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Investment Justification in Advanced Manufacturing Technology: A Study of Iranian Companies

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Abstract

During the past two decades business and manufacturing have observed significant and radical changes. Companies have used automation in the manufacturing, in order to improve quality and competency. It was expected that along with these changes, management accounting systems, which focus on monitoring and analyzing management decisions, should adapt with and encourage the changes. Many authors have claimed that management accounting systems have not helped the suitable business and manufacturing strategies in the new environment. Some even claim that it has hindered investing in advanced manufacturing technology and productivity.

This research, by analyzing information collected from 101 Iranian business units from various industries and manufacturing settings, investigates justification basis for capital investment in advanced manufacturing technology. The study demonstrates that there is more correlation between qualitative factors such as; manufacturing capabilities, improved product quality and, competition position with investment justification than quantitative bases such as; accounting rate of return (ARR), internal rate of return (IRR) and, net present value (NPV).

Keywords: Management Accounting, Investment Justification, Advanced Manufacturing Technology (AMT), Financial, Non-Financial Criteria.

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Introduction

Many authors have expressed concerns over negative effects of accounting systems on operating decisions. Management accounting effects on operating managers have recently attracted much attention in operating management literature. Many claim that this system does not support suitable production strategies, in return leads operating managers towards profit maximization which is only a goal not a strategy (Nanni et al, 1992). Some authors even clearly mention that traditional management accounting system are number one enemy to productivities (Goldratt and Cox 1984).

In practice, there is much more attention on the criticism that the claim has been reinforced that accounting methods for modern business are improvidence and unsuitable. Supporters of this idea (Denna et al 1993) mean while said "traditional accounting system shows separation of operation, more than any other system in modern business".

Probably the most current and in many cases the only performance measurement system in manufacturing firm is accounting system. As a result, operating managers often have been criticized and blamed because of its leaning more than enough on short term financial information and omission of other more useful information about total performance measurement of the firm.

Many authors (Johnson and kaplan, 1987,1984 ; Horngren, 1995; Denna et al, 1993) claim that management accounting systems are themselves the problem and operating manager are automatically trying to improve accounting reports figures, since these reports often are only management performance measurement. Skinner (1986) explains that "operating managers behavior is a productivity paradox because, managers instead of improving actual productivity, tries to measure the productivity better". Horngren (1995) suggests that the best way to solve this problem is just to leave away the traditional management accounting.

This research has tried to explore the management accounting system in Iran, relying on investment justification in advanced manufacturing technology, and providing management accounting model to be adapted with manufacturing technology.

Literature Review and Hypotheses Development

Investment Justification

Historical antecedent of investment justification and its relationship with accounting goes back to first half of the twentieth century. Capital incentive industries didn't maintain any systematic records for capital assets until 1980, and have not used any information to evaluate the return on investment. In spite of uncertainty that existed in long term investment, companies apparently didn't have to anticipate or budget capital investment for consistency and control then.

With the outbreak of the twentieth century, accounting systems gradually linked companies' performance to investment, in fixed assets for businesses which performed two or more separate activities under the aegis of one management.

Top management of multidivisional firms offered two new techniques in management

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accounting environment, and for coordinating activities in different departments with total objectives of the firms. First, they developed budget to coordinate and balance resource inflows from raw materials to customer. Then, they established new criteria called return on investment (ROI), in order to compare different sections' performance with that of total firm. In spite of changes in technology, production and management, ROI is still being used by accountant and manager. Financial statement are used as a base for calculating ROI, while relying on financial statements for calculating ROI has negative effects on investment decision. Reliance on short term performance may discourage management to invest in long term risky investment.

It has been claimed that existing management accounting and costing systems and investment evaluation have delayed new technological operation and are great obstacles in understanding competency advantages of the firm.

In response to dissatisfaction of accounting methods in investment justification, more attention was paid on the strategic aspect of investment. Some believe that strategic investment must be excluded from accounting control system (Bruggeman and Stagmulder 1995). Other adherent systematic strategic analyses and plans are based on investment share on competency improvement and long term profitability.

Some authors still believe in accounting evaluation but , they support more suitable use of capital budgeting techniques. Kaplan (1986) explains that "investment in advanced manufacturing technology should not only be on belief, but also strategic profit must be more than cash deficit". However some authors believe in combining financial and strategic considerations.

