

# Advanced Manufacturing Technology Benefits: Expectations vs. Reality

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*Abstract:* - There are numerous problems related to the advanced manufacturing technology benefits evaluation that negatively influence much wider and faster adoption of these systems. We believe that substantial differences between management expectations and the actually realized benefits derived from advanced manufacturing technology implementation are amongst the most important ones. In order to demonstrate the validity of our view the selected results of the survey focused on the various problems of advanced manufacturing technology adoption that was carried out in the Czech Republic recently will be described here. It will be shown that there are considerable differences between benefits expected when the relevant project is in the assessment phase and the benefits really attained after the project has reached the stage of routine operation. Despite of some variations our findings are conformable with the outcomes of similar surveys that were carried out in several economically develop and advanced industrialized countries and it indicates that our conclusions are right and generally true.

*Key-Words:* - advanced technology benefits, management expectations, benefits realized

## 1 Introduction

There are numerous problems related to the advanced manufacturing technology (AMT) benefits evaluation that negatively influence wider and faster adoption of these systems. We believe that one of the most important problems in this field is adherent to unrealistic and unjustified management expectations.

We have already claimed [1] that the adoption of AMT requires a high level of initial investment and also the level of risk associated with the implementation of the AMT projects is higher especially when the company management lacks relevant experience. Nevertheless, the total cost of AMT implementation is usually well defined although it might be quite easily underestimated too as it is very simple to forget some entries especially when managers are inexperienced in the field of AMT project implementation. On the other hand, it is very difficult to calculate the total value of AMT project contribution to the company as a whole because it is hard to identify and to evaluate various benefits of AMT. And that is the reason why many AMT project proposals fail in initial phases of the relevant decision making processes or the project is carried on only at the price of various restrictions. These restrictions mean either lowering the level of sophistication of implemented technology or only a limited part of the original project is realized which inevitably means lower degree of

integration and it goes hand in hand with limited extent as well as magnitude of various benefits. And finally, while managers in such a case are disappointed because the implemented restricted solution is unable to deliver once promised benefits, technology specialist are frustrated either as their original proposal was different and much better, of course [2].

The problem we have just described is worsened by the fact that there are substantial differences between management expectations and the actually realized benefits derived from advanced manufacturing technology implementation. This issue has been studied in several economically developed and industrialized countries and that is why we were interested in determining whether and to which extent the same phenomenon is valid under conditions of transforming Central European economy.

## 2 Experience from Abroad

Several surveys were carried out in the UK, New Zealand and in Australia [3, 4, and 5] in order to assess the anticipated differences between management expectations and real experience. Sohal [3] prepared a pair of questions designed to examine the extent to which respondents' views of the benefits of investing in AMT has changed as the result of the project

implementation. The respondents scored the importance of a list of benefits as perceived at the time of the appraisal investment and then the extent to which these benefits were seen to have been achieved after the new technology has been deployed.

We were especially inspired by the results of the research conducted in the United Kingdom and in Australia that were described in [3]. Sohal claimed there that reduced cost, improved quality, increased throughput, increased flexibility and acquirement of competitive advantage were the top five expected benefits and that these benefits were placed within top six positions amongst benefits experienced after the relevant advanced technology project implementation.

While he could see more similarities between the expectations and experience rankings, he realized that there are many benefits whose ranking varies considerably. First of all, “enhanced company image” that was ranked sixteenth on the expectations list has moved to the very first position on the experience list. Similar perception change was registered at several other items as “improved workforce attitudes”, “widening product range” or “improved working environment” that were originally rather underestimated. On the contrary, a number of expected benefits as, for example, “reduced work in progress”, “better management control”, or “improved response to variations in product mix or in product volume” ranked noticeably lower after the AMT project implementation.

