Model Building of Manufacturing SMEs of New Energy Technologies by Focusing on System Archetypes

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Abstract - *This study employs general system archetypes to the purpose of identifying problems which hinder fulfilling orders quickly and serving more customers in Iran's manufacturing SMEs in wind and solar energy. In order to better understand the system structures, the problems and their consequences, causal loop diagrams and dynamic modeling are applied. Some archetypes related to inventory supply, technology design, technology manufacturing, and technology maintenance are illustrated in accordance with the archetypes of shifting the burden, success to successful, and accidental adversaries. Besides, causal loop diagrams and a general dynamic model are proposed with regard to the functions of absorbing customers and marketing, technological innovation, technology manufacturing, and technology maintenance which are related to the identified system archetypes. For choosing the firms, non-random - accessibility sampling method is used and two SMEs are selected. The results show that existing patterns of behavior reduce the budget, performance of each function and company, customer satisfaction, reputation of the company, and the number of potential customer and customer base. It is proposed that company should focus on the fundamental solutions, higher level goals including the success of all functions, and collaboration based on aligning organizational aims, values and priorities between functions.*

Key words: resources; time; cost; quality; product development

1. Introduction

Energy is one of the crucial inputs for socio-economic development. The rate at which energy is being consumed by a nation often reflects the level of prosperity that it could achieve (Keyhani, 2010). Among renewable sources of energies, solar and wind powers are important sources of environmental-friendly energy and have become more and more important in the recent years. In general, 45 percent of Iran's industrial employment and 17 percent of its production are because of SMEs. In recent decades, Iran's public policymakers began increasingly to focus on the introduction of measures to assist small and medium-sized Enterprises (SMEs). The number of SMEs working in the solar energy industry is around 100 and in the wind energy industry around 50. Iran's renewable energy SMEs are usually commercial companies and they are generally technology suppliers and service providers. Contrary to commercial companies there are few technology manufacturers which their main processes are the production and sale of products.

This shift in firm size emphasis was based on the belief that SMEs were more efficient employment creators and more suitable driving factor for the economic growth, and that they had a higher inherent innovatory potential than large firms. Iran's manufacturing SMEs face intense competition in domestic and foreign markets. Given their importance to the economic development of the country it is important to have a clear understanding of their readiness to face the rigors of international competition, including the barriers and specific problems that they face. In such a dynamic environment, innovation is regarded as a prime strategic factor for these manufacturing SMEs' competitiveness (Abereijo et al., 2009). In addition, for a SME the management level of production logistics system is the key for the enterprise to utilize sufficiently all production capacity, to reduce the cost, to increase the effectiveness and improve the competitive capacity of product in the market (Xinsheng et al., 2011).

For solving the problems that manufacturing SMEs has been facing, many ways have been defined. Nickols (2012) stated that choosing the right problem solving approach makes a difference. Effective problem solving is an important aspect to any job, but it is especially important in technology related fields which are not always clear, and impact of solving could have unforeseen ramifications. According to McCade (1990) and Cherif Megri (2014), technological problem solving can be divided into three categories: design, troubleshooting, and technology assessment (impact evaluation). Designing may be defined as proactive problem solving (Baker and Dugger, 1986). It includes not only the refinement of the original concept but also the research, experimentation, and development necessary to prepare the product for production. Innovating, creativity, and designing are closely related. Troubleshooting, or reactive problem solving (Baker and Dugger, 1986), involves the recognition that technology encompasses more than innovation. Finding and correcting problems during the production or utilization of technical solutions is troubleshooting. Technicians can be satisfied with abilities in design or troubleshooting. However, technologists must add the ability to critically analyze the impacts of technical solutions in order to predict possible outcomes and choose the most appropriate solution to a problem.

Important questions related to essential problems should be considered in the modeling process of technology strategy making. In this case, modeling with the help of system dynamics (SD) by describing any problem in cause-effect relations provides an adequate expression of technological management problem situations. One of the fundamental essences of SD is the identification of system archetypes: generic systems structures describing the common dynamic processes which characterize the behavior of the system. System archetypes provide simplified insights into the system's structures (Setianto et al., 2014). The archetypes also provide a quick reference point and solutions through which many different problems can be understood. Archetypes do not describe any one problem specifically. They describe families of problems generically (Maliapen, 2008).

The present research employs the concepts of SD and system archetypes to identify technology related problems which impede prompt response to the customers' orders in Iran's manufacturing SMEs in wind and solar energy. Some archetypes related to inventory supply, technology design, technology manufacturing, and technology maintenance are defined and explained in accordance with the archetypes of shifting the burden, success to successful, and accidental adversaries. In order to have better views of the system structures, the problems, and their consequences, causal loop diagrams and dynamic modeling are applied. Causal loop diagram is a foundational technique applied in and visualizes how different variables in a system are interrelated. Causal loop diagrams and a general dynamic model are proposed with regard to the functions of absorbing customers and marketing, technological innovation, technology manufacturing, and technology maintenance which are related to identified system archetypes. For choosing the manufacturing SMEs in the field of solar and wind energy, non-random - accessibility sampling method is used and two SMEs are selected. In order to determine causal loops and system archetypes, chief executive officer of manufacturing SMEs are interviewed. This study introduces some systems archetypes and causal loops that comply with the conditions. The main purpose of the present paper is to identify structures of behavior, problems, and their consequences in Iran's solar and wind technology manufacturing SMEs.

2. System archetypes

The term archetype is used to denote knowledge level models which define valid information structures. System archetypes are patterns in corporate structure or behavior that recur again and again. They are that part of an organization, which represents keys to "pattern recognition" activities, incorporated in the discipline of system thinking (Maliapen, 2008). Systems archetypes were first studied in the 1960s and 1970s by Jay Forrester, Dennis Meadows, Donella Meadows, Peter Senge, William Braun, and others in the nascent field of systems thinking. They described system with set of standard patterns which some of them are applied in the present study

Systems archetypes are holistic in nature. Every influence is both cause and effect. Rather than reinforcing linear thinking, a "parts" mentality and analytical models of decomposition and detail, true systems thinking places emphasis on feedback, influence, and interdependencies. In this regard, it holds promise for understanding and succeeding in the realm of dynamic complex systems (Novak and Levine, 2010).

2.1.Shifting the burden

Shifting the burden archetype depicts the pressure between devising ease and low cost symptomatic solutions and long-term impact of fundamental solutions which requires deep understanding and learning about the principal problem, take a long time to develop, demand a relatively large, up-ahead concern of funds, and inspect managers' patience. That is why tensions induce managers fix problems instantly and take short term actions. It considers that a problem symptom can be resolved through applying a symptomatic solution or a fundamental solution. Applying symptomatic solutions mitigate the problem symptom in short time, however, side effects of fulfilling symptomatic solutions will worsen the problem in long time due to declining of tenseness to carry out fundamental solutions. Similar to this archetype, fixes that fail archetype is proposed and the quick-fixes make unintended consequences emerged which infuriate the initial problem symptom (Braun, 2002).