Magdy Abdel-kader and David Dugdale (1998) studied 466 manufacturing firms in England to investigate investment justification in advanced manufacturing technology (AMT). Their analysis showed that firms rely on specific intangible benefit along with traditional dimension of return and risk.

Results accumulated by Abde khader and Dugdale in a research suggest that "AMT investment decisions in practice do involve increasingly strategic analysis but not at the expense of economic or financial analysis". Intangible strategic benefits, and consistency with corporate strategy are important in investment decision making and four specific intangible benefits i.e., quality and reliability of outputs, reduced lead times, obtaining greater manufacturing flexibility and, reduced inventory levels are of particular significance in justifying AMT. The findings provide that accounting practitioners support normative models which can combine financial and strategic analysis. They do not support models which concentrate solely on financial or strategic analysis. Abdel khader and Dagdale in their survey suggest that risk treatment in practice is naive. Sophisticated techniques of risk analysis are not employed for investment in AMT project and the only technique is sensitivity analysis.

Tayles and Drury (1994) have studied management accounting in new manufacturing technology in England. The results showed that

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different methods were used for investment evaluation in AMT and non AMT environments. Firms have considered payback period for investment evaluation in AMT. Managerial conjectural judgment and personal business experiments have been effective as investment evaluation factors, especially in small firms. This has been confirmed in Abdel Kader and Dugdal study, and stems from difficulties of quantifying benefits of new technology. Large firms have more focus on discounted methods and have made improper adjustments in their calculation in order to hinder inflation which may underestimate project benefits.

Sillince and Sykes (1995) considered management accounting functional role in persuasion and dissuasion of investment decision. Separation between operation and strategy is the most distinguished result of S&S research. The first result is that operation managements perform some of cost accounting function. The next result is that accounting information was apart from manufacturing information. Both results mention the lack of relation between accounting and operation managers domain. As a result, unrelated accounting function at operation level prevents necessary changes in firms' progresses.

Beaumunt (1998) also studied criterion that firms select in decision making in manufacturing technology. Remarkable results obtained from Beaumunts survey indicate, less consideration given to intangible benefits in investment decision in manufacturing technology. Proposals must be justified based on financial criteria but after decision, intangible benefits have been appreciated greatly.

However, investment in manufacturing technology has its own implications and results which can not be justified only by financial criteria. For example, large investments in manufacturing may result in incurring a great deal of fixed expenses, remarkable decrease in variable costs, remarkable increase in capacity and quality and labor cost, creating various flexibility characteristic like changes in labor skills, more demand from suppliers, program and organization structure simplification or establishing new markets.

This paper contains input from management accounting practitioner, with reference to investment appraisal. The information, which was obtained by a questionnaire survey, represents the practices adapted and opinions held by experienced accountants. Some of this information is based on the details of specific practices such as investment appraisal and hurdle rate methods. Other information is more descriptive, based on experience and opinions of practitioners working in manufacturing environment. New markets' intangible criteria may be more important than tangible criteria.

Today, more investment in manufacturing technology is done in computerized machines (advanced manufacturing technology), which not only do what their electromechanical precedence have done (which do more quickly and precisely) but can also collect, process and reserve data that may improve planning and control.

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Survey design and variable measurement

The first reference point of the survey was a commercially available database of companies, available on a CD ROM. From this database, Iranian registered companies whose trade description included substantial reference to manufacturing or producing and whose annual turnover exceeded 50 billion Rials were selected. The questionnaire was send to a company if its divisions or subsidiaries were engaged in manufacturing activities.

In order to guarantee the accuracy of the data, it was important to ensure that respondents to the survey were appropriately qualified to do so. Thus with the cooperation of the major professional accountancy bodies, questionnaires were mailed to experienced management accountants (with at least 7 year experience) at their places of employment in the period up to September 2003. A pilot survey was conducted, prior to the mailing in which the views of practitioners and academics regarding the relevance and clarity of the questions were obtained.

The questionnaire was sectionalized in order to gather data on a wide range of the company's' practices and the opinions of the management accountant, including, for instance a section on company descriptions, like its product line, size of the manufacturing technology, and several investment justification tools. A five point Likert scale used to gauge the frequency of a particular practice or the strength of a respondent's opinion.

