A Simulation-based Approach for IT and Business Strategy Alignment and Evaluation

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Abstract: The use of IT solutions and services has drastically changed the effectiveness of business strategies. Although IT seems to create competitive advantage, modern enterprises often fail to gain the expected business value from it. This paper aims to cope with this problem. It first discusses the two key factors in creating IT-enabled business value, the strategic alignment of business and IT strategies and the mapping and evaluation of them by using the balanced scorecard method. It then proposes a simulation-based approach for an effective formulation, alignment and evaluation of business and IT strategies in conjunction. An extended simulation model for a computer manufacturer supply chain depicts the high applicability of the proposed integrated approach.

Keywords: IT strategy, business strategy, strategic alignment, balance scorecard, simulation, supply value chain.

1 Introduction

In the new digital era, emerging technologies have caused radical changes in the global market operation. The competition between enterprises has become stronger than ever before, while the innovation cycle of products and services has been significantly reduced. In such a complex business environment, Information Technology (IT) plays an important role in creating competitive advantage with respect to customer/supplier relationships, strategic alliances, innovation in product development, product customization, low cost production, continuous business process improvement, etc. For such reasons, modern enterprises invest more and more in IT. However, in most cases, they fail to gain any IT-driven competitive advantage. Thus, business executives need to know the return on their IT investments.

New IT practices, like web-based and service-oriented applications, have caused structural changes in conducting business and have supported new business models (Timmers, 2000). Towards this direction, enterprises seek ways to embrace new distribution channels, to obtain vast quantities of information, to respond timely to customer’s needs and to align their business processes with the emerging electronic marketplaces (Ferguson, 1996; Mu-Chen et al, 2007; Rishi and Goval, 2011). Although modern enterprises try to adopt all of these by investing a lot of money in IT, due to bad strategic choices, inadequate planning, misalignments in integrating IT strategy with the overall business strategy, and the opportunistic thinking for short term profits, they achieve poor IT-driven Return on Investments (ROI). In fact, they ignore the fundamentals of market operation and the principles of strategy formulation (Porter, 2001).

In order to minimize such problems, enterprises must formulate their IT strategy in compliance with their overall business strategy (Pralhalad and Krishnan, 2002; Kandem, 2008; Daim, Basoglu and Tanoglu, 2010), something which is called
Strategic Alignment (SA). If IT fails to provide the anticipated business value then IT shortfall happens (Tallon and Kraemer, 2003). Furthermore, the business strategy formulation must take into account the potentiality of new IT solutions. In other words, the synchronization between business strategy and IT strategy is vital. In order to evaluate the effectiveness of such synchronization, the Balanced Scorecard (BSC) method can be adopted (Grembergen and Saull, 2001; Kaplan and Norton, 2000; Gemlik, 2005; Tallau, Gupta and Sharman, 2010). In short, the main tasks that executive managers must undertake are the correct formulation of Business and IT strategies, the elimination of misalignments between them and the overall evaluation of their strategic decisions.

Towards this direction, the role of IT within a corporate or organizational environment must be clearly defined. In practice, a bad IT role with respect to the preset business goals leads to conflicting situations that as a sequence lead to bad financial results. The remedy of such conflicting situations requires appropriate feedback mechanisms and re-alignment methods from various perspectives. In other words, SA which concerns the joint governance of business and IT strategies is a repetitive process which must take into account the dynamic evolution of the business and technological environment. Furthermore, in order for the managers to localize misalignments and misfits, strategy mapping techniques are needed, while at the same time evaluation measurements must be possible (Marthandan and Tang, 2010). BSC has been proved a successful framework for both, mapping and evaluation, and for this reason we adopt it.

But, before the strategic decisions are realised, enterprises must have tools and ways of experimentation to understand the consequences of them. Towards this direction, simulation can be proved very useful (Barjis, 2010). The outcome can then be effectively examined using deductive logic and empirical evidence, especially e.g. in those cases that are nonlinear and empirical data are difficult to obtain (Jason and Bingham, 2007). Thus, what we propose in this paper is: first, the simulation of business activities, processes and resources (which reflect the business strategy decisions) via appropriate software tools, and second, the evaluation of the simulation results by a BSC creation tool revealing the operational and business performance via appropriate Key Performance Indicators (KPI). By running various simulation scenarios and analyzing the corresponding results, corporate executives and managers can effectively examine the formulation, alignment and evaluation of their business and IT strategies.

Thus, this paper proposes a simulation driven integrated approach for an effective formulation, alignment and evaluation of business and IT strategies in conjunction (Mitropoulos, 2007). In brief, this paper presents:

- in section 2, the IT-enabled value in modern businesses and the respective problem space,
- in section 3, the proposed technical approach,
in section 4, the background information including the main points for a successive SA (section 4.1) and the value of BSC on mapping and evaluating IT-enabled business strategies (section 4.2)

in section 5, a Supply Value Chain (SVC) simulation model for demonstrating the proposed approach by running two different scenarios that depict how to build-up the BSC, calculate the respective Key Performance Indicators and achieve SA, and finally,

in section 6, future work and the conclusions.

