Problems with evaluation of benefits and costs from advanced technology utilization

Libuše Svobodová

Abstract—This paper brings selected results of the recent survey targeted on adoption and utilization of advanced manufacturing technology in the Czech Republic. Despite of some anticipated singularities there are many problems connected with advanced manufacturing technology benefits evaluation. On the basis of the previous surveys it is possible to expect that a lot of managers and owners have problems with identification, quantification and evaluation of benefits in the companies.

The main focus in the article is on the phase of problems with evaluation of benefits realized after implementation and utilization of advanced manufacturing technology. It is possible to suppose that evaluation of the benefits and costs from advanced technologies is in the connection with the problems that managers can not solve or with the problems that they would not like to solve. Chosen findings ascertained in the Czech Republic are compared with the outcomes of analogous surveys that were carried out earlier in the Great Britain and in the United States of America. The results are gained from the questionnaire investigation that was made by the research team at the University of Hradec Králové on the Faculty of Informatics and Management.

Keywords—Advanced manufacturing technology, Benefit, Evaluation, Identification, Problems, Survey.

I. INTRODUCTION

With investment into advanced manufacturing technology (AMT) are closely connected a lot of spheres and problems. In the previous articles [1-6] we focused on the anticipated and realized benefits after implementation and utilization of AMT and on other issues that are in the connection with evaluation of benefits from AMT utilization. After detailed review of the articles in the international journals and on the basis of our previous questionnaire investigations we suppose in the time of preparation of the new questionnaire investigation that the companies have the problems with the evaluation of those benefits. On the basis of those conditions we put into form questions that were aimed on the evaluation of benefits after implementation of advanced technologies and on the problems that are with it connected. Chosen results from those questions will be mentioned below.

Topic problems with evaluation of benefits is very important for a lot of managers, owners, researchers, specialists and also globally for advanced industrialized economies.

II. LITERATURE REVIEW

A. Review Stage

Numerous definitions of AMT have been developed. For example, Yousseff defines AMT as “a group of integrated hardware-based and software-based technologies, which if properly implemented, monitored, and evaluated, will lead to improving the efficiency and effectiveness of the firm in manufacturing a product or providing a service” [7, pp. 40-42]. The next, a more global definition that combines the work of Zairi [8, pp. 123], and Zammuto and O’Connor [9, pp. 701] AMT, defined broadly, “is a total socio-technical system where the adopted methodology defines the incorporated level of technology”.

We have developed a simplified definition for this article: “AMT is commonly known as a term used for description of the new technology in manufacturing which utilizes the power of many new technologies and particularly computers.”

B. Final Stage

To keep in line with the earlier UK surveys which were used as a basis for comparison of problems with evaluation we have decided to employ the same questionnaire as Ballantine and Stray [10] utilized earlier for their investigations.

The study sought to identify the problems of evaluating both IS/IT and other capital investments, and the extent to which such problems appeared to be unique or equally applicable to both types of investment.

They wrote that clearly a range of problems exists when evaluating both IS/IT and other capital investments, and the extent to which such problems appeared to be unique or equally applicable to both types of investment.

They wrote that clearly a range of problems exists when evaluating both IS/IT and other capital investments, and the extent to which such problems appeared to be unique or equally applicable to both types of investment.

However, the problems identified in Table 1 indicate not only the diversity of problems organisations face, but also that such problems are by no means applicable to particular types of investment only.

Table 1 illustrates the problems reported by the respondents when using financial criteria to evaluate investments generally.
TABLE 1
PROBLEMS OF EVALUATION

