Australian Journal of Basic and Applied Sciences, 5(10): 551-559, 2011
ISSN 1991-8178

Adoption of Technology in the Hand Woven Carpet Industry: The Case of Alinasab Carpet Company

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Abstract: Generational features of the Persian carpets have evolved from its very traditional craft to the verge of shaping an industrialized art. Being a deeply traditional industry, carpet making has immensely influenced its production process and value chain. In this paper, the authors discuss the application of technological elements to the hand woven carpet industry, indicating that traditional technologies can be renewed by the use of the latest innovative advantages. The authors will elaborate on how new technologies have driven Persian carpet firms to expand their markets internationally. This paper will also discuss how the integration of art and technology influences the practices in the industry.

Key words: Traditional Craft, Persian Carpet, Art, Technology.

INTRODUCTION

The Persian handmade carpet is one of the most influential and pivotal elements that depicts the central theme of Persian art and culture. Being a handicraft industry implies that most of the production processes are being completed by hands of artisans. Rarely can we encounter the signs of technological adoption in Persian handmade carpets. In particular, Persian carpets which are among the most labor demanding decorative pieces, provide income to more than four million weavers, belonging to both rural and urban areas of the country. The industry contributes to the national economy in several ways and offers employment to the countryside-deprived and the economically weak segments of the society. However, it has started to lose its strong market leadership position. We can find several reasons for this decline, but the paucity of technological capabilities should be the salient reason.

The hand woven carpet industry is a decentralized industry in which skills and methods have been passed on from one generation to another, mostly without being influenced by new technologies which may bring benefit to the industry. Being an internationally reputed product and having an established market all over the world emphasizes the need for a series of necessary implementations of technological assets, which may be considered as the 'last resort' for Persian carpet survival. The reason for this being the dramatic decrease in carpet export recently, where customers lament the high price, declining quality, poor after sell service, out of date design, etc. Thus, the industry has the chance to gain immense added value, since most Persian carpets are exported and returns would be in terms of foreign exchange.

The generational features of the Persian carpet have evolved from its very traditional craft to it being on the verge of an industrialized art. Being a deeply traditional industry, carpet making has immensely influenced its production process and value chain. This paper will discuss the application of technological elements to the hand woven carpet industry, indicating that traditional technologies can be renewed by the use of latest innovative advantages. Also mentioned will be how new technologies open up opportunities for Persian carpet firms to expand their markets beyond national borders. Added to this will be a depiction of how carpet manufacturers can exploit cross-industrial technologies. The intention is to measure whether the marriage of art and technology in the Persian carpet field will bring possible beneficial influences on the whole carpet industry, or whether perhaps there needs to be defined limits in using technology to avoid its detrimental effect on the values of hand woven carpets.

Sketch of the Persian Hand Woven Carpet Industry:

The technology of manufacturing woven carpets has remained virtually unchanged over the centuries. Now, like a century ago, high quality hand woven carpets have only manually been painted with natural wool dyes and adorned with intricate ornaments. Only in this way can we have Persian rugs. No doubt, producing such a carpet is a complex art which demonstrates a high degree of talent, experience, determination and creativity of the artists. Paucity of modern technology is however obvious. Only recently rug cleaning, wool dying and spinning technology have been introduced in Iran. Hands of skillful artisans are doing most parts of the production process; hence, the cost of production reaches the sky. The recent decline in export and production of

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Persian carpet indicate that they are losing their competitive features to their rivals, especially in terms of production cost.

The industry needs to urgently adopt technology in every single steps of its value chain. Persian carpets already enjoy the unique competencies in term of quality; however it needs to lower its price to broaden its target market. According to the Generic Strategies of Michael E. Porter (1985) a mixture of cost leadership with product differentiation are seen as hard (but not impossible) to implement due to the potential for conflict between cost minimization and the additional cost of value-added differentiation. Nevertheless, to help the Persian carpet to retain its strong position in the market we need to try to do the impossible, combining the two competencies, quality and cost leaderships, into one product.