2 The Problem Space

In recent years, we have experienced new technological developments that caused structural changes in global markets operation. For example, e-commerce caused “channel enhancement” and revolutionary ways in conducting business, such as digital product provision, dis-intermediation, virtual communities, balance of information asymmetry, global access in services, etc. (Farmakis, Nanopoulos and Mitropoulos, 2003; Timmers, 2000). Furthermore, new intelligent algorithms offered innovations such as in medicine and in chemistry, while the impact of high IT usage in corporate culture, such as those of Google, Dell, Walmart caused clearly competitive advantage (Vandenbosch and Lyytinen, 2004; Rishi and Goval, 2011). Further to lowering the costs and improving the internal processes, IT can improve the information relevance, accelerate the time to market, transfer functionality to customers and enhance the relationships with them, succeed Just-In-Time (JIT) marketing and, augment the personnel skills. But, enterprises must make trade-offs between the effectiveness and the efficiency of IT (Rau and Bye, 2003). The effectiveness is related to the new methods and solutions in business, leveraging cost-effective operations, business intelligence, JIT marketing and personnel talent development, while the efficiency is related to the scale of economies for cost reduction, the efficient information access for process improvement, the failure-free services for customer advantage and the specialization of personnel. However, enterprises often fail to make the appropriate trade-offs and to develop an effective IT Strategy. They are quite confused regarding the role of IT, while inconsistencies in their strategic decisions arise (Rathnam et al, 2005). Thus, there is a strong need for the enterprises to formulate their IT strategy in conjunction with the overall business strategy, to evaluate the actual outcomes of these strategies (Kohli and Devaraj, 2004; Daim, Basoglu, Tanoglu, 2010), and then to find out misfits inside the strategies and misalignments between them. This paper tries to solve this problem by proposing a simulation based approach for Strategic Alignment, Mapping, and Evaluation (SAME). The proposed technical approach is presented in the following section.
3 Technical Approach

As already mentioned, our technical approach proposes a simulation-based framework for evaluating the degree of SA and the success of an IT-enabled business strategy. In brief, to conduct our research we followed the next steps:

1. we examined the main reasons for misalignments and inconsistencies between business and IT strategies,
2. we investigated ways of remedy that among others include the successive formulation of the business strategy determining in parallel where and how IT can enhance the overall business performance, and applying repetitive refinements of strategies and alignments between them, until the required performance is achieved,
3. in order to prove the value of the remedy solutions identified in the previous step, we selected a simulation model which fits better to the overall problem which is quite complex with a stochastic nature. For these reasons, we adopted the supply value chain model (Temizkan and Stylianou, 2009; Gunasekaran and Ngai, 2009) as it is appropriate to depict IT payoffs in many business environments,
4. we created the computational representation, namely the simulation model, of a test-bed example, in order to make valuable experimentation and construct a background for verifying the expected IT payoffs, and finally,
5. we analysed the simulation results for driving reasonable conclusions.

Before we proceed with the experimentation in the SVC simulation test-bed, we provide the required background information on SA and BSC.

4 Background Information

4.1. Strategic Alignment

SA targets to ensure that IT plays the predefined role in business operations and development. Venkatraman et al argued that the SA model consists of four main organizational areas: the business strategy, the organizational infrastructure, the IT strategy and the IT infrastructure (Venkatraman, Hedrson and Oldach, 1993). These areas must be aligned according to the requirements set on their various components, like business objectives, implementation plans, operational procedures and IT systems (Coleman and Papp, 2006; Cumps, Viaene, Dedene, 2010).

In general, greater levels of SA are preferable to lower ones (Kearns, 1997; Yayla and Hu, 2009). However, in some business environments, too much SA may cause inflexibilities and restrictions that limit the organizational ability to respond to environmental changes, business threats and opportunities. Thus, there must be a strategic intend for SA in enterprises. For example, enterprises that focus on operational effectiveness, which means to perform similar activities...
better than rivals by trying to eliminate wasted activities, employing advanced IT systems, motivating employees and having greater focus on management, need augmented SA. While enterprises that focus on strategic positioning which means to perform similar activities in very different ways than their rivals, e.g. by using IT to achieve greater ROI, market share, revenue, etc. or to identify entirely new market opportunities, can apply a looser SA (Tallon and Kraemer, 2003).

As new emerging technologies become increasingly important in market competition, IT becomes a prerequisite, something which drives organizations to reform accordingly their business strategy, as well as their organization infrastructure (Coleman and Papp, 2006; Althonavan, Sharif, 2010; Boonstra, Broekhuis, Offenbeek and Wortmann, 2011). In other words, emerging IT potentiality can modify key attributes of a business strategy, such as the business scope, the competencies, as well as its governance. New IT governance patterns and opportunities that arise by emerging IT solutions impact on the business strategy formulation. For example, the introduction of a new workflow-based information system in a business environment probably requires the revision of the business governance, of the business processes, as well as of the administrative structure. Finally, feedbacks must take place between all the various components of the SA areas. Such an SA approach, where the IT potentiality creates strong competitive advantage and thus drives the Business Strategy formulation, is shown in figure 1. For the sake of brevity, detailed explanations are not provided.

![Figure 1: IT-driven strategic alignment for Competitive Advantage](image-url)

Of course, there are also other perspectives of strategic alignment that must be taken into account with respect to the business context and focus (Coleman and Papp, 2006; Cumps, Viaene, Dedene, 2010; Khadem, 2008). Such perspectives
concern the strategy execution, the technology potentiality, the service provision level, the organization IT infrastructure, the strategy of IT infrastructure, the organization infrastructure and the strategy for the organization infrastructure. All of them constitute a full set of alignments needed during the strategy reformulation and business adaptation.

4.2. Balanced Scorecard

Enterprises and organizations need to know the consequences of their strategic decisions. In other words, a framework which maps and evaluates the business strategy in a measurable way is required. BSC provides the managers and the business executives with such capabilities. It introduces a common framework, which drives business and IT managers to think together on how IT can support business performance. Indeed, IT role can be fully integrated and evaluated in a BSC as the latter covers all the crucial success factors. In such a way, IT plans and investments can be prioritized in relation to business goals and the shared values of business and IT managers (Zee, 1999; Preston and Karahanna, 2009; Marthandan and Tang, 2010). In addition, in a BSC, intangible assets such as customer service and technology-driven corporation culture (Rau and Bye, 2003) can be also mapped, in order to understand the whole range of benefits gained by IT.