In this regard, firstly counterintuitive behavior stated by Forrester means that actions intended to produce a desired outcome may bring about opposite results. In other words, things can get worse before getting better. Secondly, control through influence points which is identical to fixes that fail is defined as existence of a few points in any system to which behavior is sensitive. If a policy at one of these points is changed, pressure radiate throughout the system. Social systems seem to have a few sensitive influence points through which behavior can be changed. These high-influence points are not where most people expect. When a high-influence policy is determined, the chances are great that a person guided by intuition and judgment will change the system in the wrong direction. Thirdly, long-term versus short-term response like shifting the burden indicates that social systems exhibit a conflict between short-term and long-term consequences of a policy change (Forrester, 1968; 1994; Ramage and Shipp, 2009).

Senge (1990) by proposing eleven system laws referred to at first, fixes that fail through stating today's problems come from yesterday's solutions which points out that as a first step to resolve 'today's problem' is to look back into the past, to identify those 'yesterday's solutions', done by somebody and somewhere. At second, behavior grows better before it grows worse refers to shifting the burden archetype. He declared that sometimes the easy or familiar solution is not only ineffective; sometimes it is addictive and dangerous. They may even induce dependency which is presented as the cure can be worse than the disease- addiction. In this case, (Meadows, 1982) introduced addiction - exacerbate the effects of the fixes that fail dynamic.

2.2.Success to the successful (STS)

The STS archetype describes a pattern wherein competing groups or individuals for limited resources gain some advantage and, over time, if this advantage continues, one group or individual can significantly outperform the other group or individual (Anthony et al., 2013). In managerial terms this archetype is often the basis for citing the "80/20" rule (Braun, 2002). This archetype describes the common practice of rewarding good performance of a group with more resources than another equally capable group in the expectation that performance will continue to improve and further widening the performance gap between the two groups over time.

2.3. Accidental adversaries

Accidental adversaries begin their relationship with win-win goals and objectives in mind, generally taking advantage of their respective strengths, minimizing their respective weaknesses, with the objective of accomplishing together what cannot be achieved separately. This archetype states that when teams or parties in a working relationship misinterpret the actions of each other because of misunderstandings, unrealistic expectations or performance problems, suspicion and mistrust erode the relationship. If mental models fueling the deteriorating relationship are not challenged, all parties may lose the benefits of their synergy (Braun, 2002).

3. System archetypes in Iran's manufacturing SMEs in renewable energy

3.1. Shifting the burden in Iran's manufacturing SMEs

3.1.1. Inventory supply

According to Jiang and Tian (2009), in case of technology sourcing especially in developing countries, some companies may have no choice but to source internationally; otherwise they cannot get access to suitable technology in particular at a time when technology is vital. Factors that can affect the performing of global sourcing are political, legal, and cultural differences between various countries. Moreover, enterprises have to face problems like transportation, technological and capacity weaknesses in production, and lack of management systems. Other features are languages barriers, customs, and trade regulations (Kendall, 1999). How to handle global sourcing effectively and efficiently are additional challenges.

In Iran's renewable energy SMEs, suppliers usually threat to raise prices or reduce the quality of goods and services. International raw materials and component parts suppliers have a high bargaining power. International sanctions have profoundly affected Iran's energy sector. Sanctions have prompted to affect international trade and in this regard supply and delivery of solar and wind technologies for manufacturing SMEs. Furthermore, Iran's renewable energy SMEs are newly established companies and processes such as supplier selection and procurement are not completely defined, institutionalized, managed, and optimized.

Supplier selection and evaluation have a critical role and significant impact on purchasing management in supply chain and are crucial to the success of a manufacturing firm (Omurca, 2013). Purchasing must become supply management, to ensure long-term availability of critical materials and components at competitive cost coming for the risks and complexity of global sourcing (Sepehri, 2013). Purchase-related capabilities are combinations of purchasing routines that are organizational processes by which available resources are combined, transformed and deployed to create valuable purchase-related outcomes (Quintens et al., 2006).

Due to energy and financial shortages, rapid price increases for raw materials and components, and fierce competitive pressures, companies are looking for ways to decrease expenses and to transfer higher value propositions in projects to the customers. Therefore, procurement function is now a key component of corporate planning and control cycle (Sepehri, 2013). Ávila et al. (2012) and Krause et al. (1998) stated that the supplier selection is a problem for that companies that face since the beginning of its activity as well as firms which have attempted to counter the competitive forces by downsizing their work forces in an effort to reduce costs and refocus on their core competencies with enhancing their level of outsourcing and having reliable and efficient supply networks based on suppliers relations.

Iran's renewable energy SMEs find themselves confronting many demands particularly because of existing policies and regulations such as 'Renewable Portfolio Standards (5000 MW RE Power in 2020)' and new customers. To meet these demands, they have to develop the corresponding knowledge and abilities exploited in their organizational process (Söderberg and Bengtsson, 2010). One of these areas is supply chain management, however, in order to meet the needs of customers in the shortest time they adopt satisficing approach as symptomatic or short term solution instead of optimization or systematic and rational method as a fundamental or long term solution. This despite the fact that this pattern of behavior is costly and risky associated with quality in long time.

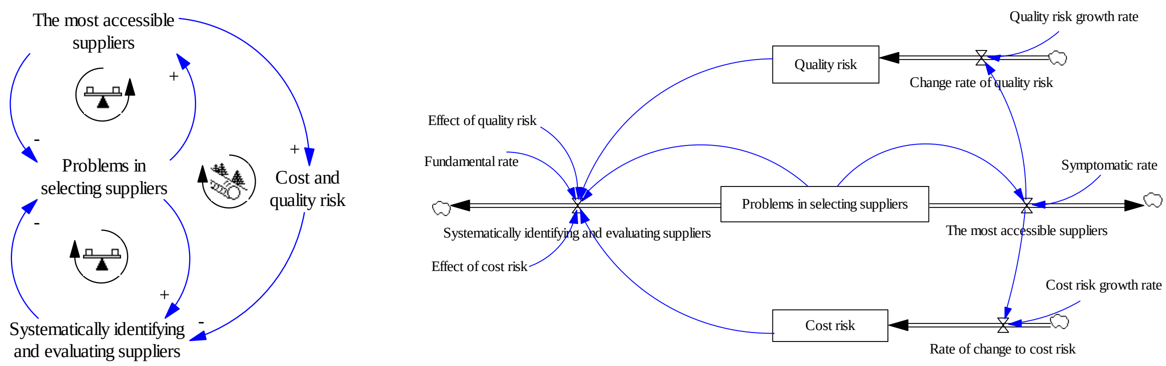

Figure 1. Causal loop diagram and dynamic modeling of shifting the burden in inventory supply problems