<table>
<thead>
<tr>
<th>Problem</th>
<th>IS/IT projects (n = 41)</th>
<th>Other capital projects (n = 45)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
</tr>
<tr>
<td>Quantifying relevant benefits</td>
<td>35</td>
<td>85,4%</td>
<td>36</td>
</tr>
<tr>
<td>Identification of relevant benefits</td>
<td>28</td>
<td>68,3%</td>
<td>25</td>
</tr>
<tr>
<td>Lack of time</td>
<td>19</td>
<td>46,3%</td>
<td>16</td>
</tr>
<tr>
<td>Quantifying relevant opportunity costs</td>
<td>15</td>
<td>36,6%</td>
<td>13</td>
</tr>
<tr>
<td>Identification of relevant costs</td>
<td>15</td>
<td>36,6%</td>
<td>14</td>
</tr>
<tr>
<td>Identification of opportunity costs</td>
<td>14</td>
<td>34,1%</td>
<td>14</td>
</tr>
<tr>
<td>Quantifying relevant costs</td>
<td>13</td>
<td>31,7%</td>
<td>16</td>
</tr>
<tr>
<td>Difficulty with interpreting results</td>
<td>9</td>
<td>22,0%</td>
<td>3</td>
</tr>
<tr>
<td>Lack of data/information</td>
<td>7</td>
<td>17,1%</td>
<td>14</td>
</tr>
<tr>
<td>Lack of interest in using technique</td>
<td>7</td>
<td>17,1%</td>
<td>4</td>
</tr>
<tr>
<td>Unfamiliarity with capital project appraisal</td>
<td>6</td>
<td>14,6%</td>
<td>3</td>
</tr>
<tr>
<td>Calculation of cost of capital</td>
<td>0</td>
<td>0,0%</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>4,9%</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: [Ballantine, Stray, p. 88]

The biggest problems in the investigation in the UK were found in the fields quantifying and identification of relevant benefits, lack of time, quantifying and identification of relevant costs and opportunity costs.

Chosen results from other questionnaire investigations made in the field of AMT will be presented in the next parts.

III. ADVANCED MANUFACTURING TECHNOLOGY SURVEY IN THE CZECH REPUBLIC

A. Previous work

The biggest motivation to start the investigations in the field of AMT at the University of Hradec Králové came from the work of Lefley and Wharton [11], Lefley [12], and Lefley and Sarkis [13].

The first postal survey started at the end of 1998 and of the 416 questionnaires sent out 92 was returned giving a response rate of 22.12%. A usable sample of 79 completed questionnaires with a response rate of 19.0% was considered to be reasonable under the existing circumstances. The first study in this field in the Czech Republic [34] revealed that despite of many differences ascertained especially in the extent as well as the level of evaluated and implemented technology, where Czech manufacturing companies lagged behind their western competitors, there were many problems that were common for managers from all the three surveyed countries. These results even fostered our interest to conduct the second survey in the Czech Republic in 2005 in order to identify the relevant changes in the results that were expected due to the quickly transforming Czech economy and its openness.

The second postal survey has been conducted from January till April 2005 and 1030 questionnaires were sent out and 135 have returned. 3 of them were unusable. We can see that the rate of response is 12.8% only which is significantly lower rate that the one we achieved in 1999 [35]. Based on the findings we can claim that AMT projects are knowingly as well as unknowingly disadvantaged because of a whole spectrum of reasons. Some of these reasons, as for example, managers’ focus on delivering positive results in short term period and contextual lack of rather strategic insight, or exploitation of unsuitable financial criteria, are well behind the border of technology specialist potential sphere of influence. Nevertheless, we believe that it is necessary to be aware of these circumstances, to anticipate them, and to use every opportunity to draw executives’ attention to them. On the other hand, the results show that there are some possibilities for technology specialist to influence the processes when the crucial decisions about AMT projects implementations are made. Moreover, it has been demonstrated that there are appreciably high differences between AMT benefits expected before the particular AMT project has been implemented and the benefits attained after the project actual implementation. Being able to identify, describe and explain the complex benefits of a particular AMT project the technology specialists might be able to prepare better background material for financial executives. Consequently, various tangible as well as intangible benefits will be taken into consideration, properly assessed and expressed in financial terms and therefore the chance to get the management approval for AMT project implementation will be definitely higher [36].

B. Research methodology

The data on which this paper is based were collected during the second half of 2008 and first three months of 2009. The survey instrument was developed in Czech Republic in 2007 and in the first half of 2008. The questionnaire comprised the following sections.

Questions in the first part were intended to establish the planning and implementation of advanced technologies in the companies.

In part number two of the survey the respondents were asked about anticipated and realized benefits findings before and after implementation of advanced technologies.

The third part was aimed at measuring of benefits after implementation of advanced technologies (what methods, concepts and tools are used in the company as the base of the measuring of benefits from AMT? What metrics do you use for the measuring of the benefits? What indicators do the managers use for the evaluation of the conditions for the implementation of AMT in the company? Can you give one example of a typical advanced technology in the company and the specific benefits and the metrics for the measuring of the benefits? The last question was dedicated to the problems with the measuring of the benefits).

