Policy Making in a Renewable Energy Manufacturing SME Using System Dynamics

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Abstract:
To promote economic growth while enhancing social inclusiveness and ensuring environmental sustainability, the world needs to grow its industries in a sustainable manner. Using system dynamics, the main purposes of this study are defining a general work structure of a small and medium-sized enterprise (SME) which operates newly in the technological innovation and related manufacturing of solar energy technologies, and providing a template for managers in the same firms. Additionally, policies of the company are examined which lead to a better performance defined as more profit through serving more customers as a result of faster dealing with inquiries and fulfilling orders. Model is validated based on the structure verification, behavior reproduction, and behavior prediction tests. According to the results, the more effective policies are making alliances, capture and reuse project knowledge, increasing the customers by market penetration or development, and providing various services especially for large and profitable customers.

Keywords: system dynamics; renewable energy; small and medium-sized enterprises; policy making.

1. Introduction

An important role of small and medium-sized enterprises (SMEs) in economic development is generally agreed. Mainly, as a result of their contribution to employment and diverse job offerings, regionally and nationally, they are known as prime job creators. Thereupon, in many countries governments have commenced to boost and reinforce SMEs (Jariangprasert, 2012). Despite the fact that, SMEs in terms of the scale and abilities are not strong as the large businesses and multitude of them are newly established (Zheng and Yao, 2011). Since great deal of smaller firms confront shortcomings of resources through using them carefully, mistakes and wrong decisions will cause more serious difficulties than they would make in big enterprises (Edvardsson and Durst, 2013). Zheng and Yao (2011) stated that in order to survive and grow, SMEs must tackle technological innovation. Therefore, if they have desires to be strong and influential in market, prevalent in the competition, and achieve the sustainable development, they must commit to ongoing technological innovation. For this purpose, they face many challenges such as lack of research and development (R&D), and scarcity of related talents. Qiao *et al.* (2014) cited that R&D, technology human resources, and cooperation in industry association networks affect technological innovation positively and considerably and can improve it which itself turn SMEs to higher performance firms.
Moreover, according to Charoenrat *et al.* (2013), manufacturing SMEs should engage with the rigors of competition in domestic and foreign markets. Factors including firm

size, firm age, ownership characteristics, and location influence on the technical incapability of manufacturing seriously. Additionally, having sufficient supply of inputs, access to financial facilities, substantial infrastructural development and training programs for staffs are main measures to promote the technical ability of manufacturing SMEs. Due to the important roles of SMEs in economic development of the country, their barriers and obstacles should be clarified and reduced (Charoenrat *et al.*, 2013).

In general, 45 percent of Iran's industrial employment and 17 percent of its production are because of SMEs (Wikipedia). Iranian renewable energy SMEs are usually commercial companies and they are generally technology suppliers and service providers. Moreover, owing to the recent focus on the knowledge-based companies and their associated benefits, a few commercial companies have undertaken knowledge-based projects meaning technological innovations which include the processes of research, development, testing, and commercialization. Conforming to this, commercialized technologies will be produced.

The present research, using the concepts of system dynamics (SD) as a computer-aided approach to policy analysis and design, tries to identify a general work structure of a SME which operates newly in the technological innovation, and related manufacturing of solar energy technologies in Iran. It also provides a template for managers of the same firms to develop a SD model of their own firms. To better understand the system structure which leads to its performance, causal loop diagrams are used and presented which is a basic technique to visualize how different variables in a system are interrelated. Afterwards, dynamic model of the system is applied to use as a mathematical modeling technique for defining the equations and analyzing the behavior of the system. Models are simulated, and then according to structure verification, behavior reproduction, and behavior prediction tests validated. Furthermore, more effective policies for having a better performance in the company are discussed and examined.

2. Literature review

SME performance is one of the critical determinants of an economy's performance. SMEs need to improve their organizational capabilities in order to become more efficient. One of the most applicable approaches to analyze companies especially SMEs is resource – based view (RBV). This theory rests on two key points. First, that resources are the determinants of firm performance, and second that resources must be rare, valuable, difficult to imitate and non-substitutable by other rare resources. When the latter occurs, a competitive advantage has been created. SD is in accordance with RBV which contributes to the understanding of a system by extracting its working mechanisms' essential structures and developing efficient management scenarios based on an analysis of inherent feedback structures to the system (Park, 2014).