3.1.2. **Technology design**

Generally technology design includes research, experimentation, and development of new technologies or improvement of existing technologies necessary to be produced and used in renewable energy industry. In Industries usually research and development is the main agent in technology design particularly technology development, thus public research institutions and research policies in many developing countries have recently gone through major transformations (Ekboir, 2003). For instance, Iran's industries has been transforming its direction from library and laboratory research into technology development through scaling up from bench scale to industrial scale. Kumar and Jain (2002) declared that diffused and undirected efforts rarely lead to successful technological development, and hard-working and high spirits are not necessarily sufficient to support such intense activity. In other words, companies need to have a defined and specified plan to indicate the direction of technological development.

In Iran's renewable SMEs, technology design is considered for the development of essential technologies in order to provide industry needs. Since technological development plays a main role in industrial development, particularly government has been helping industries and SMEs to develop technologies. However, as argued by Choi (1988, p. 279) in countries with a very short experience in the area of technology development, the rational establishment of technology development policies and plans themselves is the difficult task. At present the improvement of profitability mainly rests on two strategic pillars: ambitious and innovative new product and technology development initiatives as well as comprehensive cost-saving projects. Since SMEs have limited availability of personnel and financial development resources, mistakes relating to the development of new technologies can put SMEs, at risk. Therefore, a dedicated methodology to derive an optimized, effective technology development path while safeguarding development efficiency is needed (Schuha et al., 2014).

Iran’s renewable energy SMEs attempt to carry out their technology policies at localization and even to create new technology to provide their industry needs in addition to compete internationally. For resolving different problems during technological design, two types of solutions can be adopted: satisficing approach as a symptomatic solution and systematic and rational method as a fundamental solution. However, this pattern of behavior is costly and risky in case of time in long time.

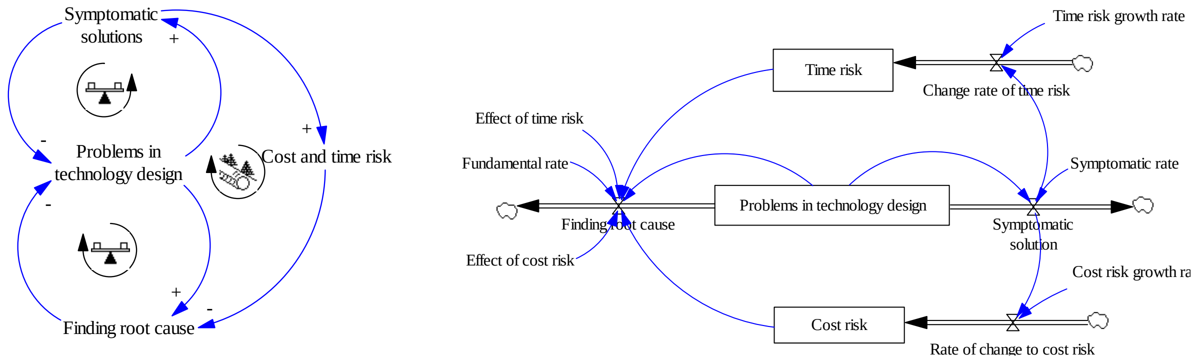

Figure 2. Causal loop diagram and dynamic modeling of shifting the burden in technology design problems

3.1.3. Technology maintenance

“Maintenance is the combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to a state in which it can perform the required function” (EN 13306: 2001). Maintenance procedures are vital in fixing problems before they cause significant damage. By applying higher-quality materials in constructions and installation-parts the technological life span and the reliability can usually be increased. As a result however the costs will also tend to increase. On account of the latter a compromise must be reached at a certain point between the costs on the one hand and the reliability of the construction on the other. In maintenance several important decisions have to be made such as the long term strategic, medium term, and short term planning, and control (Budai et al., 2008). Maintenance work depends on the ability to solve problem, the core element of maintenance skills therefore is knowledge of the equipment and its mode of failure (Gasskov, 1992).

Maintenance systems play a key role in achieving organizational goals and objectives. They contribute to reducing cost, minimizing equipment down time, improving quality and providing reliable equipment that are safe and well configured to operate (Duffuaa et al., 2002). In most developing countries, effort to introduce or implement preventive maintenance has been hindered by the negative thought of the cost involved. According to Eti et al. (2004), this misguided opinion about maintenance is that traditionally, management of companies regards maintenance as an expense that can easily be reduced in relation to overall business cost. It is however assumed that machine shouldn’t be checked or inspected for future breakdown why it is still working, instead remain inactive until emergency occurs (Enofe, 2009).

Maintenance could have two meanings, one is the maintenance of production equipment and other maintenance of technologies which are produced for customers. In order to deal with the problems in technology maintenance in both cases, satisficing approach as symptomatic solution and also systematic and rational method as a fundamental solution can be adopted. This despite the fact that this pattern of behavior is costly and risky in case of time in long time. In system modelling, maintenance of produced technologies are considered which is important especially for wind turbine producers. However maintenance of production equipment should be taken into consideration too. It is very important, because the breakdown of any production equipment causes to wastage of production hours to the management and production schedules are disturbed and delivery promises could not be met.

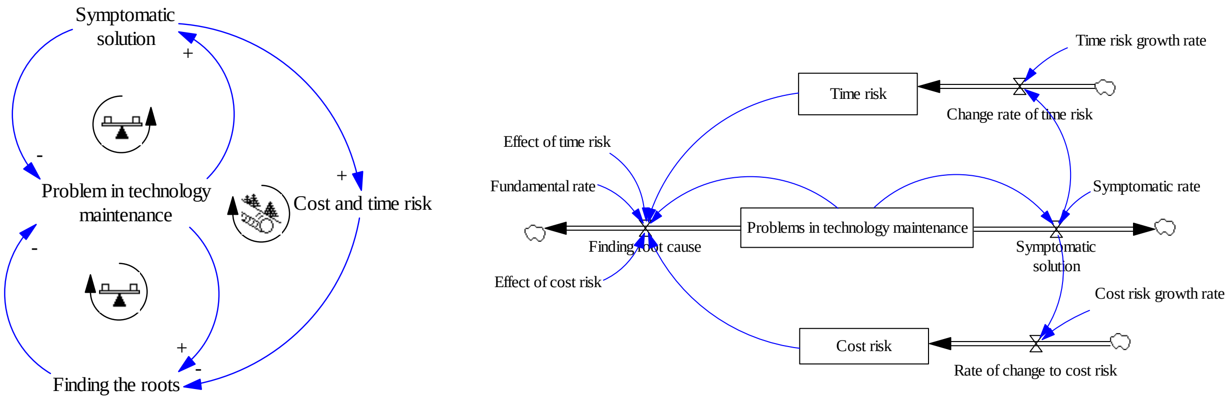

Figure 3. Causal loop diagram and dynamic modeling of shifting the burden in technology maintenance