Traditional Carpet Manufacturing Process:

The role of technology in the traditional process is nominal. From the initial design stage until the after sale stage, the most time consuming and costly processes are being followed. Traditionally, all of the designs used for Persian carpets were made manually; the design itself being entirely dependent on the designers' creativity. The design process used to take from two months to even more than a year depending on the compactness, complexity, style, and size of the design. The higher the compactness the more time will be spent by the weavers.

As mentioned, the wages, which mostly direct labor costs, constitute the largest share in the cost factor for producing Persian carpets. According to INCC (Iranian National Carpet Centre)cost structure for manufacturing carpetsis:

- Labor 37%.
- Design process 23 %.
- Used Raw material 17%.
- Overhead Expenses 15%.
- Wastage of Raw material 5-7%.

The labor costs include not only the weavers` cost, but also cover the cost of a series of activities, which are being done by different workers with different skills, such as those who dye the wool and silk before the weaving process or others who make the loom. All these manual steps are consequently very costly. If we want to adopt new technologies in the hand-made carpet industry, we need to adapt the related value chain. To put it differently, the author believes there is considerable room for the industry to be technologically improved by increasing the capabilities of innovation and utilizing technology in new ways to compete in the industry.

Diffusion of Technological Innovation:

Within the last few decades, the worth of the international carpet market has increased from USD 350 million to about USD 2 billion (Statistical Center of Iran, 2009). However, Persian carpets have lost a major scale of its appeal because of severe rivalry from other countries and particularly from machine-made carpets and Iran's market share has dropped dramatically from 60 percent to 30 percent. Albeit Iran still enjoys the largest share in the international carpet market, the slack (due to declining Iranian production) is taken up by other manufacturing nations, especially China, India, and Pakistan. All of these push the author to construe the successful diffusion of technology in Persian carpet construction as the last resort.

Technology progress over time passes through the following five stages in the diffusion process (Figure 1):

1. ***Knowledge (Awareness):*** Learning about the existence and function of the technology.
2. ***Persuasion (Interest):*** Becoming convinced of the value of the technology.
3. ***Decision (Evaluation):*** Deciding to adopt the technology.
4. ***Implementation (Trial):*** Putting it to use.
5. ***Confirmation (Adoption):*** The ultimate acceptance (or rejection) of the technology.

Considering the characteristics of the Persian carpet industry and taking personal experience into account, the author would offer the following innovative actions: process, service and feedback.

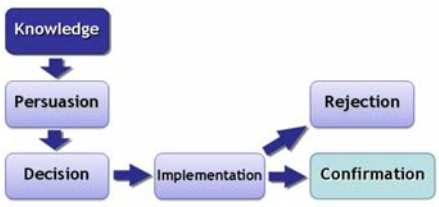

Fig. 1: Diffusion stages (Adapted from Rogers and Everett, 1983).

Process Innovation:

Persian carpets are a mature product, thus the industry should emphasize on process innovation to respond to the competition. However, in terms of product innovation the industry does not intend to produce a totally new product. In fact, what it needs is a modified version of an existing product through implementing the latest technologies. For instance, a technology that can pave the way for the industry to design and use better tools to weave.

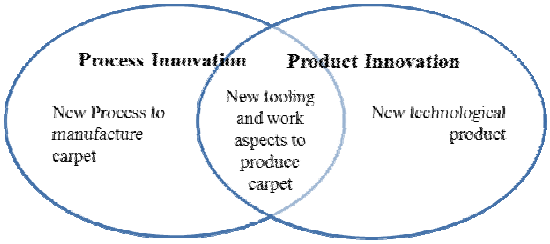

Fig. 2: Process and Product Innovation (Adapted from Parthasrthy and Hammond, 2002).

What would be the effect of implementing process innovation in the industry? To find the right answer to this question there is a need to understand the literature of 'Process Innovation'. Process Innovations either performing a work activity in a radically new way or the adoption of technologically new or notably improved production methods (Papinniemi, 1999). It is exactly what the hand-made carpet industry lacks. These methods may involve changes in production equipment or organization or both (See Figure 2). Consequently, the methods are intended to lower Unit Production Cost, often by reducing the number of disconnected process steps, which cannot be done using laborious conventional systems or production methods. It is also called 'reengineering of business process' which is a very popular item in management literature of recent years. Figure 3 indicates four main elements of innovation and their linkages.