The final version of the questionnaire was sent to 306 manufacturing firms in 2003. From the business units, a total of 101 usable responses were returned (a response rate of %33). Table 1 shows the breakdown of companies by annual turnover and Table 2 shows the group classification of the business units.

Table 1 Annual revenues of companies covered by responses (Billion Rials)

Revenue / Nos.&%	Less than 50	50-250	250-500	500-100	Over1000	Total
No.	24	38	18	5	16	101
Percentage	23.8	37.6	17.8	5	15.8	100
Acc. percentage	23.8	61.4	79.2	84.2	100	100

Table 2 Industry group classification of business units covered by responses

Ind. group / Nos.&%	Durable product manufacturer	Consumer product manufacturer	Total
No.	54	47	101
Percentage	53.5	46.5	100

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The date collected was encoded for analysis onto a statistical package, SPSS, and all summaries and descriptive statistic were obtained from that package.

In order to obtain information about extent of some AMT application in manufacturing, an enquiry was conducted about the use of technology in production process. For these purpose, subsets were created of (a) technological, (b) relatively technological and (c) non-technological firms. Advanced technologies manufacturing (AMT) include computer aided design (CAD), computer aided engineering (CAE), numerical controlling machine (NCM), flexible manufacturing system (FMS) and computer integrated manufacturing (CIM).

Table 3 shows level of technology used in business units. As the table shows, less than half of the firms were using AMT in their production process.

Table 3 The use of technology in business units

Description	Implementation of technologies			
	Not implemented	Relatively implemented	Implemented	Total
Nos.	23	33	45	101
Percentage	22.8	32.7	44.5	100
Acc. Percentage	22.8	55.5	100	100

Investment includes both direct and indirect technology. Direct technology rules over process (machines & robots which are controlled by numbers), and indirect technology includes product programming software and control devices. Designing and testing, which is an important issue in evaluating success of investment in technology, is the identifying criteria for investment justification. There is often no comparison between investment goals and its achievement. Some authors have noticed the impression of technology changes in working power and social systems. Here we can mention the vital role of senior managers. They have often mentioned the necessity of long term views and insufficiency of only financial criterion. Some of the writers (Dhavale 1995) have recommended the use of work sheets and models of processing analytical hierarchy or packs of software that include both financial and non-financial criteria in justifying investment. In this software, the appropriate weights are given on non- financial criterion.

One of the practical notes of investment in technology is the consistency of equipments. Main benefits of investment are inaccessible until all machineries are well made. Complete exploitation

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of new technology requires the managers to cogitate systematic, change their organizational culture deeply, and omit the bound production.

Failures in some investments may be related to negligence of strategic factors. Honeycutt et. al (1993) clarify that flexible manufacturing systems create flexibility in organization and will have some consequences in all over the organization, particularly strategy and competence in the market. Shani et. al. (1992) note that execution of AMT will bring enormous changes in structure and culture of organization. Some disappointed results of execution of AMT systems may be due to shortness in considerations given to the social system of organization. New technology which has roots in old structures would not be exploited completely. Managers should include the vital factors of human resources in working power strategies and coordinate these factors to AMT situations in their decision.

Research Hypothesis

In order to respond to the question that, how investment in advanced manufacturing technology among Iranian firms is justified, following hypothesis, have been developed:

"Investment justification in advanced manufacturing technology in Iranian firms is more correlated to the non financial criteria than financial ones".

Competition in market, product quality, production ability and technological capability are considered as non-financial criterion and payback period, accounting rate of return (ARR), internal rate of return (IRR) and net present value are considered as financial criterion.

Research Method

In this research, correlation method is used, where variables are related to each other. The relationship between variables can be positive or negative. The statistical characteristics resulted from correlation studies that could be a kind of "correlation coefficient" or an association degree" give a numerical indicator that shows the power of the relationship between measured variables. The important point is that "the purpose of collecting data in correlation research is never to investigate a sharp relation of cause and effect, but the investigator tries to find out if variables have got any relationship to each other? And what is the degree of this relationship? But, it is not always clear which variable or variables are under the influence of the others, since variables may have reciprocal causation in correlation researches.