3.1.4. Technology manufacturing

Technology manufacturing is closely related to inventory supply. Production inventory refers to the level of raw materials and component parts on hand for use in manufacturing. It is known as an important affecting factor of production because a manufacturer relies on inventory to complete a product for which it expects to be paid. Since buyers are usually the government especially in the wind energy industry in addition to their high volume orders, its bargaining power is high and in case of their order, the products should be delivered on time. Sometimes situations arise that orders need to be delivered on time, while the production inventory is not enough that is why the unreliable raw materials are used which is easy but ineffective solution because it is costly and risky in case of time in long time. In contrast, fundamental or long term solution can be found to resolve the problem of urgent manufacturing.

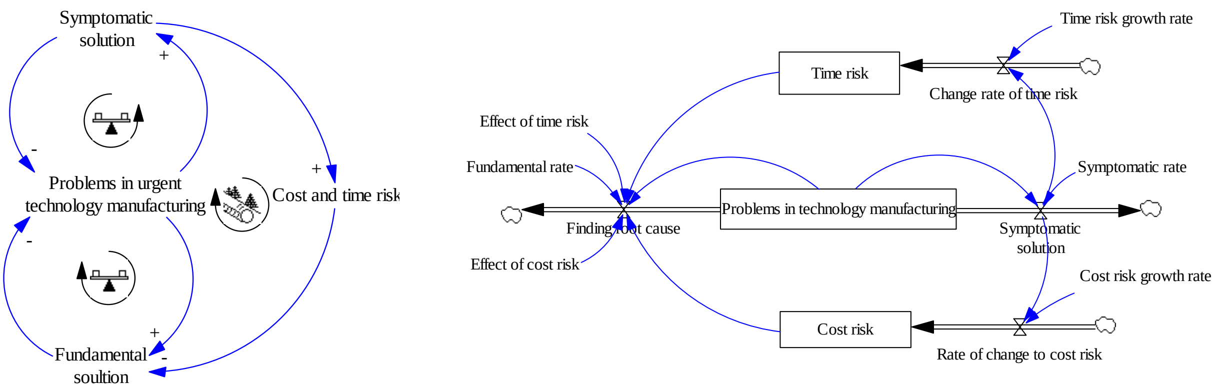

Figure 4. Causal loop diagram and dynamic modeling of shifting the burden in technology manufacturing

3.2. STS in Iran's manufacturing SMEs in renewable energy

3.2.1. STS in technology manufacturing and maintenance

Having more profit through serving more customers would be the aim of the companies. Therefore, increasing the sales which is closely related to manufacturing has the most importance. In other words, profitability is associated to all management decisions about sales and production. Traditionally maintenance is considered as a secondary system serving production. In generally, not until recently its role has been recognized, maintenance has been considered as a less important activity that only cost money rather than generating profit by most organization's executives or stakeholders, due to the blurred perception about its role in attaining company's goals and objectives (Duffua et al 2002). Two departments, technology manufacturing and maintenance are being performed in the manufacturing SMEs. Some rationale for resource allocation results better performance in manufacturing than maintenance. Not only is the lesser performer looked down upon, but its lack luster performance is cited as a sound rationale not to put any more resources into it.

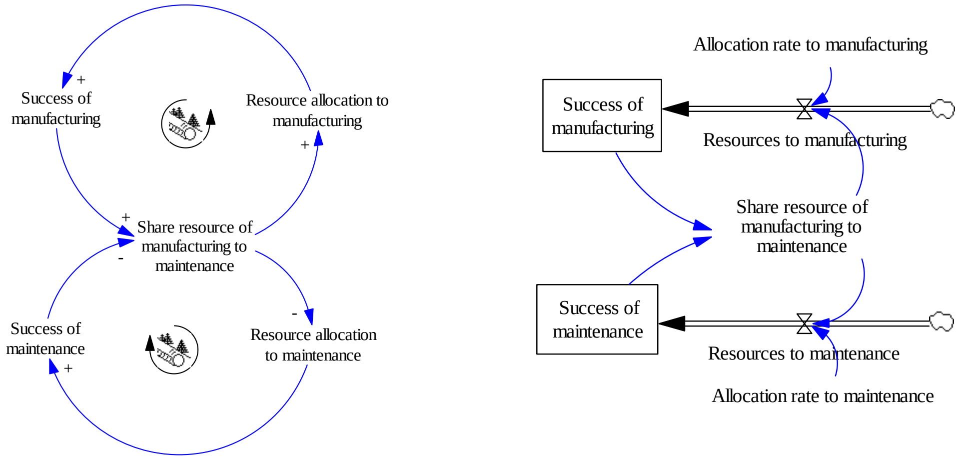

Figure 5. Causal loop diagram and dynamic modeling of STS in technology manufacturing and maintenance

3.3.Accidental adversaries in Iran's manufacturing SMEs in renewable energy

3.3.1. Accidental adversaries in technology design and manufacturing

This archetype shows problems related to misfits between technology design and its production and the interfaces between technology development and production must be managed. Whereas production tend to have very sharp deadlines, technology development has a less clear objective and completion point. Furthermore, technology development is characterized by a high degree of uncertainty with diffuse competence needs (Lakemond, 2007). Due to the cognitive and process difference, and interdependencies of their performance, unwittingly and unintentionally, they interpret other side activities potentially or actually injurious to their interests.

The production and technology development are in great need of being integrated (Drejer, 2000). In this case, instead of dividing the company into departments, the way to coordinate design and manufacturing activities should be considered. The degree of interdependence between the departments is dependent on uncertainty and equivocality in interdepartmental relations. While uncertainty can be managed by the communication of more information and equivocality can be overcome by the use of richer communication media such as face to face dialogue (Adler, 1995).