Once the problem area or management's policy issues of concern were identified, in order to use SD as a successful learning tool, SD models use positive and negative feedback loops, called casual loops, to identify the dynamics arising from these interactions and to reveal the structure of a system. As such, it is possible to express the system's behavior during a given interval (Zaim *et al.*, 2013; Zhang *et al.*, 2013). SD needs to be engage with mental models which, as the basis of decision-making process, hold the most significant information about social situations. Hence, actions undertaken to elicit, debate and facilitate change in the mental models by decision-makers can contribute to better management of a system (Lane, 2000). The main pitfall in the approach based on mental models is that their dynamic consequences cannot be mentally simulated to provide the primary rational for using SD modelling to support dynamic decision-making (K. Doyle, 1998).

Carried out in dynamic modelling are the development of the system diagram showing the main variables and issues involved in the system of interest, construction of computer simulation model, over-time simulations, generation and comparison of the model behavior with the historical trends, and model verification. Subsequently, policies and scenarios are postulated and tested.

Thanks to the recent significant advancements achieved in SD, which have made the subject more accessible to policy-makers, SD can be seen as the leader in the process of mapping policymakers' knowledge or mental model as well as other information about the business or social system, and then converting them into models and simulations (Morecroft, 1988). SD also fits into the strategy formulation process with three phases: analysis, planning, and control. In other words, SD supports the analysis phase of the strategy planning process by iteratively structuring the problem followed by testing and refining the problem structure. So, SD is applied for planning which is also an iterative process engaged with evaluation, selection and implementation of strategies. Forecasting expected performance, SD provides an essential element to the control phase any deviation from which indicates the need for additional analyses (Lyneis, 2009). SD is applied in various researches however, to the best of our knowledge, there is few researches related to this study.

3. General work structure of the solar energy manufacturing SME

The basis of the dynamic model is consistent with Figure 1 which shows the functioning mechanisms of the company. In addition, each sector is determined by two stock variables named as 'current conditions' and 'finished conditions' which are related through a flow variable. Time to fulfill each function in each sector is a key variable that affects 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.

