer look at each case.

As highlighted in Figure 1, the four cases are characterized two by two by four different variables, which could provide an explanation of a variation of ERP perceived success:

1. type of ERP system;
2. initial investment in ERP;
3. per cent of ERP end-users; and
4. number of years since ERP implementation.

Typology of ERP system can influence its success because of the intrinsic quality of the software. Initial investment in ERP (during implementation phase) can affect the quality of final realization because directly correlated to the effort of project team (internal and external). The percentage of ERP users on the total employees can impact to perception of its success because the higher the percentage, the higher the diffusion of the ERP inside company, i.e. organizational level of expertise on ERP system. The post-adoption stage is characterized by a deeper understanding of the ERP and the initial perceptions in pre-adoption and implementation phases are revised because of duration of actual usage. Consequently, we expected that time (number of years since ERP implementation) can influence users' opinion.

The percentage of initial investment in the ERP compared to the turnover does not seem to impact and consequently to guarantee a successful ERP implementation (Figure 2). As a matter of fact we observed the higher ERP perceived success, respectively, in the case C and B which shows a big difference in the investments, while the worst case D invested an amount of money similar to the best one C.

Instead, the importance of the implementation process can be deduced by the case of two companies (B and D) where IT managers told us that they had many difficulties during the implementation of the ERP. In the case D the change of the consulting firm and of the ERP system vendor created several criticalities never overcome and demonstrated by ineffectiveness of the system; in the case B we have observed that an excellent internal team has limited the difficulties during the system integrator change. The empirical evidences coming from the cross-case analysis suggest that it is fundamental to maintain the internal skills of the key-users in order to guarantee the continuity of the project also if there is a change of the system integrator. So the appropriate choice is to invest in the project team (internal and external) more than in the ERP's brand (in our research Enterprise one® is the best one and the worst ERP system).

The ERP's implementation quality impacts above all on the production timeliness, behavioural intention of use and perceived usefulness. In the D case study we discovered that an inefficient ERP implementation has been done caused by several criticalities (change in ERP advisor, change in the IT manager, etc.). In this company there is major slowing down in the end-user ERP system interaction and the activities are not being carried out on time. Moreover, we have found that data compatibility, behavioural intention of use and perceived usefulness are influenced by the intrinsic quality of the ERP solution adopted by the company. Certainly, the basic programming rules give the right exchange of information among the several ERP modules implemented; a stability platform allows to obtain right data (not contradictory) creating in the key-users a sense of security towards the ERP system.

Finally, we found that the two organizations in which the ERP system is perceived to be more successful are the companies with higher percentage of ERP users on the total employees (degree of company expertise on ERP) and higher number of years since ERP implementation (time).

Synthesizing, evidences suggest that the higher will be the organizational diffusion of an ERP implemented during a successful project, the higher will be the perception of ERP success measured in terms of terms of users' acceptance, reliability and utility perceived in the post-adoption stage; moreover the users' perception of ERP quality will be maintained over time.

Managerial implications and future research

The results of the research show the importance of the intrinsic quality of the software, but especially the importance of the implementation phases, which require a strong ability of the team composed by people from the system integrator and the key-users of a company. In this sense the results of our research have also practical implications; as a matter of fact, the companies' managers should be aware that a correct methodology of implementation, strongly influenced by the team, impacts on the technology consistency and, therefore, on the ERP system future success. So an appropriate choice is to invest more in the creation and development of internal and external project team than in the ERP's brand.

Finally it must be underlined that our research has some limits due to its exploratory nature and typical of case study researches (e.g. different distribution of respondents among the four cases). Consequently future research will concern with enlargement of the sample that will allow a better generalization of the results and to clearly identify which implementation phase among the ten studied is the most important to predict the ERP system's future acceptance, reliability and utility perceived by users.

Appendix. TAM and TTF items in the survey

Systems reliability

The ERP is very reliable (Lucas and Spitler, 1999).

I can count on the system to be up and available when I need it.