Specifically, the BSC method evaluates the various strategies based on a multi-perspective cause-and-effect network which consists of a number of Crucial Success Factors (CSF) (Kaplan and Norton, 2000A; Tallau, Gupta and Sharman, 2010). BSC facilitates the translation of strategies into action integrating financial measures with other key performance measures around customer perspective, internal business processes, and organizational growth and learning. A BSC consists of the financial perspective which links the company to its shareholders, the customer perspective which takes a look at the corporate customers, the internal business process perspective and the learning, growth and innovation perspective, which identifies the infrastructure and ability that the organisation must build to create long-term growth and improvement (Gemlik, 2005). This linkage between the CSF’s of the perspectives introduces the concept of strategy map which enables organizations to describe their objectives, measures, targets and initiatives that, in fact, provide the strategic direction (Kaplan and Norton, 2000B; Waal, 2003; Wong, Chiang and McLeon, 2009).
Figure 2: BSC-based Strategy Mapping and Evaluation

Figure 2 depicts this approach. Each perspective is considered by a number of objectives that are defined in a specific business context along with the respective measures that concern the parameters used to define if the objective is succeeded, the targets that provide quantitative values in order to determine success of the measures, and the initiatives that must be undertaken in order to meet an objective (Scherer, 2002). The measures must concern both tangible and intangible assets, and represent all the management and operational levels (Lin and Wie, 2005). Special care must be taken regarding the intangible assets, like IT capability, customer relationships, and personnel skills, because these offer competitive advantages that in some cases can be difficult copied by rivals. This can be considered as another valuable attribute of BSC, as it can represent quite easily into one framework, both tangible and intangible assets. For this purpose, we need to define a number of KPI’s that express the effectiveness of the decisions made and quantify the CSF’s. KPI’s must be quantifiable to a large extent providing a clear meaning of success, and controllable within a specific time frame (Toten, 2005). IT KPI’s can be selected from the COBIT (COBIT, 2011) or the ITIL (ITIL, 2011) frameworks, while business KPI’s can be selected from the respective business literature (Silva and Chaix, 2008). SMARTA (Specific, Measurable, Agreed to, Realistic, Timely and Aligned) can be selected as a good framework for setting up KPI’s (Nikitina, 2010).
5 Supply Value Chain: Modeling, Alignment and Evaluation

5.1. The Simulation Environment

In this section, we present the application of our simulation-based method in a supply value chain example. The simulations took place in the TIBCO Business Studio software tool. TIBCO is designed for business analysts who need to document business processes and for corporate developers who implement business processes (TIBCO, 2011). The simulation here concerns the workflow operating process of a company which manufactures (assembling ready made parts of) computers, and which interacts with customers and external business partners within a supply value chain (Gunasekaran and Ngai, 2009). The examined workflow process provides an indicative test-bed environment for gathering simulation results that under specific assumptions drive the construction of the SVC BSC. Although it is expected that the introduction of IT will improve the overall business performance, the scope of our work presented hereafter is to present our simulation based method and how it can help the corporation executives to measure and estimate the expected benefits from investing in IT.

As far as the simulation test-bed is concerned, we constructed two workflow processes. The first process concerns the operation of the company before the introduction of a workflow oriented ERP system (called hereafter the “manual” process), while the second one concerns the company operation after the introduction of a workflow oriented ERP system (called hereafter the “IT-enabled” process). In addition, a number of realistic assumptions were made according to our working experience in similar IT-enabled operational environments. A workflow oriented ERP differs from a traditional ERP system in terms of effectiveness and efficiency (Cardoso et al., 2004; Kamhawi and Gunasekaran, 2009). For demonstrating the business value created by the introduction of the new IS, we didn’t constructed a BSC for each case, but a (Δ-) BSC, which expresses the differences in performance between the two cases with respect to various outcome measures. In table 1, we provide the generic workflow simulated process and the respective activities on which the two scenarios are based, while in table 2 the main input parameters and simulation factors are depicted (Mitropoulos, 2007). The detailed assumptions made per activity for both simulation processes are shown in the corresponding tables (A1 and A2) in the Appendix.
1. The starting point of the process is the “Order Making”. For the process without the use of ERP the “Order” takes place by telephone or by fax, while for the process with the use of ERP the “Order” takes place via Internet (web applications).

2. After the reception of an “Order”, the “Check Order Accuracy” activity takes place checking if there are mistakes or omissions in the fulfillment of the “Order Form”. If there are mistakes or incomplete data then the customer is required to submit once again the “Order”, otherwise the process continues with the next step which is the “Product Availability Checking”.

3. For the “Product Availability” activity, two scenarios are possible:
   a. If the ordered product is not available:
      i. Start the process of “Procurement”. In the scenario with the use of ERP, the procurement can be done electronically (via an Internet-based B2B system).
      ii. Next, there is a check if the Supplier can support “Just-In-Time” procurement or not. If the supplier cannot support JIT the procurement is canceled. Otherwise, the supplier can proceed with an “Offer” (bid). In the case of ERP, the “Offer” can be submitted electronically, while a number of suppliers can be contacted via an “E-procurement” web-based system in order to submit their bids.
      iii. Upon the acceptance of an “Offer” by the company, the supplier must submit the ordered materials (shipment of ordered materials).
      iv. The materials are received and the appropriate arrangements take place for material storage and update of the inventory system.
      v. The “Product Availability” is once again checked and the workflow control goes to (b).
   b. If the ordered product is available the next step is the “Assembly of the Product”.

4. The product is “Assembled” and the “Product (order) Invoice” is prepared.

5. Next, the “Customer Billing” takes place and upon the achievement of the necessary arrangements for billing (e.g. credit card checking), the activity of “Product Packaging” takes place. Otherwise, the “Order” is canceled (abnormal end).

6. When the Product is “Packaged”, the “Product Delivery” starts and the process goes to the “Shipment” activity.

7. If the “Shipment” takes place without unacceptable problems and delays, the product is received by the customer, otherwise the “Order” is canceled (as well as the customer’s invoice (billing)).