At each step of the carpet production process, it is feasible to exploit the innovative process, instead of traditional costly and time-consuming ones. Based on the author's observations and interviews with different carpet industry figures, the Persian hand-woven carpet does not need to enter the pure production innovation area, since it is not aiming to produce a completely new kind of carpet; however, by applying process and production innovation as coalescence, (shown in Figure 2) would be more beneficial.

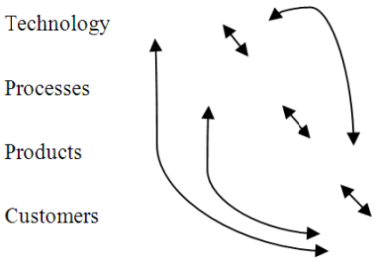

Fig. 3: Innovation Elements (Adapted from Papinnieni, 1999).

Service Innovation:

Another area, which may provide more competitiveness for the Persian carpet industry, is improved services with service innovation sometimes resulting in winning business models. Services related to carpets are limited, and as a highly priced product the customer expects better services from the producers. Researchers of Innovation do not agree if the innovation of product fundamentally differs from service innovation or not (Drejer, 2004; Preissl *et al.*, 2000; Tether and Metcalfe, 2004). Service Innovation is a new or considerably improved service model that is going to be implemented. It can be, for example, a new customer relations method, a technological concept in delivery structure, or a mixture of them.

The service innovation process often differs from the innovation of products. Two important differences are(Abramovici and Laurence, 2004; Djellal and Gallouj, 2001; Tidd and Hul, 2003):

- Services are usually developed in close interaction with the customers.
- Services are usually innovated in networks rather than labs.

The industry should exploit the technology to skip the intermediaries, which would eliminate the unnecessary cost of 'middle-men'. Implementing a better interaction system with customers would have a beneficial influence on the Persian carpet industry.

Feedback Innovation:

Customers have always been core to manufacturing companies' existence. To put it differently, customers are the source of cash flow. However, Persian carpets are experiencing a gap between their productions styles and the demand of customers. As a result needs have been shaped differently. The industry should address demands according to consumer tastes. Being a decorative product, carpets buyers are highly sensitive to decoration trends and fashions.

One problem of traditional industries is their laziness in keeping the pace with modernity. To do so, the industry needs to establish better relations with its patrons. Today technology gifts the producers the chance of collecting feedback from their customers. These feedbacks are an invaluable asset to discover what customers want in product and design. Furthermore, consumer involvement in product design usually gets creative results.

Technological Challenges for Persian Carpet:

While cutting costs is one of the reasons the Persian Carpet industry needs to pursue technology, increased efficiency and reduced complexity in the companies` product portfolio are some of the other benefits to adoption of technology. Beyond the potential downsides of diffusion of technology, there are also cultural issues within carpet companies that need to be addressed. As the priorities and processes of a company in producing its products shape the culture of the company, many companies, which want to exploit technology, have to modify their previously strong regionally oriented structure and culture (Griener and Schein, 1988).

How much should the feeling of 'them' and 'us' hinder successful development and implement of technology? Gray (2001) highlighted the need to "remove local subjective prejudices and focus on objective issues. " Also, in this literature, the degree of novelty of innovation in products or production processes has been associated with four types of knowledge deficits (Godoe, 2000; Danneels and Kleinschmidt, 2001; McDermott and O'Connor, 2002). These deficits can certainly all be related to the Persian carpet manufacturers' current situation and centre around technology uncertainty, technical in experience and costs alongside business inexperience.

