

## AGILE MANUFACTURING IN SEASONAL DEMANDED SME'S

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### ABSTRACT

Today's business environment is characterized by fast-changing technologies and shorter product life-cycles, well-educated customers and fierce competition. Within this context, agile manufacturing is praised in the literature as one of the solutions for achieving and maintaining a competitive advantage in turbulent times. This paper is aimed to fill in the identified theoretical and empirical gaps by exploring and scrutinizing the agile manufacturing concept in small and medium enterprises (SMEs) in the FAN manufacturing industry in Pakistan. Furthermore, a model illustrating the agile manufacturing enablers praised in literature and useful for studied industry is developed. A questionnaire has been developed based on the agile manufacturing enablers in the literature. Then a survey has been conducted on the developed questionnaire to find the application of praised agile manufacturing enablers in the industry and the extent of application. Result of the survey has shown that the agile manufacturing enablers are partially applied in the studied industries. Nevertheless, a conscious awareness of the agile manufacturing concept itself was not found and the enablers identified were rather described as logical business thinking.

**Keywords:** *Agile Manufacturing Parameters; Agile Business ; Factors Affecting on SMS's*

### 1. INTRODUCTION

Companies in the recent time have been challenged by the fast changing global business environment and the customers' demands. Due to this reason large scale companies have changed their production environment by implementing different world class techniques like JIT, TQM, Lean and agile manufacturing to improve the quality and productivity[1].The Small and Medium Enterprises (SME) have faced the same challenge. They are also competing for the favor of the customers.

The concept of agility and agile manufacturing (AM) is a new concept of operating business to achieve competitive advantage in turbulent business environment [2-4].[2] in particular investigates the relationship between agility, resilience and turbulence. The study shows that out of 471 North American companies, the ones investing in agility and resilience have significantly better performances and profitability during the time of intense turbulence. Therefore to continue, survive and grow, an SME needs to develop robust new products, which meet customer expectations in an agile manner.

### 2. LITERATURE/RESEARCH CONTENTS

Literature provides ways to structure AMEs (Agile

Manufacturing Enterprises). For example[5] identify seven key AMEs to respond quickly to changes of the environment which include (1) virtual enterprise formation tools; (2) physically distributed manufacturing architecture and teams; (3) rapid partnerships formation tools/metrics; (4) concurrent engineering; (5) integrated product/production/business information systems; (6) rapid prototyping; and (7) electronic commerce. However, this is not the only way of representing the enablers for AM[4] created a discussion of the different enablers. Furthermore, they also identify three resources to implement AM, namely: technology, management and workforce. This is coherent with[6], pointing out that all the manufacturing strategies need to be based on these resources, namely (1) innovative management structure and organization, (2) a skill base of knowledgeable and empowered people and flexible and (3) intelligent technologies. In addition, it is important to understand that AM has to be carried out at a companywide level[7, 8] (Christopher, 2000).

Scholars have been researching the different enablers of AM since 90s. As a consequence, there is an extensive list of AMEs that one can draw from all of these researches.

Technology is often expressed as being essential for the

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implementation of AM[9]. A variety of technological options have been identified as AMEs. For example, some authors argue that AM should contain automation[10, 11] while some opt for manufacturing cells [4, 12]. However, most of the authors agree on the fact that IT(Integrated Technologies) systems are crucial for AM[7, 9, 10, 13-15][12, 16][4, 13]. But once again, the type of IT systems can vary between the most elaborated Enterprise Resource Planning (ERP) systems to a simple email box[17, 18].

The management resources also play a very important role in achieving AM. [12, 19].For instance, an important criterion in reaching AM is a collaborative relationship with the customers and the suppliers in order to better sense the changes in the environment and also to create a better match in the supply chain[7, 20, 21].This network cooperation is essential in the creation of the “extended organization” and can take place together with concurrent engineering[4, 13, 22, 23].

The workforce appears in the literature to be a crucial resource for AM. First, in order to fully exploit the technology resources in the organization, AM needs an educated workforce see for example[24]. Furthermore, the employees’ ability of multifunctional working can increase the company’s agility[4, 25, 26],which as a consequence can reduce the dependence on key employees. This can be facilitated by an access to continuous learning and training[11, 25], and the creation of a learning organization by the management (Yusuf, et al., 1999). The empowerment of employees given by a higher autonomy and high decentralization is identified as another important input for AM[11, 26-28]. The objective therefore, is to train the workforce to become a flexible resource by itself. In turn this enables the employees to not only acquire cross functional knowledge but also to be more enthusiastic about their work, which as a result can lead to a reduced absenteeism[16, 26].

Availability of knowledge data base is essential for AM[12]. Academic literature related to the activities involved in the manufacturing and their availability to the concerned staff is an important factor for achieving Agility in manufacturing system[29].

Design of product being manufactured should be based on the strategy which correlates the goals of AM. Like it should be customizable, upgradable, it should be being designed after getting a feedback from end users [16, 30, 31].

Supply chain is very important element in achieving agility in manufacturing, a supply chain which is market sensitive, having high level of interconnectivity among the members with transparent information sharing among them is transparent is essential for that[7].

Lean manufacturing is important strategy for agile manufacturing[32]. Lean supply is closely associated with enabling flow and the elimination of wasteful variation within the supply chain[33, 34]. JIT-purchasing has a direct positive relationship with agile manufacturing while the positive relationship between JIT production and agile manufacturing is mediated by JIT-purchasing[24].

The AMEs are separated in the work force knowledge management information technology product design supply chain manufacturing strategy, even though these are deeply connected, making it sometimes difficult to distinguish. Within this context, table is an attempt to create a coherent framework of AMEs from a variety of different taxonomies used by different scholars. Following is a Table:1 comprising on agile manufacturing Enablers identified in literature.