Production timeliness

ERP, to my knowledge, meets its production schedules such as report delivery and running scheduled (Goodhue and Thompson, 1995).

Regular ERP activities are completed on time (Goodhue and Thompson, 1995).

Data compatibility

There are times when I find that supposedly equivalent data from two different sources is inconsistent (Goodhue and Thompson, 1995).

When it is necessary to compare or aggregate data from two or more different sources, there may be unexpected or difficult inconsistencies.

Ease of use

The ERP computer systems I use are convenient and easy to use (Goodhue and Thompson, 1995).

My interaction with the system is clear and understandable (Davis, 1989; Venkatesh et al., 2003).

Perceived usefulness

Using the ERP system enhances my effectiveness on the job (Legris et al., 2003).

Using the ERP system increases my productivity (Legris et al., 2003).

Behavioural intentions to use

Given I had access to the system I intend to use it (Venkatesh and Davis, 2000).

I plan to use the system (Dishaw and Strong, 1998).

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Further reading

Lui, K.M. and Chan, K.C. (2008), "Rescuing troubled software projects by team transformation: a case study with an ERP project", IEEE Transactions on Engineering Management , Vol. 55 No. 1, pp. 171-184.

Methodology

The present work is meant to help widen the knowledge basis on experiential learning and lean management and propose a methodology for evaluation based on experiential learning literature. It aims to understand how to evaluate lean management education done with experiential learning processes. This paper attempts to answer to the following research questions:

> RQ1. How is it possible to assess an experiential learning process?
>
> RQ2. How is it possible to measure the consistency of the learning content (lean learning) and learning process?

Company selection

The case refers to the LEF, which is an Italian management company born from collaboration between Manufacturers' Association of Pordenone (Italy) and the global consulting firm McKinsey & Company. The motivations for this choice are manifold.

According to Yin (2003) and Siggelkow (2007), reasons for the LEF case study selection are:

- Fit: LEF is strongly related to research aims. It is a unique example in the Italian landscape of experiential learning practices through a model factory to teach lean management. It has a peculiar learning place for educating managers through experiential learning principles. It is characterized by a real productive process. In fact, it defines itself as a "real factory": the learning place, where participants are trained and a real productive environment is shown where a real process and a real product (a compressor) are realized.
- Distinctiveness: It is a medium-sized company, but a case of success in terms of education methodologies, and especially in terms of lean and consulting capabilities. While its competitors use simple simulated processes and classroom games to teach lean, LEF considers them only as a basis to help people learn, and it continuously tries to offer to a wide experiential learning process through a simulated real factory environment. Learning comes through hands-on, first person, application of concepts.
- Revelatory nature: The company made it possible to directly observe the learning activities, and to participate in internal meetings of the faculty staff.

Therefore, we expected the results of the test to mirror the attitude of the company regarding experiential learning.

Research methodology

The research methodology includes an analysis of literature on experiential learning and of literature on lean management, from whence the theoretical proposal of the methodology was born.

This analysis of the literature highlighted the limited body of knowledge on the theme and its novelty. Because there has been limited previous research on the themes connected to implementation, they must still be explored deeply, considering also the complex system of variables that characterize the observed phenomenon (McCutcheon and Meredith, 1993; Handfield and Melnyk, 1998; Yin, 2003). This approach matches the goal of the study by focusing on a phenomenon with a dynamic and process nature and in which unfolding events play an important role in building explanations (Yin, 2003).

The case study design is opportune for presenting a relevant overview of the relevance and applicability of the methodology. The single case study is particularly appropriate for completely new and explorative investigations. The object of the case study is the test of the proposed methodology. As described by Yin (2003), the case study research design can be used to describe an intervention and its context. Some authors refer to this as a “field experiment”. In the test in this study, the intervention is the application of the proposed methodology, and the context is the company studied.

Therefore, the case study process has been divided into two main steps:

1. Gathering the data using a structured exploratory study: The investigation of the company studied (and especially the model factory).
2. Testing the proposed method: The methodology has been tested within the context of a company to verify its operative feasibility.