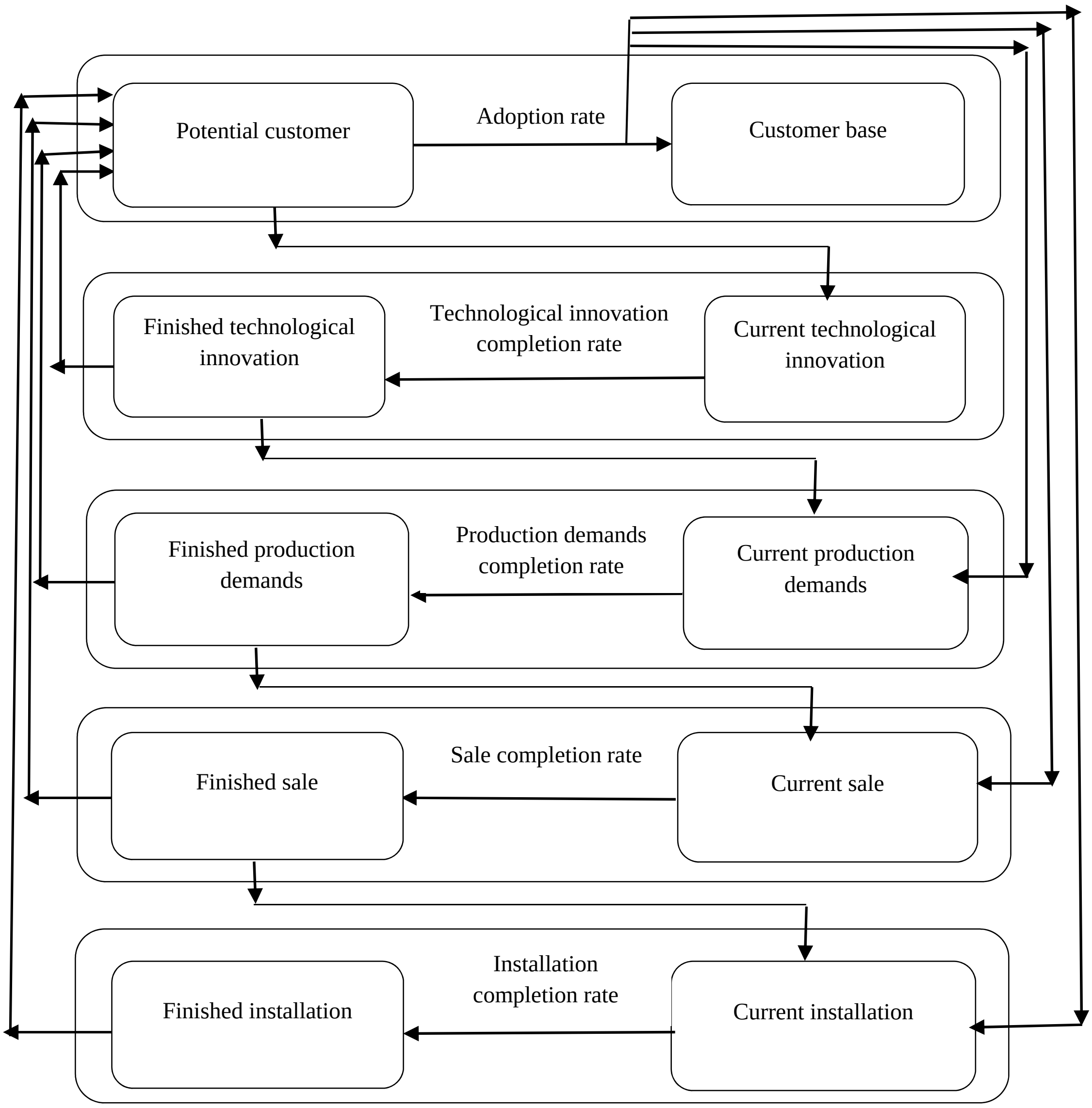

Figure 1. General view of functions of the company

The function of 'customer acquisition' is made up of two stock variables named as 'potential customer' and 'customer base'. Potential customers defined as those who may buy a technology and its related services indicate a potential market share of the company. Net increase rate of potential customers describes changes in potential customers over time which is influenced by micro and macro environment factors. The customer base represents those who have purchased the technologies and services of the company. It is affected by 'adoption rate' defined as the process by which the potential customers pass to be the customer base of the company. Adoption rate implied as the relative position of the company in the market compare to other competitors.

The function of technological innovation defined as the transformation of an idea into a new or improved saleable product, is newly founded in the company. To represent this function, two main stock variables including 'current technological innovation' and

‘finished technological innovation’ are applied which are related through ‘technological innovation completion rate’ as a flow variable. The function of manufacturing, as a new sector in the company, is set out by ‘current production demands’ and ‘finished production demands’ as stock variables and a flow variable named as ‘production demands completion rate’.
The function of selling technologies means as selling own products as well as supplied products of the foreign companies that have their behalf. Increasing the sales is the most key performance indicator in the company. To illustrate this function, two main stock variables including ‘current sale demands’ and ‘finished sale demands’ are applied which are related through ‘sale completion rate’ as a flow variable. Besides production and sale of the technologies, installation plays a main role in technological life span and the reliability. The installation process is done after the sales or customer demands. This function is exemplified by ‘current installation’ and ‘finished installation’ as stock variables and a flow variable named as ‘installation completion rate’. In addition to determining main stock and flow variables, factors that impact on the flow variables are identified. For this purpose, six types of resources are used including: human resources, equipment, budget, experience, inventory, and reputation.

4. Causal loop diagrams of the solar energy manufacturing SME

To illustrate the causal loop diagrams, customer acquisition and manufacturing sectors are considered because the others are more or less similar to manufacturing. According to the Figure 2, the number of potential customers grows by net increase rate of potential customer and declines by rise in customer base. Although there are a balancing loop and other limiting factors such as energy subsidies, currency value, and competition, but the number of potential customers has exponential growth in the company which is predicted to be continued in future because of other reinforcing factors, particularly in respect to the newly formulated renewable energy policies, and increase in the company’s records. Besides, potential customer, and adoption rate have positive effects on the customer base. It means that by increasing in the potential customers, customer base will become higher. Additionally, adoption rate is influenced by customer satisfaction in a positive way. Customer base, and customer satisfaction impact on the reputation which is related to the net increase rate of potential customer. In other words, improve in the company’s performance causes the potential customers and customer base higher.