### 3. INTEGRATION

The resources and enablers for agility cannot be understood alone. It is stated in the literature [6, 17] that integration is the key to a successful implementation of AMEs.

### 4. AGILE MANUFACTURING IN SMES

While the literature is rich with regard to AMEs for large companies, it is noteworthy that the applicability of these AM practices for SMEs has been largely neglected. This shortage is surprising as SMEs are an important factor for the economy of any country [35, 36]. The purpose of this research paper is to fill this gap by investigating SMEs. In coherence with this aim, a short literature review will provide an overview of what has been done within the field of AM in SMEs.

By highlighting that AM can be defined as relying more on people and their creativity than on the process itself, [13, 37] illustrate the agile methods used by SMEs in the construction area. The authors emphasize that the interviewed managers recognize the main AMEs in their people, the collaboration of business partners, organizational culture and technology [13] and the benefits of implementing AM. However [13] also highlight that the application of AMEs requires a strategic shift which can lead to hurdles with regard to the implementation. Within this context, [10] emphasize that in the quest for competitiveness, a crucial factor is the capability of SMEs to respond to the turbulent market by implementing appropriate manufacturing procedures and by finding a niche for their business.

Another research has been conducted with regard to the effectiveness of IT within SMEs, giving guidelines on how SMEs can manage agility. The results emphasize the need to develop people's skills and expertise in IT to reach agility [9, 38].

A further research carried out by [39] highlights a gap between the application of the LM (Lean Manufacturing) and AM concepts with regard to SMEs and large companies. While in large companies, LM is a step towards becoming agile, SMEs are capable of avoiding many elements of LM [39, 40] goes even further, stating that SMEs should neglect the lean concept and concentrate solely on achieving and maintaining AM by using enabling tools, like workplace organization and quick set-ups. This view, however, is a contradiction to the statement of other authors who describe LM and AM as not mutually exclusive [6, 7, 12].

However, most of the concepts and theories focus on large manufacturing companies they have not involved research or recommendations for small and medium industries. [41] has discussed agile manufacturing in aerospace industry. [5, 23, 39, 41-43] and thus highlight the lack of research in the particular field of AM in

SMEs. This scarcity of AM theory for SMEs is unexpected due to the fact that 99% of the companies in Europe are SMEs. With approximately 23 million companies and 75 million employees [35] SMEs are often named the "engine of the European economy" [35]. However, some studies could be found within the context of AM in SMEs. Implementation of MC starts with the design of product families that offer customers choice while optimizing the use of components. With a lack of understanding of how this is carried out, SMEs often embark on a strategy of offering customers more choice without a considered attention to the impact of this on their operations. It is often difficult for SMEs, with conflicting measures of performance and a proliferation of tools and techniques, to clearly identify how to proceed. The large enterprises can afford the risk of mistakes but small and medium can't afford this risk and are typically vulnerable, author recommends the design of products families that maximize the reuse of components [44]. A company's business environment, organizational culture, people management, collaboration and cooperation, flexibility, adaptability and technology are the most important factors for influencing the success of AMs in SMEs [13]. Studies on agile manufacturing in construction business for small and medium enterprise and concluded the key points required to shift toward agility are to find what are the key enablers and barriers for adopting agile methods, simple and flexible structure of organization, aligning the goals with agile values, promoting the new ideas discussions, multidisciplinary skills training and alliance with partners. Nevertheless, it is noticeable that the authors researching within this field highlight the challenges for SMEs in achieving and implementing AM. The spectrum thereby ranges from the required size of investment and lack of sufficient resources [42, 44] over the lack of bargaining power [44] to the need of changes with regard to processes and layout, as well as investments within the area of employee training and development [45]. While the mentioned challenges for SMEs obviously attract the researchers' interest, just a few of them concern themselves with how these developed strategies, concepts and theories can be applied in SMEs. A contradiction seems to appear when it comes to applying AM in SMEs. It is possible to assume that small and medium organizations would have strong capacities to become agile due to their flat hierarchy and thus a faster information and decision process. It can be reasonably imagined that compared to large organizations, SMEs have closer ties with their team members, as well as their suppliers and customers. Therefore, they should be able to sense and react in a more efficient and structural manner. However, as mentioned before, the literature highlights AMEs that seem out of reach for SMEs, due to their weak financial power [13].

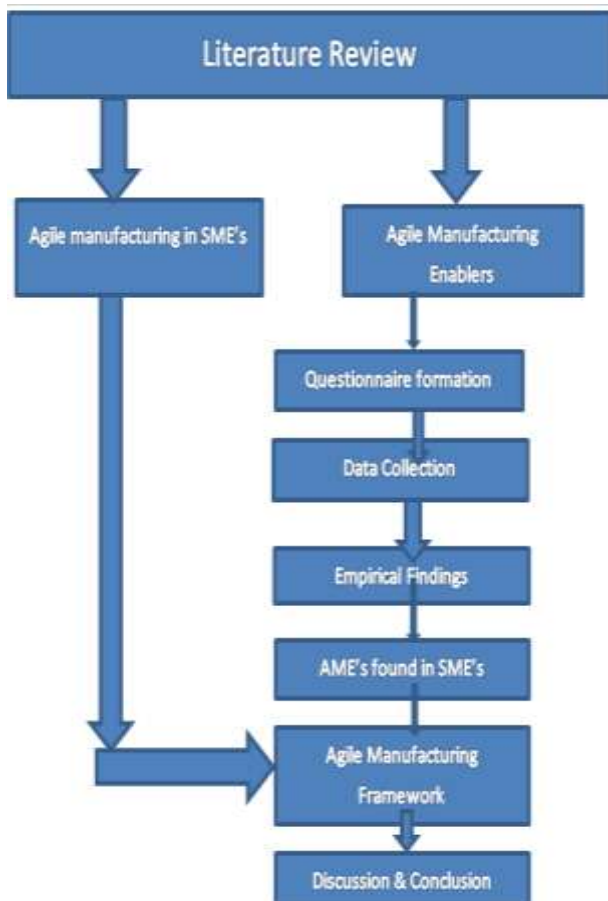
It is concluded from literature review that the agile manufacturing has been used previously in large industries but there are very few clues of its implementation in small and medium industries and if there is then too in very small measures. Now in recent days in the view of rapid changing demands of customers it has become essential for SMEs to change their manufacturing model on agile manners.