Of course, as we enquired in [1] and [2], the interesting question is why “enhanced company image” made it up to the top of the experience ranking list when this issue was a minor one during the decision making processes and surveyed companies did not targeted on this goal. There could be various and very complex reasons explaining the phenomenon but based on our observations it might be a very simple one too. We have stated above that the original target number one was the cost reduction and it was beaten by enhanced company image. Therefore it is quite likely that because the results concerning the cost reduction were not as convincing there was an apparent necessity there to prove that the implementation of AMT project was a successful project anyway. Then enhanced company image could serve as a good excuse there. And the same explanation could be utilized when explaining the higher ranking of other factors as “improved workforce attitudes” or “improved working environment” that were originally rather underestimated.

In this respect it is interesting to repeat [1] that the above mentioned benefits like “reduced work in progress” or “improved response to variations in product mix or in product volume” (that ranked noticeably lower after the AMT project implementation) are in general much easier to evaluate, measure and expressed in

financial terms. It is impossible to generalize such an assertion, but we can speculate on the possibility that there might be some degree of coincidence between the relevant benefit measurability and the corresponding expectations-experience change. While the benefits that are difficult to evaluate and measure could possess a tendency to improve its position in the experience column, the easily and straightforwardly measurable benefits could tend to rank lower comparing with the original management expectations.

These findings as well as questions motivated our interest to explore the situation in this particular field in our country and that is one of the principal reasons why we carried out the recent survey in the Czech Republic.

### 3 Methodology

Our team carried out three major surveys focused on advanced manufacturing technology utilization and exploitation in the Czech Republic within last two decades. Our first postal survey was realized in 1998 and we used the questionnaire that was derived from the original one that was used when the earlier AMT utilization surveys were carried on in the UK and the USA (see [6]). The goal of this survey was to find out the level of implementation of AMT that had been achieved in the Czech manufacturing companies to date; to determine which techniques and criteria were used in capital project appraisal and what methods, if any, were used to measure and take into account project risk; to determine which measures were used to assess the performance of senior executives as it appears that management in general is reluctant to make long-term risky investments (such as those in AMT) and prefers to invest in short-term projects that show early profits and low risk [7]; and to explore opinions about the need for AMT investment, the efficacy of the investment criteria used and the extent to which other factors and considerations had a bearing on capital investment decisions.

The second postal survey that was focused on the same issues was conducted in 2005 and we decided to include also the middle sized Czech manufacturing firms this time. Moreover, we added one additional section to the questionnaire that was used in the Czech Republic in 1998. It was devoted to the utilization of EVA (economic value added) indicator in surveyed companies as there were some suggestions that there might be a relationship between utilization of this concept and investment behavior of manufacturing companies. The results of the both surveys (1998 as well as 2005) concerning advanced manufacturing technology utilization in the Czech Republic were described in [8].

Our last survey in the Czech Republic was conducted at the end of 2008 and the beginning of 2009. This time

a completely new questionnaire was designed and used. Of course, we have partially built upon our previous experience acquired during the former surveys, but as we already indicated above we wanted to enlarge the scope of our research focus.

The questionnaire comprised of five parts. The first one was designed in order to find out which kind of advanced technology is regularly used and/or planned and comparing to our earlier surveys we have broadened our view with the aim to include not only hard technology but the relevant pieces of soft technology too. The second part was devoted to the advanced technology benefits evaluation issues and the following one was focused on measurement of these benefits and the pertinent problems. The fourth section comprised of questions related to the measures used to assess the performance of senior executives and the opinions of top management concerning utilization of advanced technology. Final part of the questionnaire was devoted to the whole company performance measurement and the utilization of EVA concept as we did already in 2005.

Due to the economic problems caused by the global financial crisis we have decided to further increase the set of respondents up to 1360 manufacturing companies. Unfortunately, many questionnaires returned back as undeliverable, some companies were closed down and several companies reported termination of their manufacturing activities, which restricted the original larger pool into 1127 virtual respondents. The questionnaires were sent out in two rounds within a time span of six weeks and then we started a wide campaign based on individual attempts to get the results by means of individual e-mails and telephone calls. Altogether we have managed to collect 132 usable questionnaires out of 1127 respondents. The response rate 11.7% is slightly lower than in 2005 but taking into account the current economic circumstances it should be considered favorably.