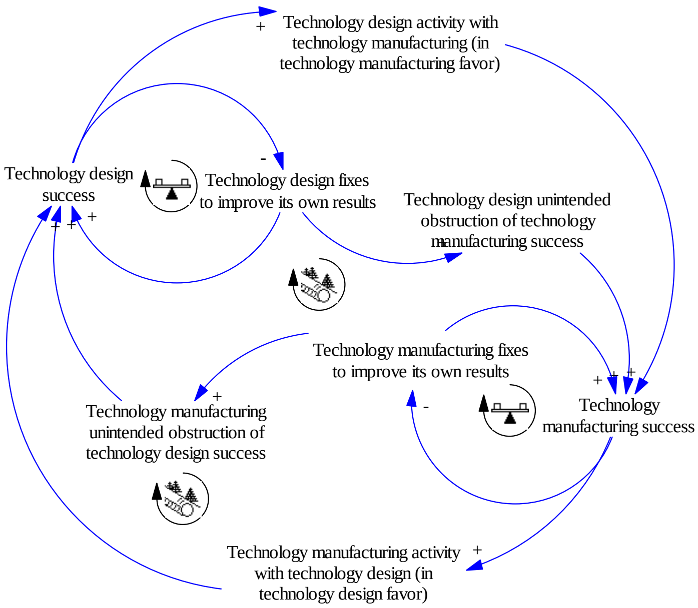

Figure 6. Causal loop diagram of accidental adversaries between technology manufacturing and design

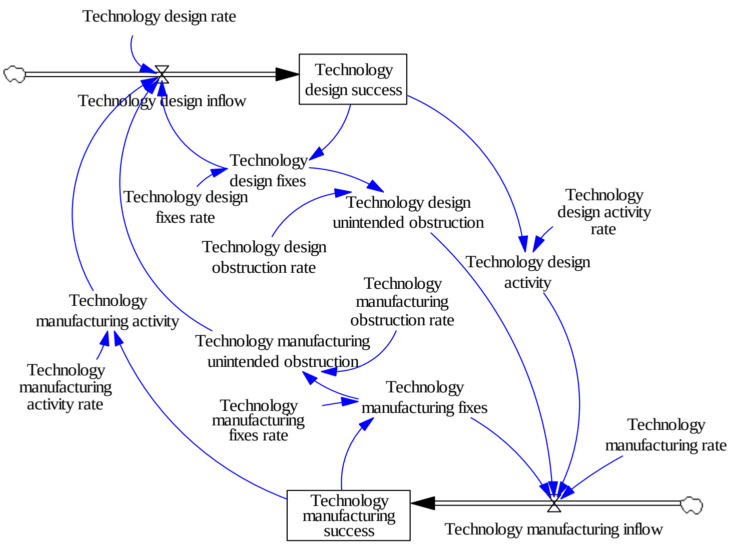

Figure 7. Dynamic modeling of accidental adversaries between technology manufacturing and design

4. General dynamic model related to identified system archetypes

Identified system archetypes are related to four functions of Iran's manufacturing SMEs in renewable energy including:

- **Marketing and absorbing customers** includes converting potential customers into customer base meaning as customers who purchased the technologies of the company in large quantities and have contracts with the company through giving them good services.
- **Technological innovation** is determined as the transformation of an idea into a new or improved saleable product. It usually points out reverse engineering which is used as a principal means of technology acquisition in many developing countries. This function is a newly founded in some companies. Technology design problems are related to this function.
- **Manufacturing technologies** can be found rarely in SMEs and it is the primary process of the manufacturing SMEs. In general, manufacturing SMEs were public organizations that through participation with international companies their new business in the field of renewable energy has been established. They have been operating as an independent company after the execution of the privatization and private sector development law. Although, there is now no international participation particularly because of international sanctions.
- **Maintaining technologies** is essential because sustainable products, parts and materials wear as a result of use. A required technological life span includes maintenance tailored to that wear.

The basis of the dynamic model is consistent with the following figure which shows four sectors of the Iran's manufacturing SMEs in renewable energy according to SD theory determined by current conditions and completed conditions as stock variables which are related through a flow variable. Time to fulfill each function in this sector is a key variable that effects the flow variable. A fast response time usually means the customer gets a better impression of the company. The ability to deal with inquiries and fulfill orders quickly means the company is able to serve more customers, resulting in higher profit.

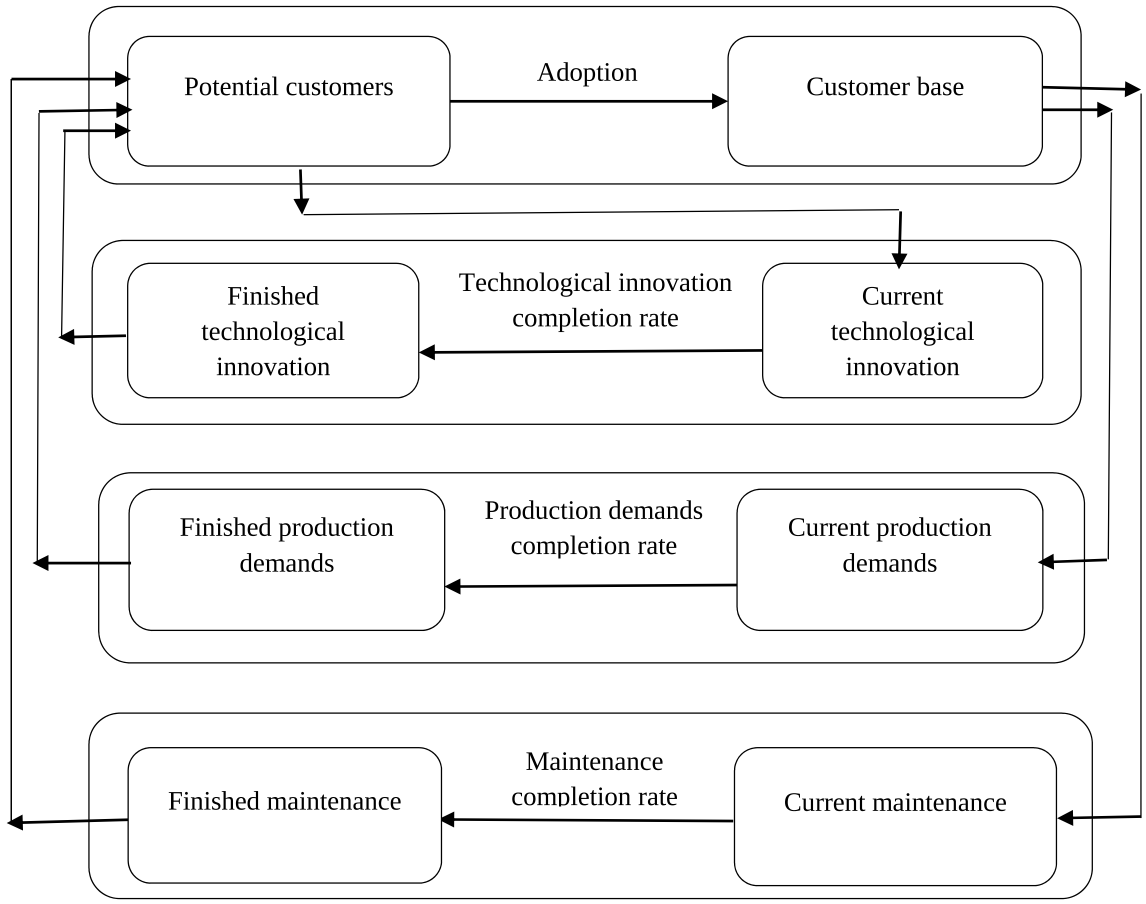

Figure 8. General view of four functions related to identified system archetypes according to the SD theory