## 5. METHODOLOGY

A methodology has been developed with the aim of achieving a data collection which will provide a way to compare the collected data with the AME identified in the literature and the extent of their applications. The object of this section is to provide the reader with an overview of the used research approach and strategy.

The design used in this study is survey. The target population for a survey is the entire set of units for which the survey data are to be used to make inferences. The target population for this survey is the production managers of the SMEs mainly.

production is also carried out in Lahore and Karachi. This industry primarily belongs to small and medium enterprisers (SMEs).



## 6. FAN INDUSTRIES IN PAKISTAN

Targeted industry for the study is FAN industry in Pakistan. Pakistan is known as the homeland of FAN industries in the region, it exports fans in a huge numbers to the region. Gujarat, and Gujranwala, are two key players in the production of fans which is almost 98%. Some of the There are 450 SMEs engaged in the production of fans both for domestic market and export. Out of this a major number of 300 units are known to exist in Gujarat. Fan sector is not only earning precious foreign exchange for the country but is contributing in multiple ways to the National economy. This industry employs up to 30,000 workers. However, the down side is that the production is mostly seasonal and confined to 1st six months of the year. Therefore the workers are not adequately skilled as they are forced to find alternative sources for earning livelihood. Few major companies have endeavored to keep their workers engaged throughout the year by shifting to related engineering products. A major contribution of the fan industry is that it has developed clusters in Gujarat and Gujranwala. Around 90% productions cater to domestic demands. It is interesting to note that local consumer demands better quality and innovative designs as compared to export products which are of low margins. Most of the companies operate under locally created brands with only a few moving towards international branding. Fan industry is producing around 90,000 indirect employment opportunities. Thus its contribution to total manufacturing employment is up to 1.54%. Pakistan's exports are mainly concentrated in low-income markets, such as Africa, Bangladesh and some Middle East countries. The average export price of Fans made in Gujarat and Gujranwala is around \$23-25, which is much lower than some of the more sophisticated fans which sell for around US\$400-500. The retail price of Pakistani fans in its export markets on the other hand varies between US\$35-40.

## 7. DATA COLLECTION

A detailed literature review is conducted to understand and explore the agile manufacturing enablers. Different authors have proposed different enablers for achieving the goal of agile manufacturing. These agile manufacturing enablers have divided into six different categories. A detailed four point likert scale questionnaire is developed to collect the data from the targeted industries. Questions of the questionnaire are based on the factors identified in the literature review according to different authors. These agile manufacturing enablers are enlisted in the table 1.

**Table 2: Research data overview**

Population under study	Manufactures within the FANS industry
Population census	60 surveys
Geographical area	Pakistan
Data Collection method	Semi-structured and open-ended interviews Structured survey
Sample size	60 answered questionnaires
Valid response rate of surveys	100%
Time frame	Mid of March – Mid of April
Respondent profiles	CEOs/managing directors, production managers, development managers

These questionnaires are filled by production managers and CEO’s of the relevant industries. Personal visits have been made to get the questionnaires filled and distributed in local language for better understanding.

**8. EMPIRICAL FINDINGS**

The findings of the conducted surveys are presented here. In total 60 surveys were filled out. Within this context, the literature review of AMEs provided the foundation for the survey questions, and thus were a source of insight information. The figures shown in this findings part reflect the results of the survey answers. At this point it has to be mentioned that survey is to identify the AMEs in the SME which are praised in the literature and to find the extent of their application in the SMEs again,

Investigated companies based on the number of employees are distributed in the following order.

- 76% \_\_\_\_\_ 10 to 50
- 16% \_\_\_\_\_ 50 to 100
- 6% \_\_\_\_\_ >100
- 2% \_\_\_\_\_ <10

The respondents’ professions were mainly CEOs/managing directors, production managers.

**9. AGILITY ENABLERS IN THE FAN INDUSTRY**

**A. Work Force**

Following are the questions asked in survey under the category of work force. Every question was offered with four scale choice from never, rarely, often to always.

WF1. Decision making is not centralized, in charge of respective areas are independent to take decisions in their domains. 50% companies responded it as always and 50% as often, it shows that owners or CEO don’t effect the decisions of the work flour managers and they are free to choice what they want to use for the best production.

It is being emphasized throughout the world that the involvement of the employees in the decision-making process is a tool to integrate their human resources and thus to create an understanding of the business itself. This was assumed by the managers for having a huge impact on the motivation and commitment of the employees.

WF2. Continuous education and training is being given to employees about new techniques and technologies.

80% companies replied it never, only 20% rarely. Mostly workers learn from senior employees, there is no special education or training for the job. On asking that they responded that there is no need of any particular training because the changes in the work are so minor and they are doing it for years so there is no need of continues education and training.