**Table 1: The simulated process**

1. the number of input cases (orders),
2. the personnel employed per activity,
3. the duration of an activity,
4. the cost per employee per activity per hour,
5. the probability of activity success,
6. the maximum number of activity failures,
7. the distribution of values,
8. the deviation from the mean value,
9. etc.

**Table 2: Input parameters and simulation factors**
Figure 3 depicts the SVC process without the use of an ERP (manual process), while figure 4 depicts the SVC process with the use of an ERP.

Figure 3: The workflow SVC process without the use of ERP (“manual” process)
Table 3 presents the simulation results (total simulation time, average time of cases, average cost per case and cumulative cost) of the two scenarios plus the differences between their corresponding values. What can be easily observed is that in all metrics the IT-enabled approach presents much better performance results.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IT-enabled</td>
<td>68915.9</td>
<td>21322.2</td>
<td>190.4</td>
<td>95215.9</td>
</tr>
<tr>
<td>manual</td>
<td>108877.9</td>
<td>44085.2</td>
<td>1639</td>
<td>819533.2</td>
</tr>
<tr>
<td>Difference</td>
<td>39.962</td>
<td>22.763</td>
<td>1.448,7</td>
<td>724.317,3</td>
</tr>
</tbody>
</table>

Table 3: The total simulation results per scenario

Except from the above simulation results, the results per activity extracted from TIBCO, were examined in detail. Such results are useful for the detailed examination of the differences between the manual and the IT-enabled processes. As for example, we provide the activity results for the “Customer Billing” activity. In the “manual” scenario, the duration of this activity, follows “Gaussian Distribution” with mean value 30 minutes, “Standard Deviation” 6 minutes and maximum duration 45 minutes. In this activity, 4 employees with cost 15 units per hour per employee are engaged. The “Customer Billing” is checked if it takes place with success. The probability of success of billing activity is set to 95% and the process is directed to the activity of “Packaging and Start Delivery”. Otherwise the process is directed to “Cancellation”. Table 4 shows the “Customer Billing” activity results in the “manual” scenario.

Table 4: The “Customer Billing” activity results in the “manual” scenario
In the IT-enabled scenario, the duration of “Customer Billing” activity follows “Gaussian Distribution” with mean value 10 minutes, “Standard Deviation” 2 minutes and maximum duration 15 minutes. In this activity, 2 employees with cost 10 units per hour per employee are engaged. The “Customer Billing” is checked if it takes place with success. The probability of billing to be successful is set to 95% and the process is directed to the activity of “Packaging and Start Delivery”. Otherwise the process is directed to “Cancellation”. Table 5 shows the “Customer Billing” activity results in the “IT-enabled” scenario.

Table 5: The “Customer Billing” activity results in the “IT-enabled” scenario

5.2. Comparison of the two Scenarios based on the BSC Approach

Hereafter, a detailed comparison of the two scenarios takes place based on the BSC approach. We provide the performance evaluation for each business perspective as defined in BSC. Specifically, for each perspective, we defined a number of CSF’s. The calculation of their respective KPI’s was made based on the results provided by the simulation runs. Figure 5 depicts the defined per BSC perspective CFS’s.

<table>
<thead>
<tr>
<th>BSC Perspective</th>
<th>Increased Revenue</th>
<th>Cost Reduction</th>
<th>Net Income Increase</th>
<th>ROI Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>Customer Orientation</td>
<td>Customer Retention</td>
<td>New Customers</td>
<td>Increased Market Share</td>
</tr>
<tr>
<td>Internal Process</td>
<td>Process Innovation</td>
<td>Convenience in Order/Billing &amp; Customer Service via Internet</td>
<td>Supplier Relationships for JIT</td>
<td>Internal - External Data</td>
</tr>
<tr>
<td>Growth &amp; Future Readiness</td>
<td>Innovation Capability</td>
<td>Productivity Increase plus Cost Control</td>
<td>Knowledge</td>
<td>Process Improvement</td>
</tr>
</tbody>
</table>
5.2.1. Growth Perspective

In this perspective, the following four CSF’s were determined:

- **Innovation capability**: new IT systems incorporate new capabilities and innovative technologies (future readiness)
- **Potentiality of productivity increase and greater cost control**: IT driven product assembly provides (e.g. via CIM systems and Robotics) the company with tools for higher productivity and improved cost control
- **Improved knowledge**: e.g. information tracking regarding the product delivery status and the inventory status
- **Personnel training in new technologies**: the new IT system can provide user empowerment via web-based training and on-the-job help.

These factors are not estimated quantifiable in our example but they are assumed to be incorporated someway in the calculations of the crucial success factors of the other perspectives by using the simulation results or making the respective assumptions. The reason is that in order to calculate measures of these crucial success factors, detailed organizational research analysis must take place which is out of the scope of this paper, while we also lack of such data.

5.2.2. Internal Process Perspective

This subsection focuses on the comparison of the two processes regarding the internal process perspective. The comparison is based on the % difference calculations. We note that the equal factor in the calculation of mean values is *indicative* and more complex mathematical expressions might be needed in some cases. Thus, we calculate the following differences of various KPI’s of the two scenarios:

### %Δ in “Process Innovation”

Here, we compare the performance regarding Process Innovation. Two measures are considered, the “Order Making time” and the “(e-) Procurement time”. We calculate the % time difference (%Δ) of both cases as follows:

\[
\frac{\text{New Time} - \text{Old Time}}{\text{Old Time}} \times 100 = 69.06\%
\]