In addition to the postal survey we have also visited 12 selected companies and we held structured interviews with the top managers of these companies in order to learn more about some specific issues and problems related to the AMT utilization in general and AMT benefits evaluation in particular the Czech Republic.

The overall results of our research have been summarized in [9]. We will narrow our focus only on the selected results corresponding to the above mentioned problems linked to the differences between various benefits expectations and attained experience in this article. It will be shown that managers of Czech manufacturing companies acknowledge serious difficulties associated with the process of the benefits identification and evaluation and that there are considerable differences between benefits expected when the relevant project is in the assessment phase and

the benefits really attained after the project has reached the stage of routine operation.

#### 4 Selected Results

We knew the results achieved by Sohal in the United Kingdom [3] and other countries as we described them above and so it was quite easy for us built on his experience. The original Sohal's questions were translated into Czech language and we also carefully followed his layout (order of individual questions as well as the methods of their evaluation). It is interesting to mention that while the expectations were assessed by 5-point scale (higher score means higher importance perceived by the respondent), the attained experience was assessed by 3-point scale only. Nevertheless, in order to assure comparability of our results, we followed the Sohal's work here too.

The returned questionnaires were processed using statistical software. Sohal [3] calculated the average score for each question and then the relevant benefits were ranked according to their importance. That is why we did so likewise and our results are summarized in table 1.

We can see that the first four expected benefits (reduced cost, improved quality, increased throughput, and obtaining competitive advantage) preserved their position within top five benefits realized. The item "increased flexibility" improved its position from the seventh place up to the third one indicating that implementation of advanced technology facilitated much higher degree of flexibility than managers originally expected. It should also be noted that the most desired benefit "reduced cost" has not been fully achieved as it scored on the fourth place amongst benefits realized. Moreover, we can see that the significance of "increased sales" was clearly overestimated (it fell down from the fifth place to the eleventh) and the desired effect did not appear. We can observe the same trend at "improved integration of information systems across functions" (the eleventh place and then the fifteenth) and "improved integration of manufacturing information systems" (the seventeenth place and then the twenty-second). These findings could be interpreted in such a way that the expectations that new technology will bring alone a higher integration of information systems have not been fulfilled. And finally, it is obvious that the lowest descent has been associated with "improved workforce attitudes" which went down from the twelfth place to the twenty-first which means nine positions difference.

On the other hand, there are some interesting reverse changes of rankings too. It was already mentioned above that "increased flexibility" rose by four places but it is not the only underestimated benefit. It should be noted that "reduced product development time" went up by

three positions (from the thirteenth to the tenth) but there are two very interesting benefits placed at the bottom of the table 1 that made even much bigger upswing. While “improved response in variations in product volume” went up from the twenty-first place to the twelfth, “widening product range” marked even higher leap as it jumped from the twenty-fourth position up to the thirteen (which means eleven position difference).

It should be stressed that all three benefits referenced above that scored much better in the experience ranking column than in the expectations ranking column are the benefits that could be easily measured and quantified. It is a very interesting fact that these benefits were underestimated by managers and then they proved themselves to be ascertained in much higher extent than it was expected.

Despite the time difference between both surveys as well as many other differences between the Czech Republic and the United Kingdom (in terms of different macroeconomic environment, historical development, economic power of both countries etc.) it could be interesting to very cautiously compare the above presented results with the earlier findings observed by Sohal in the United Kingdom. We have already made an attempt to do so in [1] and therefore we will limit ourselves only to few brief comments here.