Training and education is considered as an important ingredient for the agile work force, authors have stressed on continues training of the employees to upgrade their knowledge and skill level to perform e the tasks. World view about this has main focused in the advanced and updated education and training should be a main part of the company’s policy.

WF3. There is a spirit of team work and collaboration in work force

66.7% replied always and 33.35 often. Mostly workers remains in friendly environment with each other and the small size of the industry help to get it because they are all well acquainted with each other hence there is a good team work spirit.

Good level of cooperation enhances the responsiveness and then customer service level, motivation to work in teams is highly recommended because of its synergy effects, it is widely praised and implemented in the world for the sake of achieving agility in the manufacturing process.

WF4. Work force is trained to perform multifunctional tasks if needed

100% answered it yes. As the process of assembly and the production line is not so much complex and long so all most all of the workers can perform all the tasks of the whole process but we can’t deny the fact that if someone is working on the balancing of fans for years and other one on the winding of motors they can’t be as good if we switch them but if there is need to do they can perform each other’s tasks at least. High training and capability to

perform the multifunctional tasks is recommended feature for the agile human resource, it reduces the time of response and make the more people available to perform the task if someone assigned is missing from the spot.

WF5. The workforce is committed to perform the assigned task.

20%often, 80% replied always. Workers are committed with their tasks.

High level of commitment is very basic need of an agile work force, responsibilities are given them to make them committed with the assigned tasks, without good commitment no work force can be an agile one.

WF6. Workers are knowledgeable with computer and IT solutions

From the responses 46%never uses IT, 53% rarely.IT solutions are mostly not adopted in the fan manufacturing SME's so workers are not knowledgeable with it, but now some companies have started using at least mail service for communication and almost everyone has made a page of their product on Facebook.

World is getting more and more IT oriented, IT is making an impact on every aspect of life, in manufacturing arena application of IT is getting high and higher with the passage of time so to cop the modern day needs of manufacturing it is globally accepted that the work force should be knowledgeable with the prevailed IT solutions relevant to the used manufacturing process.

WF7. Every shop floor manager is free to take decisions at his responsible work. Furthermore, decisions are taken and implemented quickly without wasting time.

From the resonses76% replied it often, 23%always. Owners usually don't interfere in the decision until it becomes very critical.

Being responsive on time without any delay is main focus of agile manufacturing , taking decision on time and then implementing them without any delay is a key to the agile shift, companies working on the agile concept of manufacturing have developed a very quick decision making process.

WF8. There are good internal relations between employees & departments

53% of the responses were always, 46%often Because of the small size of the industry relations are mostly good between employees and the section.

Good relation between the persons doing tasks is first and the foremost requirement of agility in the performance. Figure 2 is presenting all the factors about work force in the form of graphs.

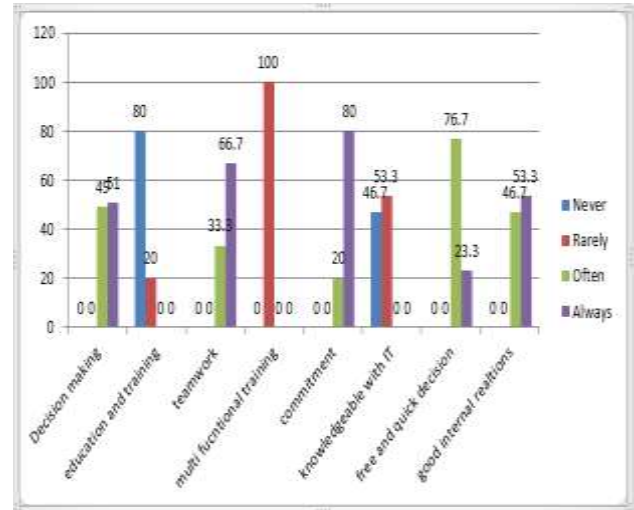


Figure-2 Work Force Factors

## B. Knowledge Management

Following are the questions asked in survey under the category of Knowledge management and their response. Every question was offered with four scale descriptions.

KM1. The company prepares his knowledge database which is accessible to all the workers

83% replied never and 16% rarely. There was no data base in the industries, sometime some manuals kept secure for the understanding of some new coming machine but as a specific data base there was nothing like that.

Availability of knowledge data base is one of the praised prerequisite of agile transformation, availability of relevant information regarding the manufacturing process, records of manufacturing activities etc. helps to expedite the manufacturing process, companies which are working on agile manners have developed their own knowledge data base.

KM2. Academic literature of work related activities is available

Academic literature regarding manufacturing activities and the facilities being used in the manufacturing process is recommended and being used widely in the world of agile manufacturing, it helps to train the new hired employees and to fix the problems if occur in the process of manufacturing.

From the responses 33%never use this facility 66%rarely academic literature in the form of specifications of different fans was available in some companies. But a special academic literature related to the activities was not present.



KM3. There is a Transparency of information (product and process related) flow in organization and partners which is not very much secret.

96% companies replied it to always, there is nothing like secret in the case of information follow everyone knows what is happening on the other corner or section of the industry and this is mainly because of the small size of the industry.

Transparency of information is very important and cardinal factor in achieving agility in the manufacturing process; it has a direct influence on the time consumption during the manufacturing process. Making the flow of information transparent can reduce the time utilized during the transferring the instructions and orders based on the hidden information, making it transparent and available to all reduce the extra layer of people hired for the conveying that information on the required time and consume time as well

KM4. The company has developed the best practice procedure, and proper mechanism is available to teach these practices to the workers.