### %Δ in “Convenience in Order/Billing and Customer Service via Internet”

In this CSF, we have the following measures: “Order Making Time”, “Cancellation Time” and “Customer Billing Time”:

\[
\frac{\text{Cancellation}_{\text{Manual}} + \text{Billing}_{\text{Manual}} + \text{Order}_{\text{Manual}}}{\text{Cancellation}_{\text{Manual}} + \text{Billing}_{\text{Manual}} + \text{Order}_{\text{Manual}}} \times 100 = 69.14\%
\]
%A in “Supplier Relationships for JIT (Just-in-Time)”
In this CSF, we have the following measures: “Supply & Shipment time”, “Supplier Offer time” and “(e-)Procurement time”:
\[
\text{Supply & Shipment} + \text{Supplier Offer} + \text{(e-)Procurement} = 65.65\%
\]

%A in “Internal/External Data”
In this CSF, we have the following measures: “Check Product Availability time”, and “Accounting in Order time”:
\[
\frac{\text{Availability Check} + \text{Accounting}}{\text{Availability Check} + \text{Accounting}} \times 100 = 49.92\%
\]

%A in “Risk Reduction”
In this CSF, we have the following measures: “Check Product Availability time” and “Credit Card time”:
\[
\frac{\text{Availability Check} \times \text{Credit Card}}{\text{Availability Check} \times \text{Credit Card}} \times 100 = 67\%
\]

%A in “Time Distribution”
In this CSF, we have the following measures: “Inventory Management time”, “JIT time”, “Product Receipt time”, “Assembly Products time” and “Packaging & Start Delivery time”:
\[
\frac{\text{Inventory + JIT + Product Receipt + Assemble + Packaging}}{\text{Inventory + JIT + Product Receipt + Assemble + Packaging}} \times 100 = 62.41\%
\]

%A in Product Customization
In this CSF, we have the following measures: “Assembly Products time” and “Order Making time”:
\[
\frac{\text{Assembly} \times \text{Pack & Delivery}}{\text{Assembly} \times \text{Pack & Delivery}} \times 100 = 69.01\%
\]

The final results are shown in table 6.
5.2.3. Customer Perspective

In this subsection, we compare the performance of the two processes regarding the customer perspective. The comparisons are based on % difference calculations as before. In this perspective, the following CSF’s are defined:

**%Δ in “Customer Orientation”**
In this CSF, we have the following partial measures: “Response Time”, “Less Money” and “Product Customization”. The % difference of “Response Time” is calculated based on the mean time for the fulfillment of an order. The % difference of “Less Money” is calculated based on the mean overall cost for the fulfillment of an order. The % difference of “Product Customization” was calculated in the previous section for the Internal Process Perspective. For the overall difference of “Customer Orientation” we calculate the average of the differences of the partial measures, as an indicator for customer orientation:

**%Δ in “Customer Retention (Loyalty)”**
In this CSF, we assume two of equivalent value performance drivers, the first is the “Customer Orientation” which its %Δ has been already calculated above, and the %Δ of “Number of Order Made”. For the manual process, the “Number of Orders” is 232, while for the IT-enabled process is 500, in the same time period. Namely, when manually 232 cases are completed in a specific period, for the same period in the IT-enabled process the completed cases are 500.

**%Δ in “New Customers”**
In this CSF, we have just one measure, the difference between the number of new customers of the two processes (manual and IT-enabled). This number is calculated from % differences of the “Response Time” and for the “Less Money”. The % difference between the two is calculated as follows:

**%Δ in Market Share Increase**
In this CSF, we calculate the “Market Share Increase” based on the following formula:
In this CSF, we have the following measures: “Delivery with Integrity”, “In Time Delivery” and “Rejection Rate”. We assume that the “Delivery with Integrity” is of the same value hence the % difference is equal to zero. Of course, this needs further investigation and depends obviously on the special characteristics that may influence the delivery integrity. The % difference in the Success Fulfillment of Order is calculated by the “In Time Delivery” indicator, whose value is extracted from the measure concerning the number of days needed for the delivery of an order. In the IT-enabled case it is:

$$\frac{21.322.17 \text{min} / 1440 \text{min/day}}{14.8 \text{days from the start of order},}$$
while in the manual case it is:

$$\frac{44.085.2 \text{min} / 1440 \text{min/day}}{30.6 \text{days from the start of order}.}$$

Thus, we have the following % increase in “Quality in Delivery”:

$$\frac{30.6 - 14.8}{30.6} \cdot \frac{100 + 0}{2} = 25.81\%$$

All the calculated CSF measures along with their breakdown analysis are shown in table 7.

<table>
<thead>
<tr>
<th>Customer Perspective</th>
<th>Customer Orientation</th>
<th>Customer Retention</th>
<th>New Customers</th>
<th>Market Share</th>
<th>Perfect Quality</th>
<th>Service Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Time</td>
<td>Customer Orientation</td>
<td>Response Time</td>
<td>Naf Orders Made</td>
<td>Delivery with Integrity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% improvement</td>
<td>51.63417655</td>
<td>69.7</td>
<td>51.3</td>
<td>115.51</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less Money</td>
<td>Naf Orders Made</td>
<td>Less Money</td>
<td>Old Market Share</td>
<td>Successful Fulfillment of Order</td>
<td></td>
</tr>
<tr>
<td>% improvement</td>
<td>88.3817254</td>
<td>115.51</td>
<td>88.88</td>
<td>10.22 (flat min)</td>
<td>21.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product Customization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% improvement</td>
<td>69</td>
<td>(New Order Ratio / Old Market Share)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% difference (%Δ)</td>
<td>69.70265325</td>
<td>97.609</td>
<td>70.00796597</td>
<td>11.269</td>
<td>25.81699346</td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Customer perspective measures

5.2.4. Financial Perspective

In this perspective, we focus on a number of indicative financial crucial success factors that are mainly based on the previous results and various assumptions. We assume that the company decides to offer substantial reduction in the PC price due to its higher production capability occurred after the introduction of the
new IT system. The current average price of PC in market is approximately 2000 monetary units (mu’s), but now our company sells at 1000 mu’s due to its new IT-enabled processes. We also assume that for a specific time period, we have 500 orders fulfilled. The previous revenue (referred to the same time period with the fulfilled 500 orders of the new scenario) is equal to: 232*2000 = 464,000 mu’s, while the new revenue is equal to: 500*1000 = 500,000 monetary units (for the same time period).