The case study and testing activities were conducted by:

- Face-to-face interviews with key informants: model factory designers, instructional designers, trainers, professors, consultants and learners to gain multiple perspectives.
- Observations of the training activities and courses.

Finally, the application of the operative tools of the framework was carried out by an heterogeneous team of four experts (a University research fellow, a trainer, a McKinsey’s advisor and a PhD candidate from LEF). The research team considered the different learning phases and assessed the lack of the learning activities.

A proposal of a methodology for evaluating lean experiential learning

The methodology (Figure 1) grounds on learning literature and lean management literature, in particular a learning model labeled eight-phase learning path and on the lean management model. We propose to assess both process and content, and to assess them contemporaneously. The methodology is based on two main phases:

1. The coverage analysis, which assesses only the content.
2. The experiential analysis, which assesses the content and the process.

Each of these two phases is operatively supported by a tool.

In particular:

1. The coverage analysis measures if the content of the course has been covered and at which level/percentage. This phase is supported by a tool called the Learning Contents Covering Scheme (Figure 2): it shows, in a visual manner, the coverage degree (level) for a lean training course in terms of contents with reference to the amount of lean items mapped within the proposed lean management model. For each block of the model, lean principles and techniques taught are listed and the coverage percentages can be reported in a box at the bottom of each block.
2. The experiential analysis measures not only the content but also the process. It allows analyzing each formative module in relation to the proposed model for learning. It is supported by a tool, the Learning Process Analysis Matrix: each phase of the process can be marked if accomplished, if partially accomplished or if not accomplished with that experiential learning process phase (Table I).

Specifically, for content and process, the following section develops the proposed methodology and operative tools and details the content and the process.

Content: lean management

Lean is conceived as "an integrated socio–technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability" (Shah and Ward, 2007). Lean production uses less of all: less effort, less space, less investments and less time for new products development (Womack et al., 1990). In addition, to-be lean:

> […] requires a way of thinking that focuses on making the product flow through value-adding processes without interruption (one-piece flow), a pull system that cascades back from customer demand by replenishing only what the next operation takes away at short intervals, and a culture in which everyone is striving continuously to improve (Liker, 2004).

The lean management model firstly grounds on the works of Sakakibara et al. (2001, 1997) and De Toni et al. (1994, 2013). These authors group lean tools, techniques and principles into three levels: just-in-time (JIT), support functions and value stream mapping (VSM).

Each level is then subdivided into lean building blocks. The JIT level groups practices related to the productive flow that have the main objective of continuously reducing each kind of muda (waste) up to the elimination (Shah and Ward, 2003). JIT is subdivided into three building blocks:

1. Planning and control: Principles and techniques grouped into the planning and control block aim at synchronizing production and market demand (Panizzolo, 1998). These goals can be attained through leveled production, the use of small lots, pull control of flows, and so on (Panizzolo, 1998).
2. Process and equipment: The production processes should be able to ensure mix regularity and uniformity over time. These conditions require, for example, shortening of set up times, the use of cellular layouts and of mixed model lines, process capability, availability and reliability of machines, the use of "error proof" equipment, and so on (Panizzolo, 1998). Such practices are grouped into the second lean building block of JIT: process and equipment.
3. Supplier–customer relationships: It ensures a supply chain vision, grouping lean principles and techniques for creating solid and trustworthy relationships, upstream with suppliers, involving them during the activities of product development and quality management; and downstream with customers, basing on the skills of the sales network, realizing the exchange of information and analysis of customers' needs to focus on product development and production.