100% replied it rarely companies are keep on manufacturing the products based on the already established ways, there is no research to find the best practice currently and then to teach it to workers.

With the passage of time and development of technology new and new tools and techniques have been developed by the researchers, so adopting them and then exploiting them for the best service of customers and gain of company is widely recommended as a key factor for achieving agility in manufacturing , it has been used worldwide with a considerable focus. Following figure 3 is graphical representation of the values of these factors.

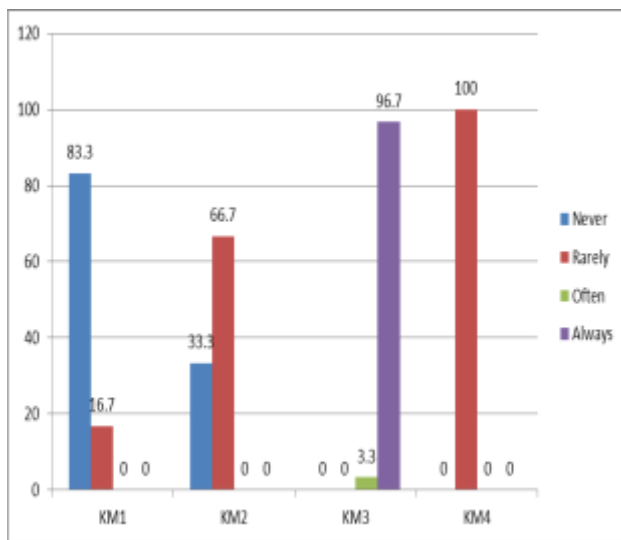


Figure-3 Knowledge management All Factors

### C. Information Technology

Following are the questions asked in survey under the category of Information and Technology solutions being used and their response. Every question was offered with four scale choice from never, rarely, often to always.

#### IT1. Internet based communication is used

53% replied never 46% rarely, few industries were using emails for their communication but most of the communication was from landline numbers and cell phones. So the scope of internet based communication was almost zero in the industries.

With the development of information technology the mods of communication have changed, now the communication has become faster than ever before , internet based communication is widely praised for the agile transformation of messages and coordination with partners customers and other related people.

#### IT2. Material Requirement planning (MRP)

As a common all industries use to plan their production material requirement for this production but as we are discussing material requirement planning under the umbrella of IT solutions so in this case there was not any software being used for this purpose across the board so the response was 100% never.

Information technology has developed the way to handle thing more easy and in more agile manners, application of software for the material requirement planning are being used worldwide in the industries for whom being agile is the motive of their production.

#### IT3. Enterprise resource planning (ERP)

Same is the case of enterprise resource planning as well, response was 96% never.

Software based enterprise resource planning is recommended by different authors and being used by different companies in the world for achieving agility in their manufacturing process.

#### IT4. Capacity requirement planning (CRP)

There was not any software being used for the purpose of capacity requirement planning, 100% responses were “never”.

Capacity requirement planning based on software is part of the solution for shifting conventional manufacturing system to the agile manufacturing system, largely praised and accepted all over the world as an agile enabler.

#### IT5. Computer added design (CAD)

There was no use of CAD software in the companies because generally they don’t need it and it they get need



to have a drawing of something they make it available from some designer but don't have this facility on their own. Response was 100% rarely.

Computer added design is one of the diversely used software for the design of parts of machines and other small parts of the products; it is among the recommended solutions for agile manufacturing and being implied as an enabler for achieving agility from conventional manufacturing system

IT6. Database (Product and process)

There was not any electronic data base, but emails saved for only those companies which use emails for their communication. 90% replied never to the existence of any data base in the industry.

Electronic data base is among the being used agile manufacturing enablers throughout the world; it reduces the time to make the desired information available to the respective people figure 4 is showing graphical details of IT related factors for agile manufacturing.

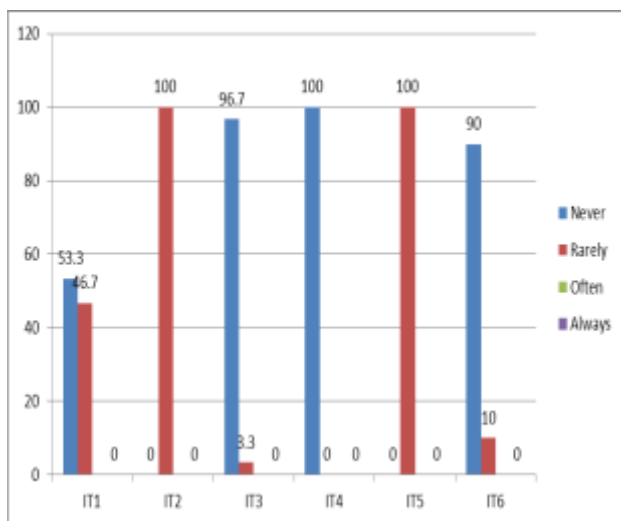


Figure-4 Information Technology All Factors

D. Product Design

Following are the questions asked in survey under the category of Product Design being used and their response. Every question was offered with four scale choice from never, rarely, often to always.

PD1. Company emphasizes that the Products are being designed after taking feedback from customers

73% replied to this question as never. There is no concept of taking feedback from customers to make a design of the product, however sometime some fan are prepared of special orders.

Design of a product is very important thing to keep under consideration, agile manufacturing not deal only with the

work Flore but with the customers as well, designing the product which has demand among the customers is a factors recommended and being used for achieving agility in manufacturing.

PD2. It is company's policy to Designs the products which are upgradable

From the responses 73% replied often 26% always. Fans are upgradable machine. You can change motor, wings buttons but these parts cannot be changed with some other size fan.