In justifying decision in AMT, some theoretical factors have been selected as a justification criterion. In the first step, the goal is to identify the relationship between these factors and investment decision which can be done by the frequency counts of each factor and the use of central indexes. In the second step, aim is to sort the criteria under two groups of financial/non-financial, in order to calculate their correlation rates to investment decision, and show which group has more correlation with investment justification. An other analysis carried out to recognize the difference in justifying AMT based on firms technology level. We will also determine the differences among justification views of industrial groups (consumer & durable), which can

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be searched in companies' considerations of their sizes.

Statistical Analysis and Results

From the eight introduced criteria of investment justification, four of them i. e.; payback period (pp), accounting rate of return (ARR), internal rate of return (IRR) and net present value (NPV) are sorted as financial criteria (quantitative) and four others: market competency, product quality, production ability and technological capability are considered as non-financial criteria (qualitative). Payback period, market competency, product quality and production ability were selected as the highest respectively. Hence, financial criteria, one and of the non-financial criterion, three factors, have gained the most frequency as the determining criteria of investment justification in AMT.

Based on the data received from companies which had selected payback period as investment justification criteria in AMT, the average period selected is approximately 4 years. This period for non-technological projects, was 3.78 years. The average rate for ARR, IRR and NPV, for the purpose of investment justification in this kind of technological projects is %25 in a year, and for investment justification in non technological projects is %20 a year. The minimum rate (hurdle rate) after deducting tax has been declared %14. Seventy percent of the firms' management accountant agree with the change of financial criteria to non-financial ones, in order to improve methods of investment justification in AMT. Only %13 of accountants are against the change of financial criteria and the rest (%17) were uncertain.

With the distribution frequency of criteria, described above we can claim that non-financial criteria compared to financial criteria have got more correlation to investment justification. To test the data, we have also used advanced statistical techniques. The average size of production ability, market competency and product quality among all criteria have got the greatest size and the average size of PP is located at the fourth level. The T- test shows that, difference between the average of financial criteria and non-financial ones is strongly meaningful (Table 4):

Table 4 Test for deference between means of quantitative and qualitative criteria

Description	T-test for equality of means		
	T=mean difference	Sig.(2-tailed)	df
Equal variances assumed	-2.3561	0.007	137
Not equal variances assumed	-2.3561	0.007	133.95

Correlation of each criterion to investment decision in AMT was calculated by using Pearson correlation. Four qualitative (non-financial) criteria, along with payback period had the most correlation with investment decision in AMT. Three quantitative (financial) criteria of IRR, ARR and NPV enjoyed the least correlation with investment justification.

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Table 5 Correlation test for quantitative and qualitative criteria for investment justification

Description	PBP	ARR	IRR	NPV	Competency	Product quality	Production ability	Technology capability
Pearson correlation	0.949	0.103	0.386	0.176	0.927	0.925	0.957	0.824
Sig. (2 -tailed)	0.000	0.322	0.000	0.90	0.000	0.000	0.000	0.000

Based on the data collected, among all criteria, production ability has got the most correlation with investment justification in AMT. With the aim of comparing correlation degree between total financial/non-financial criteria and investment justification, all criteria were sorted in two group of financial and non-financial, and their correlation with investment justification in AMT was calculated. This testing also showed that non-financial criteria have more correlation with the financial ones. Following statistical formula has tested the meaningfulness of differences.

$$z = \frac{\frac{1}{2}\ln(\frac{1+r_1}{1-r_1}) - \frac{1}{2}\ln(\frac{1+r_2}{1-r_2})}{\sqrt{\frac{1}{n_1-3}+\frac{1}{n_2-3}}}$$

Because it is seen that z (6.75) is much greater than $z_{\alpha/2}$, hence the assumption of equality of correlation is rejected.

Table 6 Test for Pearson correlation with total criteria and investment justification

Description	Financial criteria	Non- Financial criteria
Pearson correlation	0.869	0.980
Sig. (2-tailed)	0.000	0.000

Since the average size and correlation coefficient between non-financial criteria and investment justification is greater than those of financial ones, the hypothesis is confirmed. With the probability of 95% (α=5%), it can be declared that the correlation between non-financial criteria and investment decisions is greater than financial criteria.