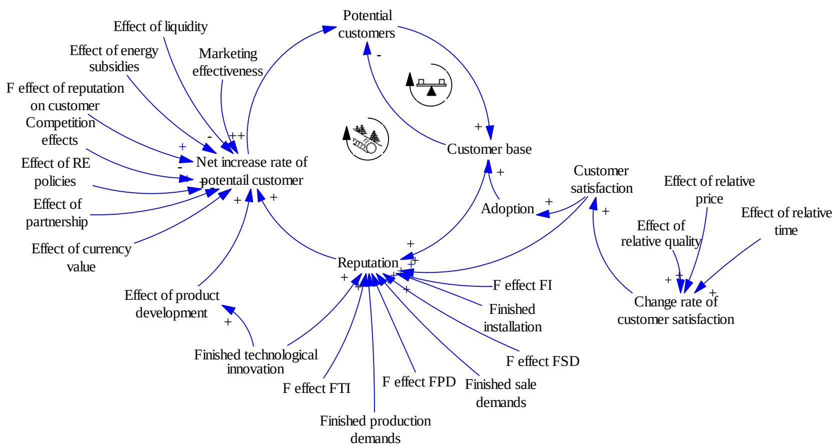

Figure 2. Causal loop diagram of customer acquisition

In the customer acquisition function, net increase rate of potential customer is influenced by several factors including: 1) instability in the currency market and the sharp decline of local currency value, 2) energy subsidies, 3) renewable energy policies, 4) marketing effectiveness, 5) reputation because of its business records and customer satisfaction, 6) liquidity means as the amount of money in the hands of customers, 7) product development described as the number of product types and the supply of new products, 8) partnership in different forms such as outsourcing, joint venture, or mutual investment, and 9) competition effects.
Besides, adoption is affected by customer satisfaction which itself is influenced by factors such as: 1) relative price as a ratio between the price of the company's products and an average price in the market, 2) relative quality refers to a ratio between the quality of the company's products and an average quality in the market, and 3) relative time illustrated by a ratio between the real time of the performing of each function and its expected time. It means that the company's performance and its position in the market impacts on the customer base of the company.
In manufacturing function, production demands completion rate is influenced by resources in the categories including: production inventory, manufacturing experience, and other resources such as budget, equipment, and staff. As it is clear in Figure 3, if all required resources are available, enough inventories exist, and staffs have enough experiences related to manufacturing then the time duration will be as a time schedule without delays. In other words, inadequate resources, inventories, and manufacturing experience cause delays in manufacturing technologies.

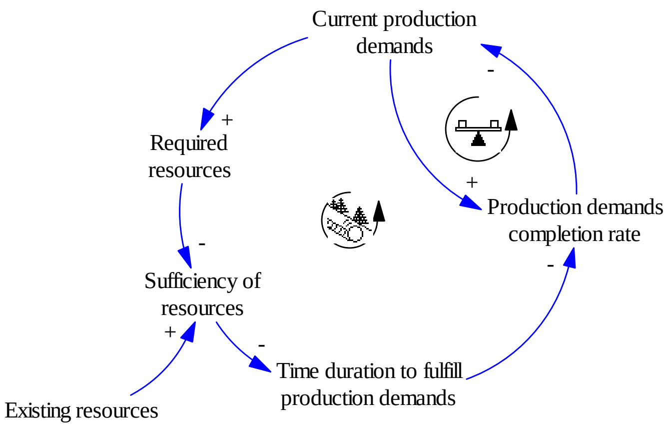

Figure 3. Causal loop diagram of the production demands completion rate

Figure 4 shows that start rate of production demands is affected by adoption rate, finished technological innovation, and the production demands completion rate. Finished technological innovation is prerequisite for production. Production in this industry is based on customer requirements and their demands. In addition, if time to fulfill production demands takes more time than it was expected then start rate of production demands and also current production demands decline.