The fourth part of the survey was designed to explore opinions about the need of advanced technologies investment...
and criteria used for measuring to assess the performance of senior executives (evaluation of their effort).

The last part was dedicated to evaluation of the business performance (methods and concepts that are used for measuring and utilization of EVA).

To assure a straightforward comparison of collected data in different countries we carefully followed some of the questions used by our predecessors. The survey was aimed at those companies who, it was believed, would have had some experience in the utilization of AMT and that the person who was asked to complete the questionnaire should have had a significant contribution to make in decision in the field of AMT. A number of databases were reviewed (with the main stress on data acquired from EDB - company Creditinfo Czech Republic, s.r.o. - and Czech business register) to identify the manufacturing companies in the Czech Republic.

This article deals with the selected results corresponding to the first, second, third and fourth part of our questionnaire only and due to limited space we cannot dwell on the other issues here. From the fourth part are taken the questions that are connected with the problems of evaluation of AMT.

We finally chose sample size of 1127 firms in 2008. The questionnaire was mailed out together with a covering letter. After a follow up letter sent to non respondents and a follow up telephone reminder to a selection of companies and oral interviews, the survey resulted in a total of 132 replies being received and usable in the final analysis. This represented a response rate of 11.62 per cent. Table 2 summarizes the profile of respondents firms. This profile may have influence on the problems with evaluation of the realized benefits after implementation of AMT.

### TABLE 2

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Number of companies</th>
<th>Ratio of all respondents</th>
<th>Ratio of involved companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-99</td>
<td>76</td>
<td>57.6</td>
<td>61.8</td>
</tr>
<tr>
<td>100-499</td>
<td>37</td>
<td>28</td>
<td>30.1</td>
</tr>
<tr>
<td>500+</td>
<td>10</td>
<td>7.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>93.2</td>
<td>100</td>
</tr>
<tr>
<td>Unknown state</td>
<td>9</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Source: [5, p. 116]

In the next parts of this chapter there are shortly presented chosen results from our last questionnaire investigation.

C. Advanced technologies in survey in the Czech Republic

A total of 28 advanced technologies were listed in the questionnaire. Respondents were asked to indicate whether or not they had made an investment in each of these ATs or whether they are planning investment in it.

Most often used technologies by the Czech respondents are CAD, CNC, CAE, TQM, workflow, MRP and ERP. “Soft” technologies are in the involved companies used more than “hard” technologies (three hundred and twelve to two hundred and ninety six). Technologies that are not now used a lot and that are very interesting such as competitive intelligence or FMS or E-learning may be the opportunity for better competitiveness in the future.

D. Anticipated and realized benefits

We focused on the anticipated and realized benefits in the Czech companies. The positives are that Czech managers evaluate a lot of benefits from utilization of AMT very positively, such as increased throughput, improved quality, increased flexibility, reduced costs, obtaining competitive advantage, enhanced company image, increased productivity and others.

E. Concretization of benefits for individual technology

The research team asked the managers and owners in the questionnaire not only in check question with prepare answers but also in open question - connect the realized benefits with the concrete technology that is used in your company.

The most often referred technologies were CNC, CAD, RFID, MRP, robotics and data warehouses. Those technologies were also mostly marked in the first question – in the prepared variations of the planned and used technologies in the companies. From detailed results is evident that managers in open question referred more “hard” technology than “soft” technology. The results in the third part of the form (in open question) are not the same as in first part of the questionnaire. There predominated “soft” technology.

Managers in the open question indicated mostly improved quality, seventeen of them. With the distance is continuing increased throughput, reduced costs and increased productivity. The most often presented benefits are intangible benefits such as improved quality, widening product range, faster production or increased flexibility.

Above mentioned benefits are the same with the most often published reputable authors [15-22]. It is a little bit surprising that there was no often answered enhanced company image. This benefit was valued in the prepared question by the managers abroad as realized on the highest position [19-21] and in the Czech Republic it was the 6th position [1-2], [5].

Readers who are interested in further details from our questionnaire investigation are advised to look at [1-6].

IV. PROBLEMS WITH EVALUATION OF BENEFITS AND COSTS

Problems of AMT have been investigated for a long time from various points of view. Researchers are not interested only in using of AMT in the companies and in the identification of benefits that are important for a company and that are realized but also in the evaluation and problems with measurement of benefits and costs.