Firstly, technological uncertainty is the degree to which the development of products or production processes involves the creation of new knowledge representing a substantial challenge. The greater the knowledge-creation demands, the greater the degree of novelty of innovation. Secondly, technical inexperience being the degree to which the development of products or production processes involves the use of skills and equipment where the firm suffers from a lack of knowledge. The greater the need to acquire knowledge related to the learning of new skills and absorption of new equipment, the greater the degree of novelty of innovation. Thirdly business inexperience as the degree to which the development of products or production processes involves the creation of new knowledge for the development of new business practices (i. e. , the development of organizational innovations). The greater the need to acquire knowledge related to the creation of new business practices, the greater the degree of novelty of innovation. Finally with technology costs and the amount to which the development of products or production processes involves investments in the acquisition of knowledge embodied in equipment important to the firm: the greater the costs of acquisition of knowledge in equipment for the firm, the greater the degree of novelty of innovation.

Computerization:

We can consider Computer Aided Design (CAD) as a feasible solution to reduce initial costs of carpet production. It also provides design variety for carpets, which is essential for having a global product. Various carpet producers suggested this and recently some technology companies introduced a series of software for designing the hand woven carpet; indicating that an Information and Communication Technology (ICT) platform can accelerate the transition phase of introduction of technology to carpet.

Naqsh-Sazis a CAD software tool for carpet designers and can be used to create a wide range of designs by focusing on requirement of international market. The software reduces dramatically the design time and also provides more flexibility in the process of design. Naqsh-Saz incorporates the following helpful tools: Color-Saz, Show-Saz and Dye-Saz. Color-Sazhelps in selection and formation of color arrangements by buyers. It enables manufacturers to reach out to their customers and offer them anextensive rangeof options in terms of color combinations. Show-Saz is a presentation tool for designers, manufacturers and end users. It shows the final product even before starting to manufacture it. It is very beneficial particularly for pictorial carpets. Dye-Saz is a calculation tool for the amount of wool, silk and dye needed for a design. As previously noted, more than 20% of total cost of carpet is beings penton raw material. Dye-Saz offers a practical solution to reduce this cost by minimizing the wastage of raw material (5-7% of total cost). Before Dye-Saz, there was no accurate method for calculation of the raw material requirements. Therefore, the producers had to dye 10-12% more wool

and silk than their requirements to avoid the common problem of shading. Moreover, it was nearly impossible to reuse and recycle these waste raw materials.

Obviously, A CAD platform is useful in shortening design time, adding to the product range and facilitating the visualization of carpet designs. In fact, it unravels product design constraints and provides capability to visualize the carpeteven before it is woven. The CAD platform is beneficial in enhancing the involvement of customersin product design. Itimproves the richness of designs by facilitating new color combinations. Thus collaborative design is the result of the CAD platform and computerization is also helpful in the decline of phase time and reducedconsumption of raw materials.

ICT and E-Commerce:

Nearly all handmade carpet companies are small or medium size firms (SMEs). Involvement of ICT to boost the performance of SMEs has long been appreciated (Morgan *et al.* , 2006). In addition to the above finding, Oyelaran-Oyeyinka and Kaushalesh (2006) indicated that a pre-requisite for technological progress is by skill upgrade through an in-depth understanding of the latest technologies. No doubt, company competitiveness is profoundly related to the level of technology, levels of skills, learning and experience.

The globalization of business has provided SMEs with opportunities and challenges (Saarenketo *et al.* , 2008). Exploiting ICT technology is one of the potential opportunities. Above all, business-to-business e-commerce has been introduced as an emerging trend. Both sellers and buyers can reap the benefits of the profitability and productivity improvements related to e-commerce (Papinniemi, 1999). There is no need for huge investment in e-commerce in order to gain remarkable benefits. According to research by Kearney (2002), SMEs are capable to achieve a 41% reduction in cycle times, 10% decrease in staff costs and a 13-fold increase in return on investment. So, e-commerce itself may facilitate the exchange of information, products, and payments.

Following are some of the functions of e-commerce applicable to the carpet industry:

- Providing on-line catalogues which provide the potential buyers with required information.
- Matching buyers and producers through dynamic trading processes.
- Facilitating the transactions by providing access to financial and logistics services.