By using the analysis variance and the multi amplitude technique (Duncan), a meaningful difference between payback period and technology level was not seen, and so between discounted rate and technology level. The average statement size of financial or non-financial criteria for improving investment justification method in AMT was tested by t-test, showing that, the average of the two statement differed from each other and this difference is significant. So, the equality of these two statements is denied. Direction of difference is towards non-financial criteria. The comparison test on companies size and investment criteria showed that big companies and small ones have different opinions in selecting NPV. Large companies have more tendencies to selecting NPV. One-way

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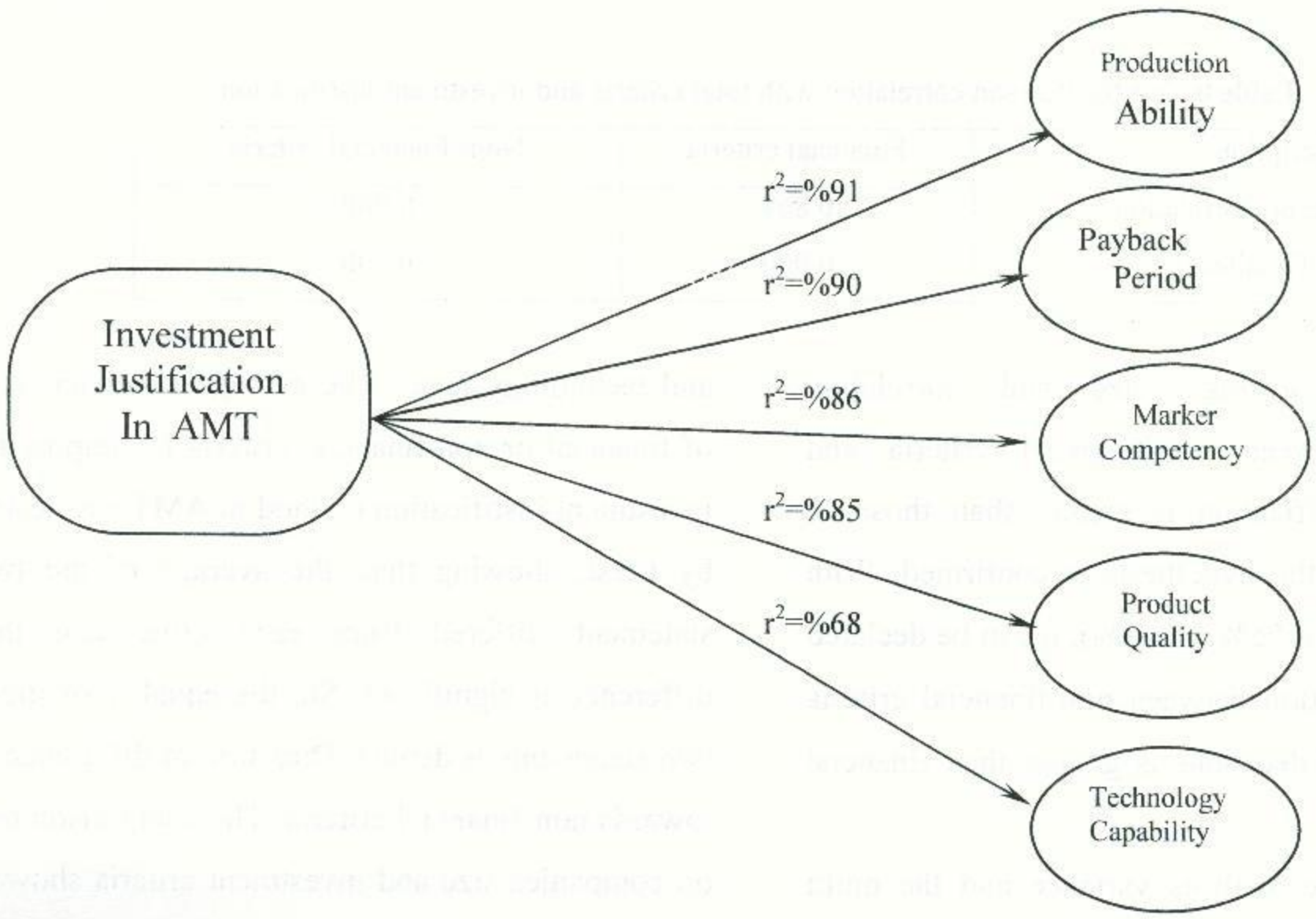
analysis of variance showed that the difference between market competency criteria and technology level of companies is meaningful. In the Post Hoc test, with Duncan technique it was identified that, the most difference exists between "relatively" technological companies and "technological ones". Relatively technological companies have more tendencies towards selecting market competency criteria for investment justification in AMT. Table 7 shows the test result.