As the customers are becoming more and more sophisticated and particular in their demands, the design of manufactured products becoming more and more upgradable for being agile to respond the need of the customers. Throughout the world companies manufacturing on the agile manner are designing their products which are upgradable.

PD3. Company emphasize on the modular design of the products

From the responses 56% replied often 43% always. Design of the fan is mostly modular consisting on different parts.

Modular product designs are used in the companies working on the agile manufacturing grounds.

PD4. It is policy to integrated the customers in the process of product design

Customers are not the part of the process of product design, company himself decide what to design for the market, there isn't any such integration is present there. 96% responses were never.

It is recommended to take the customers in the process of product design, take opinion from them before designing the product to understand the nature of demand of the product you are going to manufacture, it is being used as an agility enabler across the world.

PD5. Company emphasize on the customized product design

80% replied there is not any customized product design but the different designs are available in the market and customers have to choose from them, while 20% responded that they sometime make customized products but it depends upon the order.

With person to person specific demand customized design products have become the need of the time, to respond this diverse nature of demand of the products companies are manufacturing customized products recommended by literature as an important agility enabler. Figure 5 represents the graphical details of product design related factors.

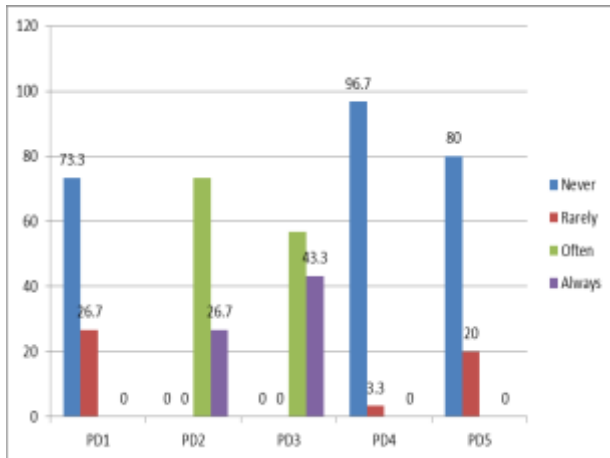


Figure-5 Product Design All Factors

### E. Supply Chain

Following are the questions asked in survey under the category of Supply Chain being used and their response. Every question was offered with four scale choice from never, rarely, often to always.

SC1. The company has a high degree of process interconnectivity With the suppliers

70% replied always there is a good interconnectivity in the supply chan. While comparing the supply chain enablers praised in literature with the SME's we have found that chains are very much agile, everything is available to the manufacturers in the market and there is no delaying as well. What all they need is to come up with money and take it.

An excellent interconnectivity with the partner suppliers is widely accepted as one of the important factor of agile supply chain, agile supply chains being used anywhere in the world are highly interconnected with the fellow suppliers

SC2. Supply chain gains flexibility by using the strengths of specialist Suppliers

73% replied it to always and 27 percent often, there are number of suppliers are available in the market who are very specialist and particular in their supplies.

Flexibility in supply chain is another recommended factor, flexible supply chains use the strength of the suppliers based on their specialists.

SC3. Supply chain is market sensitive in the sense of connection with the end users

Market sensitive means that the supply chain is capable of reading and responding to real demand. Most organizations are forecast-driven rather than demand-driven. Agile supply chains are used to be very sensitive to the markets to which they are responding.

Supply chain is very much market sensitive in the way that what products are being manufactured their supplies are always remained there in the market and there are no such huge changes in the products for which supply chain has to be sensitive for the change so for existing scenario supply chains are sensitive.

SC4. The company shares complete product information with its suppliers

There is no secrecy in the information follow, everyone knows everything about others. What they prefer to hid is their revenue and this is too from income tax officers not from suppliers. Figure 6 describes the SC factors in graphs.

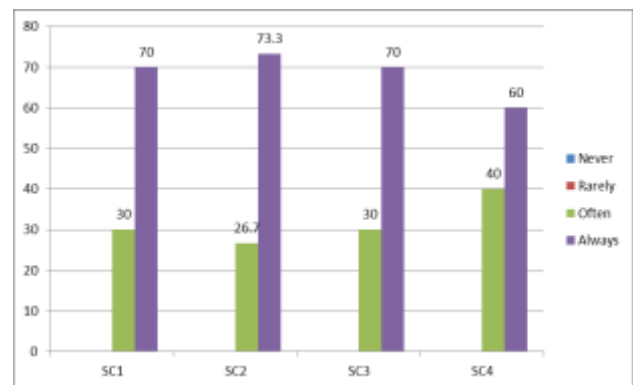


Figure-6 Supply Chain All Factors

### F. Manufacturing Strategies

Following are the questions asked in survey under the category of Manufacturing Strategy being used and their response. Every question was offered with four scale choice from never, rarely, often to always.

MS1. Lean manufacturing is applied for manufacturing

Respondents were not aware of what is the lean manufacturing actually but on describing they have told that they always remains in the pursuit to minimize the waste, hence 70% replied that the work on the principle of lean manufacturing in fan industries of Pakistan.

Lean manufacturing is one of the highly recommended and diversely used agile manufacturing enabler.

MS2. Automated manufacturing systems are in use for the manufacturing of products

There is no automation in targeted fan industry, most of the work is being performed manually, however some companies have acquired some automation like for winding of motors but no one is fully automated.

Automated manufacturing systems have become the order of the day; it has become impossible to cater the modern day manufacturing demands without them so they are

being used throughout the world for achieving agility in manufacturing.