To sustain the JIT level, a second-level support functions is necessary. This level is subdivided into:

- Product design: Practices related to the product development block aim at improving manufacturing and assembling processes. They play an important role in supporting advanced production methods (Panizzolo, 1998).
- Human resource management (HRM): The HRM block groups all the principles linked to people development, training and employee involvement and commitment to support JIT practices (Panizzolo, 1998).
- Quality management: Respect for workers can be conceptualized as the glue that holds the other lean production dimensions together (de Treville and Antonakis, 2006). Quality management block groups practices aiming at sustaining processes and products of great quality. Among them, Shah and Ward (2003) include techniques of process capacity measurement.
- Maintenance management (or total productive maintenance): The maintenance management or total productive maintenance block includes lean practices designed to maximize equipment effectiveness such as planned predictive and preventive maintenance of the equipment and maintenance optimization techniques (Shah and Ward, 2003).

Performance improvements are connected to firm competitive advantage (De Toni et al., 1994; Sakakibara et al., 2001, 1997). To maintain this advantage, the whole lean system has to be "held in running" by the consciousness that supports the philosophy of continuous improvement. We conceptualized the continuous improvement as a lean block that acts as a feedback loop (De Toni et al., 1994).

To fill up the building blocks of lean management model, we mapped from the literature a total of 102 items related to lean. A total of 32 contributes (26 papers and 6 books) about lean were reviewed. Items were then grouped and ordered according to their definition. We split lean items on lean techniques and methods and lean principles and characteristics, ranking them considering the number of citations in literature.

Process: learning path

A comparison of the main experiential learning models, which see learning as a cyclic or helical path (Quaglino, 1985), is shown in Table I. The comparison of these nine models leads to an identification of four macro-phases of experiential learning, reported in the last column of Table I:

Concrete experience: A tangible experience of a real event.

Reflective observation: An analysis of the experienced event.

Abstract conceptualization: A conceptual synthesis of the analysis.

Experimentation: A practical application of what has been conceptualized.

Concrete experience.

The learning path starts from a cognitive discovery made by the learner. He observes a mismatch between the real situation that is being experienced and an ideal situation. This gap originates a cognitive dissonance between what Moon (2004) calls internal experience (cognitive individual interior representation) and external experience (objective reality). From this realization, or mere discovery, the learning process begins as a process of searching for a gap resolution. The learner will “struggle” to fill that “real–ideal” gap.

Concrete experience is composed of two sub-phases: introductive briefing and as-is state exploration:

1. Introductive briefing: Entering the learning process from the concrete experience, a learner has to carry out an act of problem setting of reality (Dewey, 1938). During this act, the learner must use his own cognitive matrix defined as the amount of prior experiences, a sort of experiences baggage (Moon, 2004). He uses it to analyze the experiencing situation. The learner focuses on the aspects of the situation that he subjectively considers more relevant. The introduction (briefing) aims at making explicit this act of focalization and drives learner’s attention to the situation aspects that are linked to and relevant for the didactical objectives of the training module carried out. In synthesis, a “frame of reference” (Moon, 2004) is given to learners. The first learning macro-phase aims also to instill a doubt, that is, according to Engeström and Sannino (2010): questioning prior learners’ opinions and ways of thinking.During this first learning step, didactical objectives have to be set up. Learners conduct a “reflection for action” (Cowan, 1998). They become aware of actions that they are going to perform within the learning circle. Ideas and purposes drive the whole process of learning (investigation). As a principle of adult learning theory, learning is triggered by the

overall results that learners are willing to achieve. Ideas are continually revised on the basis of feedbacks collected during the testing phase of each round of the learning cycle.

2. As-is state exploration: After having shared learning objectives between faculty and learners, the process goes on with a concrete diagnosis of the situation as-is state. This first state can be considered a Deweyian messy situation. During this phase, learners focus on imperfections, problems and inefficiencies of the situation. During explorative actions, learners perform an act of "reflection in action" (Cowan, 1998; Schön, 1983). They must be aware of actions that they are carrying out.

Reflective observation.