Table 7 Comparison of competency criterion with technology level

Technology level	No.	Subset for α =%5	
		1	2
Technological	45	1.84	
Non-technological	23	2.22	2.22
Relatively technological	33		3

Hypothesized Model

Based on the data analyses and hypotheses test, model of investment justification in AMT looks like:



Conclusions

Based on the results of this research, the number of companies which use numerical control machines (NCM) and flexible manufacturing systems (FMS) in production process are relatively more than other companies (technological %44.5). A little

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less than half of the companies studied use new production methods and equipments. So, it could be concluded that technology level of Iranian production environment is more than medium level. Hence, in terms of hardware, they have reached some progresses in changing from the traditional to a modern environment. Investment in AMT needs long term views of capital return. Meanwhile the non-technological investment justification is usually based on short term views of capital return.

Researchers' work (Kaplan 1984, Bessant et. al. 1994) show that emphasizing the financial criteria and accounting systems in investment in AMT have got no ability in justifying cost and benefit of such investment.

The more correlation of non-financial criteria with investment in AMT shows an evolution in accountants' views on investment decisions, and this indicates hopes for a better situation for industry. Therefore it can be forecasted that future investment in Iran will be justified on the basis of production ability, improving product quality and competition in market. The results show that relatively technological companies, compared to other two company groups, have selected the market competency as investment criteria. Therefore, it must be expected that these companies, in order to gain market competency, will need more investment in AMT and that they will join technological companies in pursuing their aims.

Management accountant of the studied companies highlight that for promotion and rationalization of investment justification we must rely more on non-financial criterion like: improving product quality, on time delivery, flexibility and competency advantages than financial ones. This reflects the changing views towards new trade situations in the world, which many authors had pointed out. One of the outcomes of the statistical analyses show that a meaningful difference do not exists between company groups with different technological levels and years of payback period. This means that the insights of management accountants of non-technological and relatively technological companies have no differences and that they have similar expectations. The reason is not completely clear, but it is speculated that non-technological companies and relatively technological ones should consider more years for payback period in order to promote investments.

The insight of rapid return of investment in AMT may be inaccessible practically and may prevent the evolution in these companies. Same conclusion exists on high discounted cash and no differences found among three groups of companies.

Based on the data analysis, it may be concluded further that the companies, which have reached an appropriate level of technology, are not looking for competitive preferences when compared to two other groups of non-technological and relatively technological companies. This probably shows the monopoly of such companies in Iranian industry. It seems that production ability is under the authority of technological companies and other companies hope that they can gain a degree of competitive advantages. The point that non-technological and

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relatively technological companies are seeking competition advantages is a positive point. But technological companies, which ignore the competition factor in market, may cause damages to the improvements in production quality. Moreover, by the expansion of communication and information throughout the world, domestic customers will be more tended to purchase the products of international quality.

Research shows that, a payback period criterion has got a high correlation in investment justification of AMT and other projects. The average size of payback period and mode based on this research is 4 years each, which shows a relatively rapid expectation of return on investment in AMT. This conclusion is the point that researchers have mentioned before and that, financial criterion prevents investment in AMT. Investment, particularly in AMT, needs long term views and expectations of capital return. Expecting capital return in 4 years probably will prevent investment in AMT.

Recommended average rate of discounting cash flows in typical technological project is 25% and for non-technological project is 20% in a year. Comparing to the payback periods, selecting 25%-interest rate annually, will result investment return in four years. Undoubtedly, the declared rates by studied companies have been selected in relation to official rates, which are available in Iranian capital market. Again, it should be reminded that, investment decisions in AMT with this kind of expectation would make the use of interest rates arguable, like other financial criteria.

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