On the other hand, selling carpets through an Internetplatform in a developing country has encountered many limitations. Some of these barriers surround B2C e-commerce, and includecustomer can see but not touch and feel the quality of the carpets (Jelassi and Leenenl, 2003), digital photographs may not give accurate colorations (Hadjimanolis, 1999), the buyer's need to trust the company and brand, expectation of high service standards (replacement, refund, customization) and especially customer financial security (Oxley and Yeung, 2001).

Employing E-commerce does offer opportunities for carpet producers and can enhance performance and efficiency at the different stages of a value chain. However, as explained this is not without concerns.

Customizations:

Evolving the carpet manufacturingapproach from mass production to mass customization is not just simply employing E-Commerce or using information technologies in the practiceof marketing, production, or delivery. The challenging part in the practice is how to define successful management to integrate these components. Here the author analyzes the application of some essential management technologies used at each level of mass customization.

Customizing Management:

The target of customizing management in the carpet industry should surround designing the right carpet with the quoted and shipment time based on customer demand. Usually there is only one kind of customizing method defined in a handmade carpet which is costly to the single customer. However, we can exploit a new approach to customization, which brings strategic advantage and economic value. This is “Mass Customization”, which combines the adjustability of individual customization with low unit costs of mass production processes (Tseng and Jiao, 2001). Both customers and manufacturers can benefit from mass-customization. Customers appreciation of customized products tailored to their specific demands are often translated into paying a premium price. Also carpet producer can employ CAD system to determine precisely what specific group of customers demand: this approach is called Collaborative Customization(Pine, 1992). This information is then used to design and weave specific kinds of carpet for particular destinations.

Technology of Raw Material:

The quality of raw material for a product which is supposed to last for decades is vital. Persian carpet quality has suffered from low quality wool and silk, since the country has not developed related technologies.

Thus there are additional technologies which could benefit the carpet manufacturing process and influence Persian carpet quality.

Nanotechnology gives us an opportunity to improve manufacturing abilities and consumer benefits of hand woven carpets. “Lanasan NCF” is a chemical which was developed in New Zealand, and consists of nanoparticles which adhere to fibers of wool to enhance its performance and give the yarn an improved resistance to abrasion and fiber loss. The invisible nanoparticles occupy sites on the fiber surface, thus resulting in a significant reduction in soiling.

There are several benefits of using this new generation of wools in carpets which include: reduction of soiling (up to 35%), improvement of abrasion resistance (up to 100%), reduced fiber loss (up to 50%), reduced surface fuzzing (up to 50%) and improved yarn strength (by up to 80%). Thus this technological advance in wool manufacture will improve tufting and weaving efficiency – especially for that kind of wools that are used in weaving Persian carpets – of wools with lower tensile strengths. This technology also reduces the maintenance needs (vacuuming and wet cleaning) of a wool carpet and will keep wool carpets looking good for longer, resulting in more satisfied customers.

Sometime however, we observe visible color changes in Persian carpets, particularly when they are exposed to sun or any strong light. It is an unfavorable situation, which would spoil the appearance of the carpet and would have detrimental effect on customer satisfaction . This effect is known as photo bleaching. A method to eliminate this has been found after extensive research. By employinga liquid, "Lanalbin APB", as the dying liquid, it would effectively solve the problem. "Lanalbin APB" has a simple application with no costly auxiliary plant needed to the standard production setup. It can be used not only as a protection against photo bleaching of dyed wool carpets, but also can provide a more economical protection to un-dyed yarns.

Empirical Evidence:

Alinasab Carpet Companyis a leading medium sized company in the Persian hand woven carpet industry. It has won a number of quality accolades from mostly European organizations for its high achievements in its field. Retailers and representatives in Canada, Europe, UAE, and Japan have exhibited the works of the company in their galleries. More than 65 years of experience in carpet production has gifted the company with invaluable capability to reach the highest possible quality in Persian carpet production. However, the management of the company is enthusiastic for employing novel technologies to enhance their competitiveness in the market. Here follows an indication of the effect of implementation of the above-mentioned technologies in this company.