MS3. Just in time(JIT) is implemented as manufacturing strategy

There is no concept of JIT in fan industry of Paksitan, 96% replied never. They keep on manufacturing fan on the orders and guess work in which they have become expert, they understand the market demands and the manufacture it on the bases of demands, when order is place the seek time for delivers, although some time if there are products in the inventory they deliver it immediately.

JIT is a globally recommended and used enabler of agile manufacturing; it has changed the manufacturing paradigm by eliminating the inventory.

MS4. Total quality management (TQM) is used in the company

Same is the case of TQM as was of lean manufacturing, 70% replied they keep on working to raise the quality of products, every time they do some sort of work they try to do it better than before but there was not any special accountability for TQM which is praised in literature.

Total quality management is an important and highly used agile manufacturing enabler, everywhere there is the motto of production is achieving agility TQM cannot be avoided,

MS5. Flexible manufacturing systems are in used for manufacturing

Depending upon the products being manufactured the available facilities are flexible, from the responses 73% replied it often and 26% always.

MS6. Mass customization is a focus of the company

There is not any concept of mass customization in SME's. 96% respondents replied it never. They produce things according to their design and then customers select from these available designs.

MS7. Concurrent engineering is a part of manufacturing process

Concurrent engineering is a part of process in the targeted industry; different sections keep on working to manufacture their related parts, and work concurrently with each other.

MS8. Manufacturing cells technology is applied for manufacturing

Manufacturing cell technology also has application in fan manufacturing SME's. Work floors are designed in the way that closely related machines are near about with

each other to help the process. Figure is about MS factors in graphs.

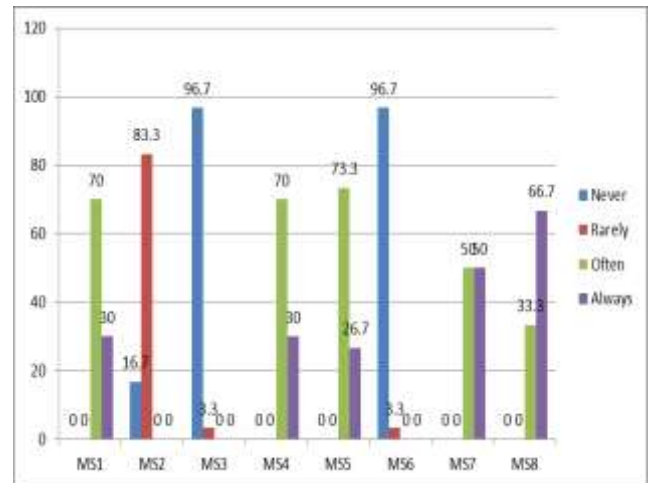


Figure-7 Manufacturing Strategy All Factors

As illustrated in the literature, it is crucial to reflect upon the ability of SMEs to integrate their different resources and therefore to create a coherent bundle of enablers. It appears that although the extended organization and the human resources of SMEs are highly integrated, these organizations lack a companywide initiative to develop a vision for AM. Therefore, the set of AMEs explained above is inherent to the organizations, rather than actively created for an overall agility purpose. Companies are lacking a consistent AM plan of action, which results in an incomplete consistency with the AM model praised in the literature. An overview of the existing AMEs in the organizations surveyed is provided using the table 3.

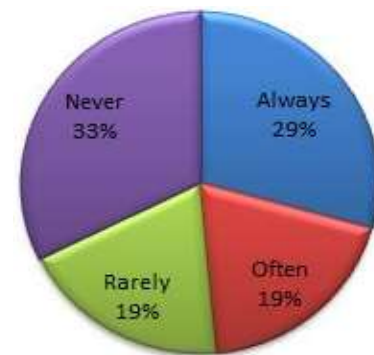


Figure-8 AME's distribution chart of Companies

#### G. Agile Manufacturing Frame Work

Keeping the findings of the survey under consideration and taking guidelines from literature about the AME's the following frame work (figure # 9) is prepared for the SME's in the fan industry of Pakistan. It can be argued that the main AME's are rooted in the workforce, knowledge management, information technology, supply chain, product design and manufacturing strategy. Some

of the AME's are being implemented up to some extent in the industries but not wholly especially in Pakistan. So the focus of the frame work is to keep all the praised AME's under consideration to recommend a way forward for their integrated implementation.

It can be concluded that the AMEs identified in the literature are partly reflected in the practices of the

studied SMEs. 29% AME,s always applied, while 19% often, 19% rarely and 32% never applied shown in figure 8, this comparison shows that SME,s are far away from implementing the praised AME,s. There is still a significant need to implement AMEs in SME,s in more progressive way to adopt the changing demands and then to react them timely.

**Table: 3 AME's Identified in SME's**

		Always	Often	Rarely	Never
Work Force	Decentralized decision making	✓			
	Continues education and training				✓
	Team work	✓			
	Multifunctional workforce			✓	
	Comitted work force	✓			
	knowledgeable workers with I.T			✓	
	Qick decision Process	✓			
	Good internal relationabt departments and employs	✓			
Knowledge Management	Availability of Database				✓
	Academic literature			✓	
	Transparency of information	✓			
	Mechanism to dissiminate the best practices			✓	
IT	Internet based communication			✓	
	MRP				✓
	ERP				✓
	CRP				✓
	CAD			✓	
	Database				✓
Product Design	Customers feedback for product design				✓
	Upgradeable design		✓		
	Design modularity		✓		
	customers integration with design process				✓
	Customizable design				✓
Supply Chain	Process interconnectivity between network members	✓			
	Flexibility by using the strengths of specialist players	✓			
	Supply chain is market sensitive	✓			
	Information sharing amnong all chain partners	✓			
Manufacturing Strategy	Lean manufacturing		✓		
	Automation			✓	
	JIT				✓
	TQM		✓		
	Flexible manufacturing system		✓		
	Mass customization				✓
	Concurrent engineering		✓		
	Manufacturing cells	✓			
	specialisation on core products				✓
	Modular reconfigurable system		✓		