Thus, the Revenue Rate Increase is \( \frac{500 - 464}{464} \cdot 100 = 7.35\% \) due to the higher number of orders in the IT-enabled scenario.

Let’s now examine the Net Income (NI) increase. Speaking on the base of 500 PC’s, the previous profit margin was: 500*(2000-1639.06) = 180,470 mu’s, while the new profit margin is: 500*(1000-190.43) = 404,785 mu’s, where 1,639.06 and 190.43 are the respective average production costs.

This implies a significant increase of the Net Income equals to 404,785 – 180,470 = 224,315 mu’s with the respective rate of increase to be: N.I. Increase Rate = (404,785 – 180,470)/180,470 = 124% due to the lower cost of orders in the IT-enabled scenario.

We indirectly assumed that the rate of increase of orders in the case of IT-enabled scenario within a specific time period is due to the increased customer satisfaction plus the lower prices, benefits occurred by the introduction of the new IT system. Specifically, the cost reduction on the 500 number of orders is equal to: 1,445.63 * 500 = 722,815 mu’s, where 1,445.63 is the average cost difference per order.

The percentage of the cost reduction based on total cumulative costs is as follows:

As far as the Return on Investment (ROI) Increase (%) is concerned, we have the following formula:

\[ \text{ROI Increase} = \frac{(\text{Revenue}_{\text{IT-enabled}} - \text{Cumulative Cost}_{\text{IT-enabled}} - \text{Revenue}_{\text{manual}} + \text{Cumulative Cost}_{\text{manual}})}{\text{Cumulative Cost}_{\text{manual}}} \times 100 \]

assuming 500 orders and per PC price 1000 mu’s for the IT-enabled scenario and 2000 for the manual scenario. Thus, we have finally the table 8 for the Financial Perspective measures.
Table 8: The financial perspective measures

<table>
<thead>
<tr>
<th>Financial Perspective</th>
<th>Increased Revenue</th>
<th>Cost Reduction</th>
<th>Net Income Increase Rate</th>
<th>ROI Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>% improvement</td>
<td>7.75%</td>
<td>-88.38%</td>
<td>124%</td>
<td>1830%</td>
</tr>
</tbody>
</table>

According to the assumptions made, it is clearly shown in table 8 that the business performance can significantly improve by introducing strategic IT solutions and services.

5.3. Strategic Alignment Achievement

This subsection depicts how SA can be evaluated and achieved in the examined test-bed by using simulation. As known, IT strategy must support business operations according to specific criteria that are usually expressed and formulated in IT-enabled environments as Service Level Agreements (Silva and Chaix, 2008). The efficiency and effectiveness of IT processes is evaluated via the definition of a number of crucial success factors (CSF) which are measured by appropriately selected KPI’s. IT KPI’s must support and cause the right range of values for their corresponding business KPI’s. If this is the case then a good level of SA is achieved, otherwise further improvement must take place regarding the use of IT and/or refinement of the internal corporation processes. Towards this direction, a number of simulation scenarios must take place making the appropriate refinement decisions each time.

In order to demonstrate the above approach, we provide hereafter a short number of SA simulation scenarios. Specifically, the process simulation takes place for two cases, the “AS-IS” and the “TO-BE”. The “AS-IS” case concerns the initial process that needs amendments, refinement and finally alignment with the business goal. The “TO-BE” case concerns the final process which is going to be deployed in the modified IT environment. The “TO-BE” process may come from a number of iterative refinements. In our example, the “TO-BE” process is driven by the adoption of the Service Oriented Architecture (SOA) model which provides flexible means for efficient planning, development and operation of IT applications, dynamic management of IT resources, improved business partner transactions, low-cost service customization, easy service exposition to third parties, SLA fulfilment, change management, etc. (Mitropoulos and Douligeris, 2011; TIBCO, 2011).

More specific, our example concerns the “Customer Billing” sub-process for which we assume the arrival of 30 cases that follow the normal distribution with mean time 15 minutes and standard deviation 5 minutes within a typical working day. Figure 8 depicts the “manual” scenario for the “Customer Billing” sub-process (the “AS-IS” process).
Running this simulation, we found that the average case time is about 25 min. As we can see in this figure, a number of activities such as data entry, credit card checking (e.g. by exchanging fax), manual errors logging, amount definition and update of systems via data entry, as well, enforcement of a discount policy from a supervisor and, preparation of the final invoice or (alternatively if something goes wrong) a bad notification. The performance of this sub-process in the new competitive business environments is not accepted and for this reason the process must be appropriately refined in order to succeed average case times less than 7 min. For this purpose, the company must purchase new IT systems for automatic data import, credit card checking (via interoperability with external banking systems), discount policy enforcement, error handling, etc. Such systems can play an important role in execution time and operating cost reduction and thus, must be included in the new workflow process. Figure 9 depicts the “IT-enabled” scenario (the “TO-BE” process).
The average case time for this sub-process is about 6.4 min which means that the new system fulfils the preset business operating goal regarding the response time of billing activity. In order to succeed such an operating goal, a number of SLA’s at the IT service level must be defined first. For example, the interoperability system for automatic credit card checking must present maximum delay 40 seconds, while the enforcement of an automatic discount policy must not take longer than 4 seconds. If there was a deviation from the required final result regarding the billing activity, further refinement should have been made in the system configuration and more strict performance requirements should have been set up. In this way, we have a progressive alignment of IT systemic goals with the respective business goals.

The provision of very effective and advanced IT systems can improve significantly business performance, as well as bring possibilities for new IT services, such as secure e-billing. Thus, by the introduction of new IT systems, the companies must in parallel consider potential new business goals and policies, e.g. an increased e-selling product discount over the internet. In such a case, we have a technology-driven competitive potentiality of the company, something which may require the business strategy to be accordingly re-formulated.