During the second learning macro-phase, each learner performs a reflective analysis on the past concrete experience:

- Sharing: Learners relive the precedent experience. They mentally reprocess activities carried out with the aim of sharing them in a logical way with the faculty and other learners. The main distinctive features of the as-is state are exposed, debated and discussed.
- Re-elaboration: A key learning activity is the re-elaboration of what has been experienced. A reflective activity on actions, stand over by a faculty member, is done. The trainer captures insights provided during the sharing phase and, in this way, leads learners to the abstract conceptualization phase, in a motivated way. Learners analyze collected data, observed procedures and implications of such data. The overall learning process done so far is revised (Moon, 2004).

Abstract conceptualization.

What has been observed in the earlier stages is conceptualized here. Learners develop, individually or in groups, abstract concepts through prior concrete experiences, lessons and guidelines received. At this stage, they receive external input to be probed later in the subsequent phase of experimentation:

- Theoretical concepts transfer, explanation: In a hetero-directed learning process (formative), the trainer explains or recalls, entering details of the problem, concepts that allow the resolution of the as-is state. It is important that the trainer acts as a coach, inviting learners to reflect and to build themselves concepts and theories on which ground solution proceeds.
- To-be state planning: Learners apply in a theoretical way concepts and contents explained to problems detected in the as-is state. They design solutions to be tested in the next learning phase.

Experimentation.

Testing phase consists of the practical implementation of the designed solution and in the final review of the entire learning process. The analogy, for a lean transformation process, consists of the practical application of lean principles and methods under study to the future state (to-be state) of the model factory:

- To-be state application: The solution proposed during the to-be state planning phase is verified "in the field" and allows learners to bring the as-is situation to a final "to-be" situation. Here, learners can implement their own solution and make a comparison with other proposed solutions (generally lean solution proposed by the faculty).
- Consolidation: The learning cycle finally ends with an overall reflection on what has been done through the learning path (Engeström and Sannino, 2010; Cowan, 1998). If the problem is not completely solved, learners can retrace the learning cycle again, identifying new problems to the final situation obtained. This becomes the new initial situation (new as-is state) for a second learning cycle. On the other hand, if experimentation leads to a functional solution, learners enter the consolidation phase. During this last phase, concepts are consolidated and learners acquire competences. At this stage, learners have also transpose and drop learned contents to their own daily working experiences.

The test of the methodology: LEF case study

The methodology has been tested to the formative modules supplied by the LEF of Pordenone (Italy). At LEF, a lean transformation is simulated through a productive process reconfiguration, passing from a departmental configuration (as-is state) to an optimized cellular layout (to-be state). LEF delivers different catalogued courses spanning from 1 to 22 days, content-focused courses from 1 to 3 days and courses on contract.

The case study allows to understand the learning processes, through the application of the operative tools of the framework, and to test inductively from the field the learning model deducted from the literature.

Content and process: lean management learning path in LEF

In this section, we describe the application of the eight phases of the learning process (process) to lean management (content) in LEF highlighting content and process.

Concrete experience

Introductive briefing

- Process: Almost all the training modules at LEF start by an introductive briefing during which learners share their prior "experiences baggage" (Moon, 2004) and "reflect for action" (Cowan, 1998). They prepare their mindset for going through the learning cycle. They set learning objectives, also reporting real concrete working-life situations, and build the first "emerging" concepts of the contents they are going to learn. Most of the time, learners are "exposed" and moved into their "uncomfortable zone".During this phase, LEF's staff operates in two ways, depending on the contents' (the training module) difficulty and on learners' perceived capabilities. The higher the difficulty and the lower the capabilities, the more the trainers present carefully the concepts and detail the procedures; on the contrary, they skip the introductive step to rapidly go to the explorative phases.

- Content: The waste analysis (Technique 1), for example, consists of a brief introduction on the muda (waste) concept and on the seven Ohno's (1988) seven waste typologies. A physical distribution of templates follows. These templates will be used during the exploring phase. Possible LEF's weakness points in this step are linked to the duration of the phase that is strictly bundled to the kind of learners (how many explanations they need to catch the concept).