Computerization and Use of Naqsh-Saz:

During recent years, the company has started to use CAD programs, in particular Naqsh-Saz, which has reduced 45% of the designing duration time. It also had beneficial effects on designing cost. Previously, four highly skilled designers took part in designing a carpet, which was reduced to two persons with moderate skills in using computerization to design; it means 60% less payment to the designers. Moreover, it has helped cut the cost of raw materials by up to 25%, by including minimizing of wastage of wool and silk and cancelling the dying and preparing cost of them. The company is also able to define a 'Just-In-Time' inventory system through exactly determining the needed raw material for each piece of carpet, which has led to further reduce 22% of its inventory costs (including capital, warehousing, depreciation, insurance, taxation, obsolescence costs).

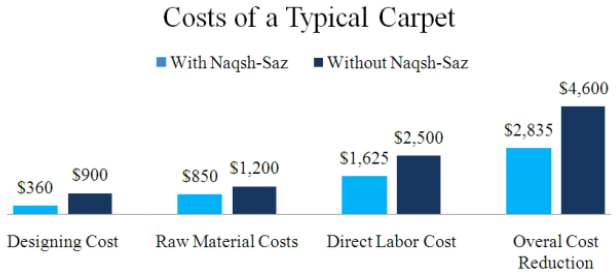

Fig. 4: The effects of advent of Naqsh-Saz. Source: Alinasab Company.

The company has since ordered the producer of Naqsh-Saz to add a coding feature to its software. This application enables the company to transform the carpet designs into numeric codes. These codes then can be printed and replace the sophisticated carpet design. Hereby this advanced method has a number of benefits with the weavers being able to read them and weave the carpets faster and with less weaving defects and less re-working costs. There is no need to employ costly skillful weavers anymore using old methods, as normal less experience weavers, (with 35% less salary), are able to weave a better quality carpet by exploiting the coding

system of Naqsh-Saz. Thus, Figure 4 illustrates the impact of Naqsh-Saz on the direct cost elements of a typical carpet.

E-Commerce:

The company has reaped the benefits of e-commerce and trading online through introducing comprehensive websites (specifically, three different websites). These websites offer various services including:

- *Pre-sales Service*: During the pre-sale phase, the company offers online customers information on their service offerings. Through the Internet, customers have been given the opportunity to design or customize their carpets. However, before making their purchase decision, online customers canevaluate different offers or use some online help to determine the 'truly distinctive value proposition'.
- *Transactions*: AlinasabCarpet Company uses the internet to increase its sales and profits. The company knows thatto impress customers, it is essential to offer a simple and risk-free online transaction system andto fulfill it quickly, and reliably.
- *After-sales Service*: Delivering a great product is not enough to gain customer loyalty. Alinasab Carpet Company also provides online and offline after-sales services, which forms a new achievement in the manufacturer's value chain and feedback process.

A critical success aspect for Alinasab company`s e-commerce techniques is managing the integration of its front-end website with its back-end infrastructure - specifically its internal systems, databases, and applications. The company offers customers real-time visibility of its production capacity, inventory and transportation accessibility. Based on real-time demand data, the management of the company has been preparing a more dynamic price system; moreover, they optimized their promotional offers and product customization.

All these approaches helped to reduce the traditional intermediary costs by approximately 35%. Now the company has a successful presence all over the world and customers have an opportunity to directly place their orders and follow their orders through the steps of production. They can customize their carpets in terms of size, dimensions, style, and color easier and faster than before. Previously the company had to weave mostly without any direct orders from any customer, hoping to sell the generic carpets in fairs or galleries; hence, it needed to shoulder heavy capital expenditure resulting in less production capacity.

However, the exploitation of e-commerce and the CAD systems has now enabled the company to collect most of the cost of the custom-made carpet from the buyer even before initiating the weaving process. It has been translated into a 67% climb in production capacity, from 112 looms in 2002 to 168 looms in 2010. The managers of the company revealed they experienced a positive 130% increase in the value of orders. From these figures they are now more flexible in customizing the carpets to meet the taste of buyers. Naqsh-Saz has empowered them to increase the range of their products from 45 in 2002 to 99 in 2010, a staggering 220% surge in carpet variety within only nine years (See Figure 5).