5.4. Discussion on Simulation Results

The purpose of the conducted simulations was to give a way to get a clear picture of the effects of IT on business processes and the respective strategic choices. Towards this direction, we defined a workflow process which is quite representative, while we made a number of reasonable assumptions per process activity. Although, the assumptions made come from our working experience, for more realistic results, we need analytical data for each step of the described process from enterprises of the real world. But, obtaining such data is a very difficult task because enterprises are not usually willing to reveal such data for confidentiality reasons. However, our work based on reasonable assumptions produced simulation results that highlight the value added by IT in a very specific and measurable way.

Although the business value created by IT might be obviously expected, our goal was to depict the simulation based method which provides the managers with specific performance measures, useful for as much as possible accurate decision making on IT investments and choices. For instance, if we invest an amount of money in IT, it is not enough to know that IT will increase the business performance, but we also need to know how much exactly, and this is the reason why the simulation based evaluation is needed. The adopted simulation approach does not only incorporate IT relevant issues, but also business strategy ones. This is extremely important for the success of a business strategy, as well as, of an investment on IT. We can easily observe from the simulation results that the
increased productivity and the reduced costs caused by IT in each business process step result in an improved corporate product. Even though this was expected, what our approach succeeded to reveal was the quantified estimation of the benefits arisen from IT in a business context.

Further to the construction of BSC, we provided an example on how to estimate via simulation the strategic alignment between IT and business goals e.g. expressed by a Service Level Agreement. We followed a try-and-error approach in our simulation environment. This is very useful, because in real business environments any change might cause significant loss of money. Thus, experimentation via appropriate simulation models can protect the investors of making the wrong decisions.

In conclusion, the simulation results showed that applying an integrated approach on mapping, aligning and evaluating the various choices over the business and IT strategies, enterprises can achieve higher IT payoffs, while at the same time, they can discover new ways of conducting business by exploiting the potentiality of new IT systems and solutions.

6 Conclusions

New information technologies incorporate new capabilities for innovation in business products and services. In addition to the well-know benefits from IT, mobile and ubiquitous computing can provide all the involved business partners with enhanced competitive advantage. Enterprises must invest in IT, not in a fragmentary way, but in an integrated way by incorporating IT Strategy into their overall business strategy. During our research for the development of an integrated model for IT/Business strategy formulation, alignment and evaluation by using modeling techniques, simulation and the BSC, we first investigated the expected usage results from its enforcement in real business and organizational environments. We strongly believe that the top management, the senior executives, as well as the tactical management will benefit by using our approach. Thus, a main implication is that all of these key players can take real competitive advantage by taking the big picture of how things must be defined and implemented. Our approach incorporates all the main aspects for a successive strategy execution. As a consequence, the strategic management will not be isolated and uncorrelated, but on the contrary will be progressively adapted and refined towards the right direction. In other words, the adoption of the proposed approach can lead to high business performance, agility and consistency in decision making, increased coordination, improved resource control, and finally positive financial results. Of course, in order to achieve all of these, there are limitations that must be overcome by the enterprises and organizations. As such limitations can be considered the bad business tactics and practices, the communication gaps, the cultural gaps and inconsistencies, etc.
Concluding, this paper uniquely proposes a simulation driven approach for a joint and effective business and IT strategy alignment and evaluation. Our simulation-based approach contributes towards this direction by successfully integrating SA with BSC which is a method for mapping and evaluating IT-enabled business strategies. Finally, our approach was effectively demonstrated in a Supply Value Chain (SVC) simulation model.

In the near future, we are working to develop a theoretical integrated architectural model for a joint business and IT strategy formulation, alignment, execution and evaluation, by incorporating further to SA and BSC frameworks, the strategic architecture (Littler et al., 2000) and the business architecture frameworks (Versteeg and Bouwman, 2006). Towards this direction, we are planning to develop further our simulation-based approach in order to cover all the aspects of the new architectural model. Last but not least, we also target for the new architectural model and the corresponding simulation model to represent also collaborative business environments, something which calls for synchronized multi-BSC’s (Kent and Geraght, 2004).

Acknowledgements

I would like to thank Mr. V. Giotsas for his valuable help, as well as the reviewers for their constructive and helpful comments.

References


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## Appendix

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration of activity</th>
<th>Number and cost of employees</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival of Order</td>
<td>• Total number of simulated orders = 500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order Making</td>
<td>• Arrival of orders ~ Gaussian distribution with $M = 60$ min. and $SD = 10$ min.</td>
<td>2 employees</td>
<td></td>
</tr>
<tr>
<td>Check Order Accuracy</td>
<td>• Probability of accuracy = 90%</td>
<td>4 employees</td>
<td>• Non-accurate orders return to “Order Making” activity for corrections and then again to “Check Order Accuracy”.</td>
</tr>
<tr>
<td>Check Product Availability</td>
<td>• Number of loops ~ Gaussian distribution, $M=3$ times, $SD=1$ time.</td>
<td></td>
<td>• Number of loops ≤ 3</td>
</tr>
<tr>
<td>Procurement</td>
<td>• JIT capability must be first checked</td>
<td>4 employees</td>
<td>• Probability of product availability = 95%.</td>
</tr>
<tr>
<td>Supplier Offer</td>
<td>• JIT is not possible the order is canceled</td>
<td>2 employees</td>
<td>• Probability of JIT = 96%</td>
</tr>
<tr>
<td>Supply &amp; Shipment</td>
<td>• Inventory management returns “Check Product Availability” with maximum number of 3 loops</td>
<td>20 employees</td>
<td>• In case of JIT the process is directed to the “Supplier Offer” activity.</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>• After the loops the ‘Assemble Product’ activity is triggered (without IT-enabled system)</td>
<td>4 employees</td>
<td>• If JIT is not possible the order is canceled</td>
</tr>
<tr>
<td>Assemble Products</td>
<td>• Inventory management returns “Check Product Availability” with maximum number of 3 loops</td>
<td>20 employees</td>
<td></td>
</tr>
<tr>
<td>Accounting Data Entry</td>
<td>• Probability of successful billing = 95%</td>
<td>4 employees</td>
<td></td>
</tr>
<tr>
<td>Customer Billing</td>
<td>• In case of success the process is directed to the “Packaging and Start”’ delivery activity, otherwise it is directed to “Cancelation”.</td>
<td>4 employees</td>
<td></td>
</tr>
<tr>
<td>Cancelation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging and Start Delivery</td>
<td>After shipment there is a checking if the ‘Delivery’ was successful.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipment</td>
<td>• In case of success the process is directed to the ‘Product Receipt’ activity. Otherwise the order is cancelled.</td>
<td>20 employees</td>
<td></td>
</tr>
<tr>
<td>Product Receipt</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t$: time, $M$: mean, $SD$: standard deviation, Cost is in monetary units per hour per employee