As-is state exploration

- Process: Participants go on with a concrete diagnosis of the as-is state of the LEF's manufacturing process. During this phase, learners focus on imperfections, problems and inefficiencies of the process, collecting them, sometimes helped by physical templates given by faculty. During this phase, learners work in team. During this phase, learners concretely move through the factory carrying out a diagnosis of the main issues related to the productive process.
- Content: In this step, for example, participants do not have to recognize the kind of activities: VA or not value adding (VA) or not value adding (NVA) (Technique 2). This could be an LEF's weak point. During this learning phase, a lack can be related to the absence of team working and immediate feedback from the trainers.

Reflective observation

Sharing

- Process: Learners relive the precedent experience. They mentally reprocess activities carried out, coached by trainers, and share a logical resume of what they experienced. In LEF, these phases are considered relevant. Significant time is spent to help learners conceptualize and abstract the problems of the as-is state of the factory.

Re-elaboration

- Process: A peer review of learners' feelings and workforce's behaviors of the manufacturing environment is shared. This is in accordance with Moon's 2004 phase of reviewing feelings and the emotional state. Learners, coached by trainers, make a comparison on what experienced both in terms of collected data and emotional feed-backing of the experience. Possible learning lacks have to be connected to the absence of the discussion phase because of limited learners' involvement or short time.

Abstract conceptualization

Theoretical concepts transfer, explanation

- Process: Learners develop abstract generalizations of what they experienced. In this phase, LEF's faculty generalizes lean concepts and explains principles, tools and methods for solving the as-is state inefficiencies and ineffectiveness. The trainer explains mistakes carried out by learners during the explorative phase and introduces the concepts for an optimal planning of the future state of the factory. Explanation is the learning method that permits a transfer of many concepts in short time. However, as Dale (1946, 1969) observed, people remember only 20 per cent of what they hear. Sometimes, as in LEF, the explanation phase is used as a link among subsequent learning paths. It gives learners some concepts that are not immediately needed, but will be necessary in the following training modules.In terms of lean transformation, the conceptualization allows learners to implement principles and methods of lean production, starting from inefficiencies noticed in the as-is state, for planning the future situation (to-be state).

- Content: For example, during the set-up activity of a workstation through the single-minute exchange of dies (SMED) technique (8), the trainer explains mistakes done by the operator involved in the tool changeover with the help of a film, registered during the concrete experience phase.

Learners carry out an active qualitative/quantitative analysis of the improvements of the changeover process. Learners' suggested improvements are applied to the to-be state of the workstation. For example, for the SMED technique, the operator redoes the changeover. In this case, the cycle time of the operation are measured to put into effective performance improvements achieved.

To-be state planning

- Process: Learners apply in a theoretical way concepts and contents collected during the explanation. Working in a team, they search for solution to the issues of the manufacturing process.
- Content: For example, they reconfigure the plant layout, and write standardized procedures for some working activities of the process.

Experimentation

To-be state application

- Process: Participants implement the planned activities to the to-be state of the model factory. LEF proposes two possibilities: the first is the effective implementation of the planned activity by learners (e.g. standard operating procedures [SOPs]), while the second is a "diagnosis" of the solution predisposed by LEF's faculty in the to-be state configuration of the model factory (e.g. line balancing). Some training module do not need the experimentation phase because they cover contents related only to the as-is state diagnosis (e.g. waste analysis and VA−NVA analysis). Sometimes, due to time, this phase is not carried out, and learning module ends with a final discussion. In other cases, the improvements are shown by the faculty in the configuration of the to-be state of the model factory.
- Content: For example, for the techniques 5S and SOPs, the learners themselves operate firsthand the transformation with greater results in terms of learning. Learners design and concretely implement the standardization of an activity subsequently tested by an operator. In these phases, the improvements gained through the timing and the disposability of the workstations to effectively show the taught techniques and accompany the learning process.