4.1.Modeling the Marketing and absorbing customers

In marketing and absorbing customers function, net increase rate of potential customer is influenced by several factors:

1) **Instability in the currency market** and the sharp decline of local currency value due to international sanctions and drop in oil prices.
2) **Energy subsidies** have been costly. They were estimated to eat up around 10 percent of Iran's gross domestic product (GDP) in 2010, according to the World Bank.
3) **Renewable Energy policies** such as including an amount of 30 Rials per kilowatt-hour as electricity duties, in addition to the price of electricity sold in electricity bills, and to receive such amount from clients except rural households.
4) **Marketing effectiveness** defined as the quality of how marketers persuade the potential customers to buy
5) **Reputation** that the company acquires because of its business records and customer satisfaction.

6) **Liquidity** means as the amount of money in the hands of customers in addition to their bank deposits that make them capable of paying an asset by cash quickly.
7) **Product development** is described as the supply of products with new or different characteristics that offer new or additional benefits to the customer and satisfy a newly defined customer want or market niche.
8) **Partnership** is evident that SMEs can benefit from increased collaboration and partnership. Otherwise, working alone can be destructive to their success and long-term sustainability.

Besides, adoption is affected by customer satisfaction which itself is influenced by the following factors:

1) **Relative price** is expressed in terms of a ratio between the price of the technology/services supplied by the company and an average of the prices of all other technologies/services available in the market.
2) **Relative quality** refers to a ratio between the quality of the technology/services supplied by the company and an average of the qualities of all other technologies/services available in the market.
3) **Relative time** is illustrated by a ratio between the real time of the performing of the functions (technological innovation, manufacturing, and maintaining technologies) and their expected time.

Figure bellow shows the causal loop diagram of the marketing and absorbing customers function.

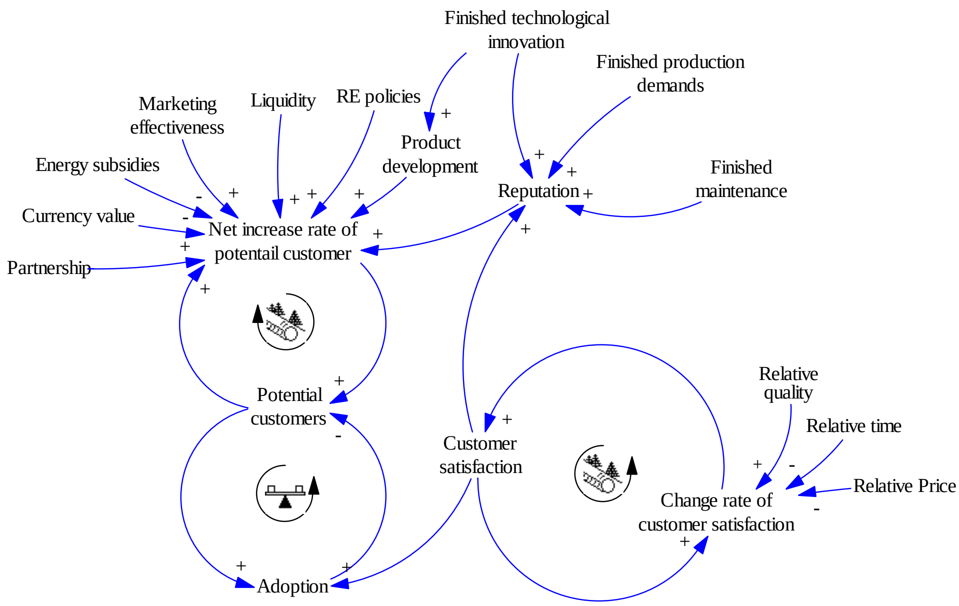

Figure 9. Causal loop diagram of the marketing and absorbing customers function

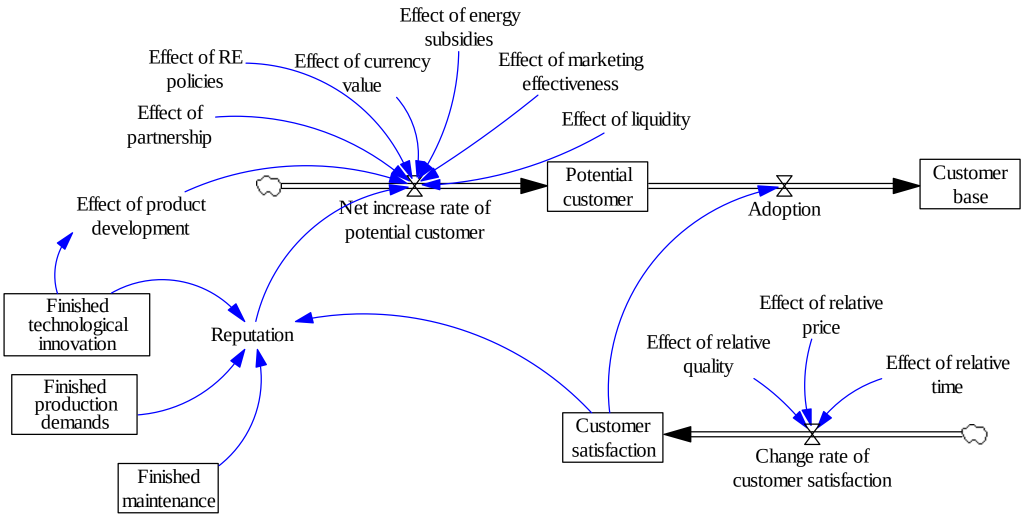

Figure 10. General dynamic model of the function of marketing and absorbing customers

4.2.Modeling the other functions

The completion rate of each function is influenced by several factors:

1) **Inventory** is known as an important factor affecting how the function is performed, particularly in technology manufacturing which includes raw materials and component parts.
2) **Resources** include budget, equipment, and staff.
3) **Experience** shows the importance of HR practices that can directly affect performance of the firm.