In sequence on the previous surveys abroad we have used to our questionnaire the same question as Ballantine and Stray [10].

We asked the managers on the financial problems that are connected in their companies with the evaluation of the benefits and costs after implementation and utilization of AMT. Detailed results from the question are in Table 3.
The first two problems quantifying and identification of relevant benefits are the same on the highest position as in the investigation abroad. The next two lack of interest in using technique and unfamiliarity with capital project appraisal technique were not such often perceived abroad. More than half companies have problems with quantifying and identification of relevant opportunity costs, identification of relevant costs and difficulty with interpreting results. Almost half respondents have problems with quantifying relevant benefits and lack of data. Some of the results such as lack of interest in using technique, unfamiliarity with capital project appraisal technique and others are alarming for the managers, owners, researchers and technology specialists.

In the next part of the questionnaire we asked with other question on the evaluation of benefits – not all potential benefits of AMT are taken into account because they are difficult to quantify in financial terms. The results are in the Table 4.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantifying relevant benefits</td>
<td>53</td>
<td>22</td>
<td>75</td>
</tr>
<tr>
<td>Identification of relevant benefits</td>
<td>57</td>
<td>24</td>
<td>81</td>
</tr>
<tr>
<td>Lack of interest in using technique</td>
<td>51</td>
<td>27</td>
<td>78</td>
</tr>
<tr>
<td>Unfamiliarity with capital project appraisal technique</td>
<td>47</td>
<td>32</td>
<td>79</td>
</tr>
<tr>
<td>Quantifying relevant opportunity costs</td>
<td>40</td>
<td>28</td>
<td>68</td>
</tr>
<tr>
<td>Identification of relevant costs</td>
<td>42</td>
<td>36</td>
<td>78</td>
</tr>
<tr>
<td>Difficulty with interpreting results</td>
<td>41</td>
<td>38</td>
<td>79</td>
</tr>
<tr>
<td>Identification of relevant opportunity costs</td>
<td>36</td>
<td>35</td>
<td>71</td>
</tr>
<tr>
<td>Quantifying relevant benefits</td>
<td>35</td>
<td>36</td>
<td>71</td>
</tr>
<tr>
<td>Lack of data/information</td>
<td>35</td>
<td>43</td>
<td>78</td>
</tr>
<tr>
<td>Calculation of cost of capital</td>
<td>24</td>
<td>46</td>
<td>70</td>
</tr>
</tbody>
</table>

Source: GACR č. 402/07/1495, [5, p. 170]

The results confirm the previous results. The managers do not take all potential benefits of AMT into account because they are difficult to quantify in financial terms. There is the small difference in the comparison in the chosen countries. In the Czech Republic were evaluated AMT and in the Great Britain were taken into account IS/IT projects and other capital investments. We believe that it is possible to compare the problems with evaluation of IS/IT and AMT.

V. CONCLUSION

It is evident that authors focused not only on the identification and quantification of the relevant benefits and costs but also on the opportunity costs that are not easy to identify and also quantify. From the tables and data above and also from the personal interviews that were made by the research team it is possible to state that there is an area for technology and financial specialists and also for the educational institutions. Moreover, it has been demonstrated that there are significantly higher problems in evaluation in the Czech companies than in the British companies. Results were supported by the research in both mentioned countries. Alarming and uncomfortable is higher percentage in the Czech companies that have problems with evaluation. It is important that more than 65 % of Czech companies have problems with lack of interest in using technique and next to 60 % have problems with unfamiliarity with capital project appraisal technique.

That is why we believe that technology specialists as well as managers and owners worldwide could study more the possibilities for solving of the problems and evaluation of benefits and monitoring of costs and learn from the issues presented and discussed here. Short description how to measure performance of the company and how to evaluate the benefits and costs are described for example in [23 - 27].

There is the small difference in the comparison in the Czech Republic in the last survey in 1999 and in 2005. In this statement is not prominent difference between Czech, British and American companies.

ACKNOWLEDGMENT

This article was supported by specific project Advanced technology used for support of the business management at the University of Hradec Králové on the Faculty of Informatics and Management.

REFERENCES

Recent Researches in Applied Informatics