Consolidation

- Process: This step ends the learning path with an overall reflection on what has been done (Engeström and Sannino, 2010; Cowan, 1998). Concepts are consolidated, and learners acquire competences. At this stage, learners also transpose, coached by faculty's members, and learned contents to their own daily working experiences.Each learning process finally ends up with a general revision of the learning path traveled by learners aimed at transposing the learned contents to the operative realities of participants' companies.
- Content: If the problem is not completely solved, that is, the training module or the learning contents are just part of a larger subject, learners can enter a subsequent learning (e.g. waste analysis, VA−NVA analysis and time charting are parts of the VSM activities). Once learners achieved concepts such as waste, value-added activities, time measurement, etc., they could enter the learning path of the VSM that is building a map of value, recognizing the sequence of operations, the sources of waste, etc.

Coverage analysis at LEF

Figure 3 shows the application of the second tool, the Learning Contents Covering Scheme to the lean week. In each block of the lean management model are summarized the lean techniques and principles taught. Each block shows the coverage percentage calculated, dividing the total number of lean items taught and the total number of lean items mapped from the literature. Here, it is possible to see that the course does not cover the product development and customer–supplier relationships items. HRM was covered by the 45 per cent, quality management by 31 per cent, maintenance management by 17 per cent and planning and control by 36 per cent. Instead, the lean blocks of process and equipment (69 per cent), value analysis and mapping (67 per cent) and continuous improvement (50 per cent) received a deep coverage. This fact confirms that the focus of the LEF is the change of mentality and aptitudes of the course participants.

Experiential analysis at LEF

The Learning Process Analysis Matrix can be applied with reference to both training modules and lean techniques. Table II reports the analysis of the lean techniques taught during the lean week course. According to the visual thinking principle, accomplished learning phases were signed with "•"; partially accomplished learning phases were signed with "◑", while phases that were not accomplished at all were signed with "○". In parallel, the presence of weakness points in the training course was also outlined by the research team. Thus, after the assessment, training modules were improved to reach better levels (Table III).

This analysis shows how it is possible to assess the experiential learning course. Considering Knowles' adults learning principles exposed in the introductive chapter, LEF's faculty recognizes that adults are relevancy- and goal-oriented and provides during the briefing step of the learning process clear explanations of learning objectives and operative usage for concepts. This operative declination of learning content can also be seen in the eighth step (consolidation) of the learning path. Here, participants transpose what they have learned to their work reality. Learners are also autonomous and self-directed. Thus, during the learning process, they should be left free to "learn by trying". This occurs during the learning phases of as-is state exploration and to-be state planning. Participants try to diagnose LEF's manufacturing plant problems using concepts and tools gained from the first phase of the learning cycle and of course, deriving from the precedent learning paths coverage. For example, regarding the assessment activities of the Ohno's (1988) seven wastes, participants move around the LEF's plant trying to recognize waste. Their learning activity is "monitored", and they are coached by the LEF's staff during the whole learning path. Thus, they received feedbacks immediately.

The faculty tries also, when possible, to recall learners' own baggage of prior life experiences and knowledge to support learning activities. Many learning cycles in LEF start by asking learners' opinion and prior knowledge about an argument, asking them to report daily and concrete examples from their working life.

The considerations highlighted by the analysis have promoted the improvement of educational processes with particular reference to both experiential phases of the learning process and complementary need of theory and practice. Revision activities, where needed, were introduced in the LEF courses training. The analysis shows that the LEF, in fact, shows performance improvements gained from the introduction of lean principles and techniques. In fact, regarding the simulated process, learners can assess the following improvements:

- 100 per cent increasing of hourly productivity per employee;
- 90 per cent decreasing of production lead time;
- 80 per cent reduction of work in progress within the productive process flow; and
- 33 per cent decreasing of the space used by the process equipment.

Discussion

The proposed methodology permits to verify the appropriateness of the learning processes of LEF according to the models derived from the literature. The test highlights that the methodology is feasible from an operative point of view because of its simplicity and effectiveness. The analysis confirms how LEF's learning processes follow the path and how LEF was able to assess and revise "learning process lacks", according to the assessment results.