As clearly seen in the figure below, if all required resources are available, sufficient inventories exist, and staffs have enough experiences then the duration will be the same as a time schedule without delays. In other words, inadequate resources, inventories, and experience cause delays in performing each function.

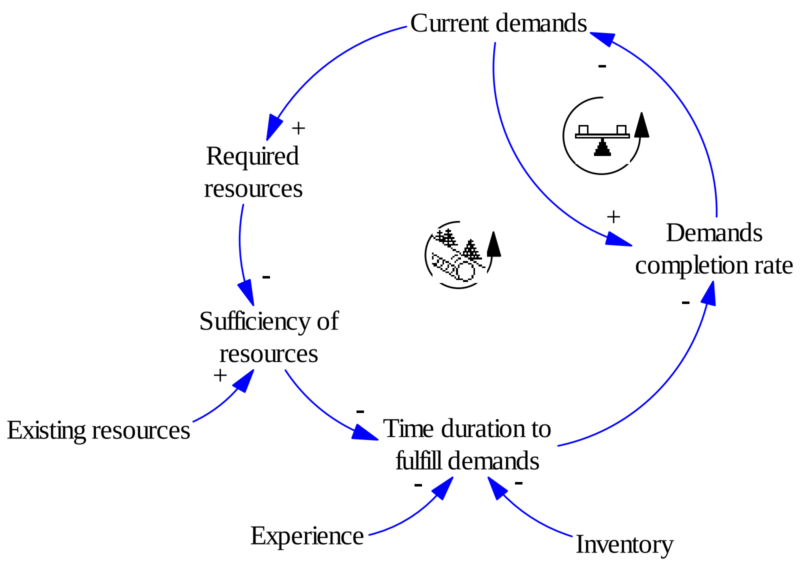

Figure 11. Causal loop diagram of the demands completion rate

Figure 11 shows that the more current demands exist for each function, the more resources are needed. If current demands have adequate resources at the moment, then demands will be fulfilled at the expected time. In contrast, if the existing resources are not sufficient to meet the requirements, then there will be a lack of adequate resources which results in increased time needed to perform each function.

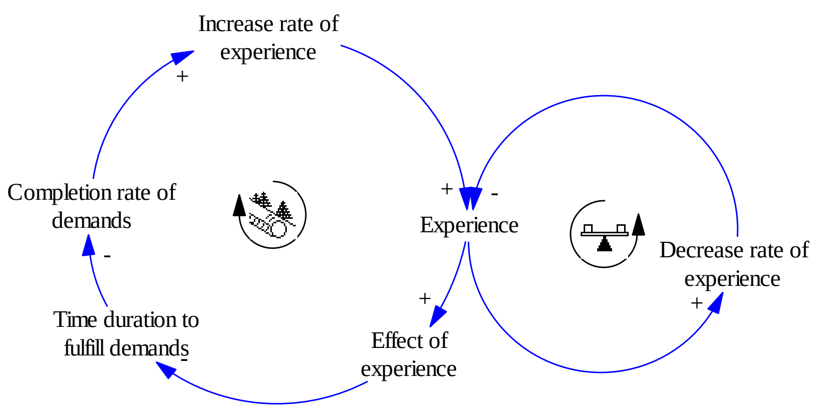

Figure 12. Causal loop diagram of experience

Experience in each function, shown in the figure above, brings reverse effects on time to fulfill demands. The higher the completion rate of demands, the greater will be the experience created. Increased experience will reduce the time needed to fulfill demands, enhance completion rate of demands, and result in self-reinforcement of this mechanism. In contrast, if human resources leave the company, experience will be reduced.

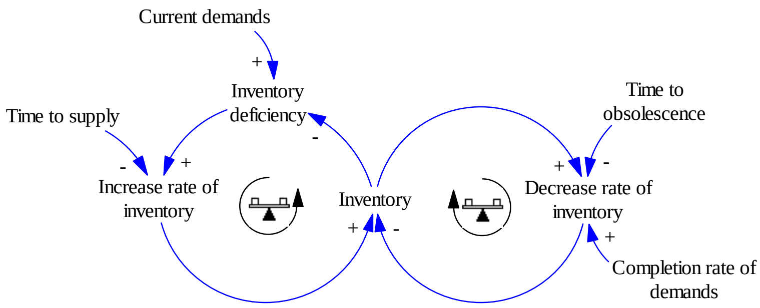

Figure 13. Causal loop diagram of the inventory

Inventory refers to the level of raw materials and component parts on hand for use in doing each function which is especially a crucial part of manufacturing. Providing them is dependent on inventory deficiency and supply time which may rise because of international sanctions. So because of barriers related to sanctions, supply of raw materials is time consuming. In the case of materials with short lifetime, this situation is much more severe. Inventory for each function is equal to the difference between current demands and existing inventory. It means that there is no specific plan ahead for supplying. In addition, inventory for each function reduces due to the completion rate of demands and time to obsolescence.

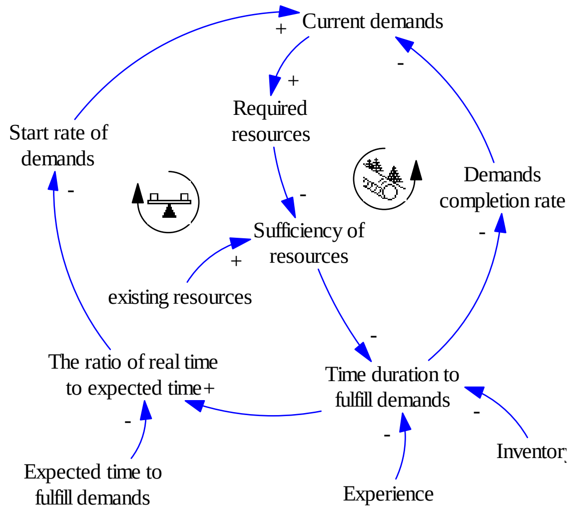

Figure 14. Causal loop diagram of the start rate of demands

Figure above shows that start rates of production and maintenance demands are affected by customer base and the demands completion rate. Therefore, if fulfilling demands takes longer, the start rate of demands and also current demands will be reduced. The start rate of technological innovation is influenced by time to fulfill demands in addition to some determinant factors including return on investment (ROI), total cost, exploitation of the knowledge based legislation, and potential customer. The figure below shows the general dynamic model consistent with each function derived from identified causal loop diagrams.