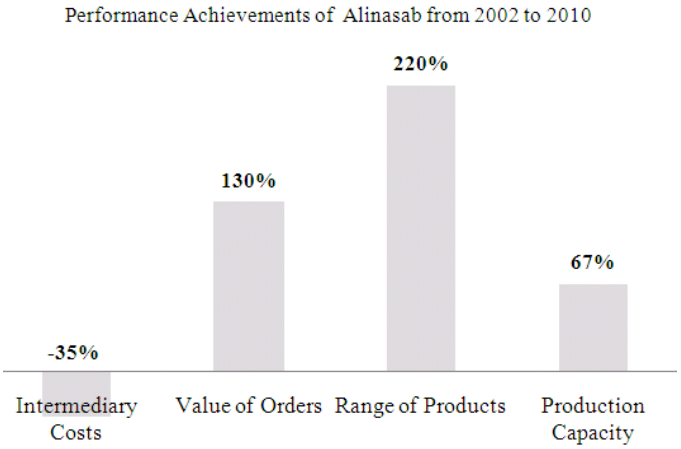

Fig. 5: Overview of Performance Achievements. Source: Alinasab Company.

Platform Strategy and Looming Technology:

Persian handmade carpets have been traditionally woven on horizontal looms. To set up a loom for each carpet takes one week by four skilled workers. However, the research and development team at Alinasab Carpet Company has developed a revolutionary looming machine. It has many excellent features including the "Double

Looming" ability, which grants the possibility of weaving a carpet at both side of the loom at the same time. This has increased the quality of the finished product, decreased the inspection cost, and reduced the required space needed for looms. Not only this, but setting up this style of loom is five times faster than using the standard loom manual power and it needs only one operator.

Thus, exploiting these technological assets has paved the way for Alinasab Carpet Company to extend its leadership position in the industry. According to the company the advent of the mentioned technological assets translated into a 165% increase in net income for the company in 2010, when compared with 2002. So, the overall performance achievements after employing technological measures has been beneficial in many ways as seen in figure 5.

Conclusion:

The Persian carpet industry in Iran is more than twenty centuries old and has enjoyed royal backing in its early stages. It is mostly famous for its high quality carpet manufacturing and attractive designs. This highly traditional industry has recently encountered declining demand. However, as a whole the manufacturers are unfamiliar with technological advances which could enhance their own production and thus profitability.

As many traditional industries are incapable of facing the pressure of competition, it is only through adoption of new technology that traditional industries may survive. While designing solutions - social, economic, organizational and technological aspects need to be considered - ICT platforms will be accepted and adopted if there are social, organizational and economic viability built into the project concept.

In this paper, the authors havefocused on finding solutions to enhance its competitiveness through employing technological and innovative assets. Developmentand implementation of an ICT platform and CAD system is considered as effective solutions. This case study reveals that technologically advanced systems have the power to transform a traditional industry to a modern productive one, in a way that the industry not only can survive but also it can prosper.

The Alinasab example illustrates how it has successfully applied CAD and e-commerce models by using the Internet in all of the stages ofproduction and sales. This case study clearly shows how innovative strategies can influence the industry structure as well as a company's core competency, competitive positioning and market share.

Thus, the brief effects of utilizing the aforementioned technologically advanced systems are:

Increase Profits by Reducing:

- Defects
- Re-work
- Scrap & Waste
- Inspection
- Inconsistent Results

Increase Revenues by Raising:

- Throughput
- Capacity
- Quality
- Customer Satisfaction
- Efficiency

In conclusion, new technologies provide opportunities for carpet firms to expand their markets internationally. However, most carpet companies in Iran have a school of thought that belongs to the past decades. The authors believe the structure of this traditional way of thinking which has roots in Persian culture needs to be revised. Today's global changes require new models of thinking and industry changes that carpet producers cannot ignore nor resist.

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