First of all, it is obvious that top three benefits expected in both countries were exactly the same ones (reduced cost, improved quality, increased throughput) which indicates that the main motives to invest into AMT are relatively stable. While the highest expectations in both cases were associated with cost reductions, manufacturing companies were unable to meet these expectations as this particular benefit ranked worse in the experience column (the fourth place in the Czech Republic and the fifth up to sixth place in the UK). It is easy to imagine that inability to achieve the originally planned levels of cost reduction can bring along a lot of disappointment from the management point of view and such dissatisfaction could negatively influence further AMT projects decision making processes.

Secondly, it was interesting to find out on the expectations side a huge difference in perception of “reduced work in progress” (the sixth place in the UK and the nineteenth in the Czech Republic), and even higher difference in “improved response to variation in product mix” (twelve places difference), and “improved response to variation in product volume” (fourteen places difference) - in both cases the benefit was much more appreciated in the UK. Regarding the experience ranking, there is a huge difference between recognized level of “better management control” (ten places difference), “improved ability to respond to engineering changes” (thirteen places difference), and “reduced

product development time” (fourteen places difference), that were much more appreciated by Czech managers than by their British counterparts.

Table 1. Expectations and experience of the benefits of AMT investments in CR

Benefits	Expectation Ranking	Experience Ranking
Reduced cost	1	4
Improved quality	2	2
Increased throughput	3	1
Obtaining competitive advantage	4	5
Increased sales	5	11
Better management control	6	7
Increased flexibility	7	3
Enhanced company image	8	6
Improved ability to respond to engineering changes	9	8
Reduced changeover/ set-up times	10	9
Improved integration of information systems across functions	11	15
Improved workforce attitudes	12	21
Reduced product development time	13	10
Improved ability to respond to variations in suppliers' quality	14	16
Improved working environment	15	14
Improved ability to respond to variations in suppliers' lead times	16	18
Improved integration of manufacturing information systems	17	22
Improved ability to implement engineering changes	18	17
Reduced work in progress	19	20
Improved management attitudes	20	23
Improved response in variation in product volume	21	12
Improved response to variations in product mix	22	19
Overcoming existing skill deficiencies	23	24
Widening product range	24	13
Overcoming PM skill deficiencies	25	26
Better working relationships	26	25

## 5 Conclusion and Further Research Directions

Based on the earlier results achieved by Sohal [3, 4, 5] we have devoted one part of the survey that we carried out in the Czech Republic recently to the problems associated with the AMT benefits identification and evaluation. In this paper we restricted our view to the anticipated differences between AMT benefits expected before the particular AMT project has been implemented and the benefits attained after the project actual implementation. The pieces of evidence presented above confirm that there are many disproportions between the benefits expected and the benefits realized and we are afraid that this fact could constitute a serious problem for further AMT projects. Overestimation of some expected benefits (as we have seen, for example, in case of “reduced cost”) could cause much lower degree of overall satisfaction with the project when it reaches the phase of routine operation. On the other hand, exceedingly conservative approach to the benefits estimation could be very dangerous too as underestimation of some benefits could easily lead to the unfavorable circumstances when the project proposal will fail in initial phases of the relevant decision making process being unable to balance the cost of the proposed solution.

These are the reasons that made us to believe that managers of manufacturing companies should pay much higher attention to these issues. Better understanding and increased ability to identify and estimate various AMT benefits would help them to assess these benefits more properly and it will prevent disappointing results of such a project when it reaches the phase of routine operation and it is too late to change the decision that was based on imperfect or even misleading assumptions.

Our results show that there is a substantial space for further research in this field as well as further training of the managers and technology specialists too. The process of AMT requirements analysis, planning, particular technology selection, the relevant investment decision and the project implementation must not be based on more or less enthusiastic individuals or groups in the company. It must be anchored in sound and clear procedures within the overall system of company management. And here we can see many interesting directions for further research covering the broad area ranging from technological readiness of companies up to the management performance appraisal systems. In this respect it might be interesting to mention that some members of our research team started participation on research focused on firms with mobile-oriented architectures [10] and we hope there might be some further sources of inspiration for our own research there too.

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