The framework (models plus tools) has implications both academics and managers. From the point of view of the literature, this work has highlighted the missing links between experiential learning and lean and between experiential learning and model factories; on this basis, the authors have proposed a methodology that bridges this gap based on a content analysis and a content–process analysis.

From a research point of view, the work contributes in suggesting that experiential learning can be assessed in a systematic way, by means of a methodology and specific tools. Following Kolb, "the watchers favour reflective observation, while the doers favour active experimentation". In designing courses for "doers", it is important to have in mind how the course can be effectively designed, in a way to have an improved learning experience, i.e. "perceiving new information through experiencing the concrete, tangible, felt qualities of the world, relying on our senses and immersing ourselves in concrete reality".

In terms of lean, the real situation is represented by the as-is state or initial configuration of the process simulated within the model factory. This state has to depict what the Dewey (2009) would define a "problematic situation". That is, a situation able to highlight the lack of efficiency and effectiveness of the organization/productive system. Inefficiencies have to be focused and linked to the conceptual material of learning (training modules). The as-is state problems and their exposition by the faculty staff have to be finetuned on learners' capabilities, without being trivial or impossible. Learners have to move forward into their Vygotskyian Zone of Proximal Development (Vygotsky, 1978). In terms of lean transformation, conceptualization allows learners to implement principles and methods of lean production, starting from inefficiencies noticed on the as-is state, for planning the future situation (to-be state).

From a practitioner's point of view, the framework can be used as an "assessment tool" to test the coherence between the learning model and the effectiveness of the learning processes carried out in the firm/school assessed: in other words, how well the learning process takes place according to experiential learning point of view. Moreover, the lean management model permits to gain a rapid view of the amount of contents delivered by the company with reference to the main lean items present in the literature.

Both the operative tools of the framework permit a schematic visualization of points of strength and weakness. Based on this diagnosis, the task of the faculty will be to evaluate how to effect a revision from the point of view of both trainers and learners.

From a dynamic perspective, then, the operative tools can be used as a tool to verify the alignment between the learning path and the learning processes of the company. Repeating the analysis with a periodic frequency, the model factory can come to redesign the learning path, to carry it out in many possible ways entering the path from different point and carrying over different learning journeys according to didactical objectives, learners and contents.

Finally, the models could be used as a tool for instructional design, in other words, to lead a design and planning of learning activities and contents. Moreover, because of its nature, the learning model can also be applied also to other fields than lean education.

Conclusions

The present study allowed for building a solid theoretical ground for the learning and training processes that occur in the model factories. A methodology for assessing learning lean by means of experience has been developed from the literature analysis. It will allow trainers to oversee each step of the "learning tour" with more focus.

However, the study has some weaknesses. The main one is the fact that the methodology is based on experts' judgments. To overcome this weakness, it will be necessary to widen the panel of experts and diversify them as much as possible. Moreover, the research can be based on a wider database, including other courses of the same model factory or to test it into other companies.

Finally, we collected many different sparks both from the literature and from learners' feedbacks that suggest that experiential learning and in particular the model factories yield to a deeper learning effectiveness due to the direct contact between a learner and a real, also familiar, learning place. A fact that has held steady in our mind was the statement of a learner at the end of a course: "you changed the way I saw the factory".

Such kind of learning paths vouches for an efficient education that merges theoretical concepts with immediate practical applications. The statement that with its simplicity synthesizes the overall research related to learning by concrete experiencing is from Dewey (2009):

> "An ounce of experience is better than a ton of theory simply because it is only in experience that any theory has vital and verifiable significance. An experience, a very humble experience, is capable of generating and carrying out an amount of theory (or intellectual content), but a theory apart from an experience cannot be definitely grasped even as theory. It tends to-become a mere verbal formula, a set of catchwords used to render thinking, or genuine theorizing, unnecessary and impossible."

Note

Notice that we always use the term education instead of teaching because educating, from Latin etymology, means draw (duce) out (e) that is helping people to learn, whereas teaching deriving from Latin insignere means impress.

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