Table A1: The assumptions made per Activity for the Simulation Process without the use of the workflow based ERP (manual process).
<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration of activity</th>
<th>Number and cost of employees</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Arrival of Order               |                      |                              | • Total number of simulated orders = 500  
• Arrival of orders ~ Gaussian distribution with \( M = 60 \) min. and \( SD = 10 \) min. |  |
| Order Making                   | \( t \sim \text{Gaussian distribution} \)  
\( M = 15 \) min.  
\( SD = 10 \) min.  
Max. \( t \leq 20 \) min. | 1 employee  
Cost = 2 | • Probability of accuracy = 90%  
• Non-accurate orders return to “Order Making” activity (via web application) for corrections and then again to “Check Order Accuracy”.  
• Number of loops ~ Gaussian distribution. \( M = 3 \) times. \( SD = 1 \) time. |
| Check Order Accuracy           | \( 10 \leq t \leq 15 \) sec. | 2 employees  
Cost = 3 | • Probability of product availability = 95%  
• Unavailable orders trigger the “Procurement” activity. After the procurement the order returns to “Check Product Availability”.  
• Number of loops \( \leq 3 \) |
| Check Product Availability     | \( t = 40 \) sec. | 2 employees  
Cost = 10 | • JIT capability must be first checked  
• Probability of JIT = 96%  
• In case of JIT the process is directed to the “Supplier Offer” activity.  
• If JIT is not possible the order is canceled |
| e-Procurement                  | \( t \sim \text{Gaussian distribution} \)  
\( M = 30 \) min.  
\( SD = 15 \) min.  
Max. \( t \leq 50 \) min. | 2 employees  
Cost = 25 | • Inventory management returns “Check Product Availability” with maximum number of 3 loops  
• After the loops the “Assemble Product” activity is triggered (with IT-enabled systems offering better monitoring) |
| Supplier Offer                 | \( t \sim \text{Gaussian distribution} \)  
\( M = 2 \) h.  
\( SD = 0.5 \) h.  
Max. \( t \leq 3 \) h. | 1 employee  
Cost = 5 | |
| Supply & Shipment              | \( t \sim \text{Gaussian distribution} \)  
\( M = 16 \) h.  
\( SD = 4 \) h.  
Max. \( t \leq 24 \) h. | 10 employees  
Cost = 15 | |
| Supply Management              | \( t \sim \text{Gaussian distribution} \)  
\( M = 15 \) minutes  
\( SD = 2 \) minutes  
Max. \( t \leq 20 \) minutes | 2 employees  
Cost = 10 | • After the loops the “Assemble Product” activity is triggered (with IT-enabled systems offering better monitoring) |
| Assemble Products              | \( t \sim \text{Gaussian distribution} \)  
\( M = 2 \) h.  
\( SD = 0.5 \) h.  
Max. \( t \leq 3 \) h. | 10 employees  
Cost = 50 | |
| Accounting Data Entry          | \( t \sim \text{Gaussian distribution} \)  
\( M = 4 \) min.  
\( SD = 1 \) min.  
Max. \( t \leq 6 \) min. | 2 employees  
Cost = 10 | • This activity is executed automatically, and there is no need for data entry. |
| Customer Billing               | \( t \sim \text{Gaussian distribution} \)  
\( M = 10 \) min.  
\( SD = 2 \) min.  
Max. \( t \leq 15 \) min. | 2 employees  
Cost = 10 | • Probability of successful billing = 95%  
• In case of success the process is directed to the “Packaging and Start” delivery activity, otherwise it is directed to “Cancelation”. |
| Cancelation                    | \( t = 15 \) min. | 2 employee  
Cost = 10 | |
| Packaging and Start Delivery   | \( t \sim \text{Gaussian distribution} \)  
\( M = 2 \) h.  
\( SD = 1 \) h.  
Max. \( t \leq 3.5 \) h. | 10 employees  
Cost = 10 | |
| Shipment                       | \( t \sim \text{Gaussian distribution} \)  
\( M = 5 \) min.  
\( SD = 2 \) min.  
Max. \( t \leq 8 \) min. | 10 employees  
Cost = 10 | • After shipment there is a checking if the “Delivery” was successful.  
• Probability of success = 90%  
• In case of success the process is directed to the “Product Receipt” activity. Otherwise the order is cancelled. |
| Product Receipt                | \( t \sim \text{Gaussian distribution} \)  
\( M = 2 \) min.  
\( SD = 1 \) min.  
Max. \( t \leq 4 \) min. | 4 employees  
Cost = 50 | |

\( t \) : time, \( M \): mean, \( SD \): standard deviation, Cost is in monetary units per hour per employee

Table A2: The assumptions made per activity for the Simulation Process with the use of an ERP system (IT-enabled process).