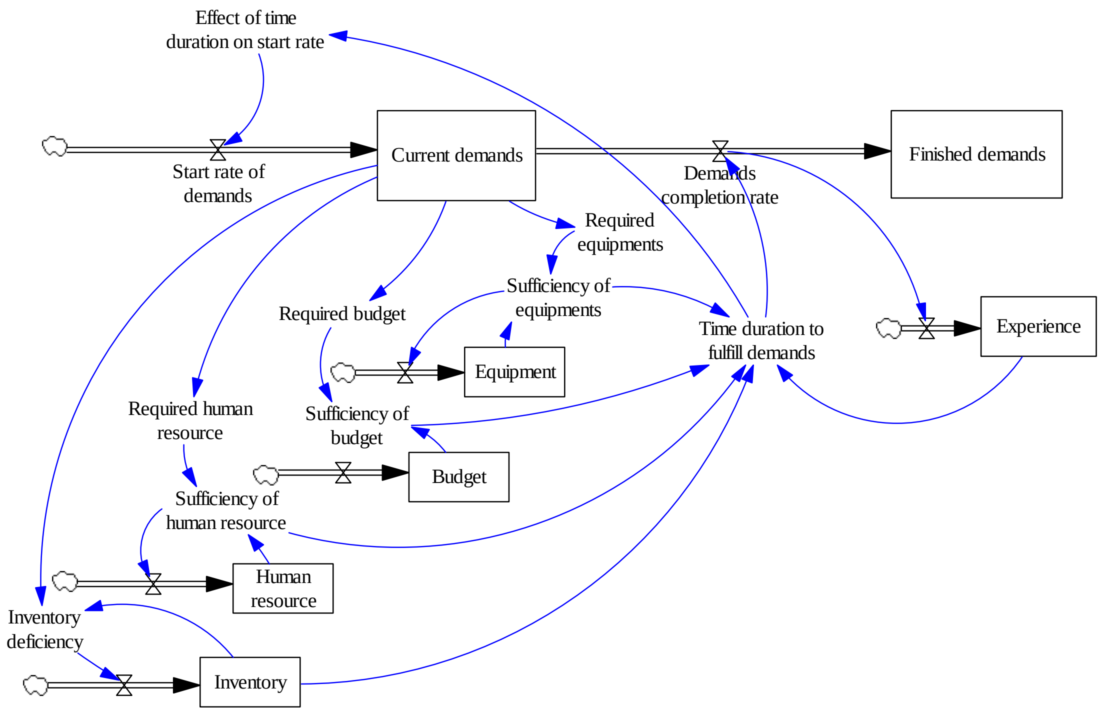

Figure 15. General dynamic model of each function

5. Discussion

According to the shifting the burden archetype in the present study, symptomatic solution has some risks which impede the performance of the company. These influences can be illustrated in each function as following:

Selecting the available solution in supplying inventory causes cost risk that affects the company's budget. Due to the reduction of the budget, production time increases, and thereby manufacturing performance and company's reputation will be negatively affected. Besides, relative time affects the customer satisfaction. It means that by increasing the time compared to expected time, the number of customers of the company declines. In addition, this short term solution creates the quality risk that influences the quality of the products and services. Since the quality impacts on the customer satisfaction, the company should try to improve the quality by different ways such as providing appropriate raw materials and component parts for each function from suppliers which are selected based on systematic methods.

Symptomatic solutions in technology design which is a part of technological innovation function create cost risk which hinders the performance of the function and the number of customers. In addition, these solutions make time risk which directly impacts on the performance and number of customer. Poor performance in terms of technological innovation adversely affects the number of developed products and reputation of the company. Thus, due to the impact of reputation and product development on the number of potential customers, this number will also decline.

Lack of attention to technology maintenance and applying short-term solutions increase cost and time which will limit the budget and deteriorate customer satisfaction, reputation of the company, and the number of customer. In case of technology manufacturing, ignoring and continuous postponement of fundamental solutions increase the risk of time and cost. This leads to lower performance in terms of technology manufacturing which is the primary process of manufacturing SMEs. This also harms company's reputation and reduces customer satisfaction and the number of customers.

According to STS, allocation of resources to manufacturing leads to low performance in maintenance. If maintenance of produced technologies is neglected or postponed, sooner or later it will require extensive or frequent repairs. Since one of the objectives of manufacturing companies is increasing the production of domestic technology, technology design and technology manufacturing should work together towards this goal. However, according to the archetype of accidental adversaries, it would not be possible to achieve growth in both dimensions.

6. Conclusion

In this study general system archetypes were considered and applied in order to identify problems and wrong behavior patterns in Iran's manufacturing SMEs in wind and solar energy. Some archetypes related to inventory supply, technology design, technology manufacturing, and technology maintenance were described and illustrated in accordance with the archetypes of shifting the burden, success to successful, and accidental adversaries. In order to have deeper insight into the problems and the consequences, causal loop diagrams and dynamic modeling with regard to four functions were used and general models were proposed for the manufacturing companies. These functions were absorbing customers and marketing, technological innovation, technology manufacturing, and technology maintenance which are related to the identified system archetypes.

Shifting the burden can explain the behavior of inventory supply, technology design, technology manufacturing, and technology maintenance. This pattern of behavior creates risks in time, cost, and quality of products and services. It reduces the budget, performance of each function and company, customer satisfaction, reputation of the company, and the number of potential customer and customer base. In order to cope with this pattern of shifting the burden, companies should focus on the fundamental solutions. If the only requirement is to gain time, the symptomatic solutions could be used while working on the fundamental solutions. Neglecting maintenance of products according to STS archetype will have undesirable impacts on the performance of maintenance, reputation, customer satisfaction, and the customer base. For dealing with this archetype, one should identify goals or objectives that will refocus the definition of success to a broader system.

Archetype of accidental adversaries shows the problem of collaboration between technology manufacturing and technology design which is related to technological innovation function. In order to manage this condition, shared vision, understandings, and expected mutual benefits should be revisited and collaborative relationship should be improved. Collaboration has been reported to accelerate the pace of innovation in three key ways: by promoting real-time organizational awareness of opportunities for innovation; by shortening the cycle time for design; and by tapping the power of grassroots participation to drive acceptance, adoption, and expansion of ideas. Collaboration is to a large extent based on aligning organizational aims, values and priorities between functions, especially regarding working with external partners. This alignment allows for the creation of synergetic effects among departments, leveraging available resources and knowledge (Smirnova et al., 2011)

As Kahn (1996) has noted, it is important for top management to implement programs which encourage departments to achieve goals collectively, to foster mutual understanding, to work informally together, and to share the same vision, ideas, and resources. If targets are set jointly then the overall direction and individual contributions to achieving these objectives can become explicit and encourage greater cooperation between individuals and departments (Meunier-FitzHugh et al., 2011).

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