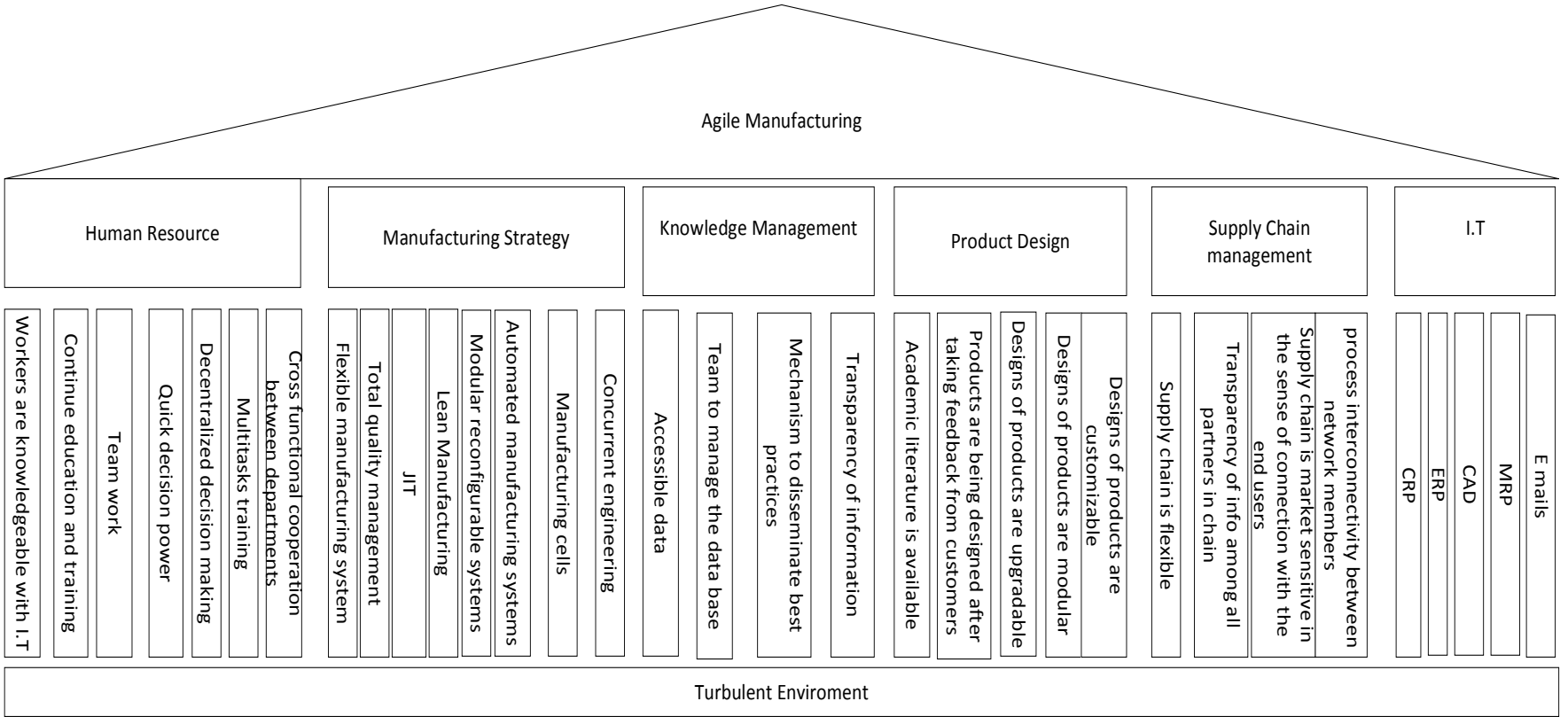


Figure-9. Agile Manufacturing Frame work

## 10. CONCLUSION

The literatures' richness of AM definition, concepts and enablers for large companies was highly visible, barely any attempt has been made to challenge the concepts' relevancy and applicability in the context of SMEs. Therefore purpose of this was to shed light on the AM concept itself and to scrutinize the concepts enablers suitable for SMEs, and thus companies with less financial resources than the large ones. The aim hereby was to challenge and to extend the existing body of knowledge not just by identifying the practices used by SMEs in the FAN industry in the quest to achieve high responsiveness, but also by providing a more practical approach gained from real-life examples. In coherence with this purpose, the main contribution of this paper is the creation of a model illustrating the AMEs applied in SMEs in the FAN industry. Furthermore, this model will give other SMEs the possibility to reflect on their practices and to identify feasible areas of improvement.. Furthermore, it is crucial to recognize the AM concept, and also the created model within this thesis, as a guideline rather than a best-practice model applicable for each and every company and industry. The capability of the SMEs managers to create the right set of AMEs relies strongly on their capability and willingness to perceive and act on change. Therefore, it is essential to pursue a continuous learning approach by constantly reflecting its own business processes and by being open-minded.

### Further Research

Considering the genuine interest in our research by the SMEs' managers from the FAN industry in Pakistan, it is believed that SMEs' AM deserves further investigations. As a matter of fact, the author of this paper is well aware of the generalizability issues raised in the methodology part. The choice made to focus on a single industry and a single country restrains the expandability of the conclusions. Therefore it would be interesting to compare the findings at a wider scope with a comparative analysis with different industries and perhaps different countries.

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