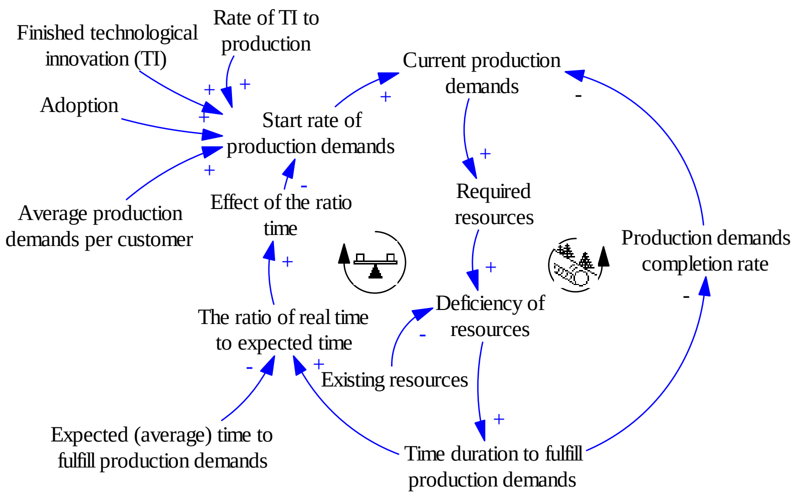

Figure 4. Causal loop diagram of the start rate of production demands

In order to describe the resources, experience brings reverse effects on time to fulfill its related function. More works cause higher experience which makes reduction in time to fulfill the function and subsequently the completion rate of the function will be enhanced, and this mechanism strengths itself. In contrast, through leaving the company by human resources, experience will be lost. Inventory is supplied based on current demands in each function instead of installation. Besides, inventory decreases through production and obsolescence. Required human resources and equipment are influenced by current demands in the function and effect of partnership. Human resources based on the deficiency of related human resource are hired after an average time to hire. Likewise, equipment according to the deficiency of related equipment is supplied after an average time to supply. Human resources decline because of resign rate and time duration to fulfill the function and equipment decreases due to the time to obsolescence. Budget is as a cash flow budget and it is aggregate data regarding all cash inflows and outflows of the company. Financial information has a high privacy for the company; therefore, a variable named as 'deficiency of budget' is used for each function which impacts on the time duration to fulfill its related function.

5. Dynamic modeling of the solar energy manufacturing SME

Like causal loop diagram, in this part, dynamic modeling of customer acquisition, Figure 5, and manufacturing, Figure 6, are explained. In order to describe the behavior of potential customers and customer base, changes in their associated variables should be clarified. Here, currency value is defined with RANDOM UNIFORM (m,x,s) provides a uniform distribution between m and x. It means that systems are affected by random changes of currency value. Some variables such as partnership, renewable energy policies, and competition are determined by the STEP function, intitial value+STEP({height} , {stime}), which returns 0 until time reaches {stime} and then it returns {sheight}. As, the market is growing, both main stock variables show growth.

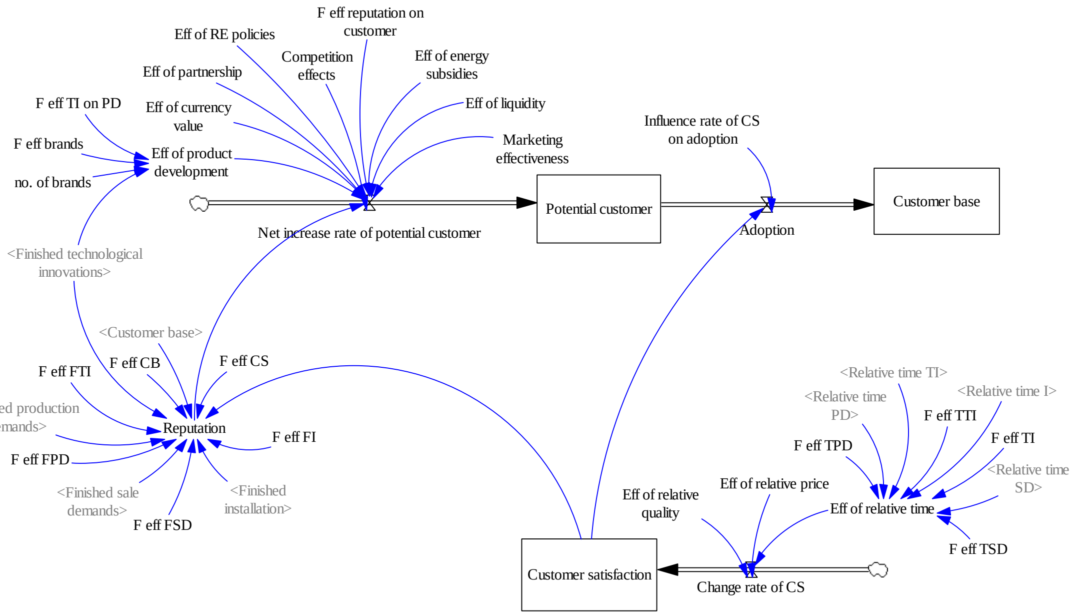

Figure 5. Dynamic modeling of customer acquisition

Besides, production depends on the average demand of the customers which is not controllable and predictable. Thus average demand per adoption rate is supposed to be random, defined as RANDOM UNIFORM (m,x,s) which is a uniform distribution between m and x. Start rate of production demand is defined as IF THEN ELSE({cond} , {ontrue} , {onfalse}) and condition is existence of completed technological innovations. Time duration to fulfill production which itself is affected by deficiency of resources, and average time influences start rate of production demands.

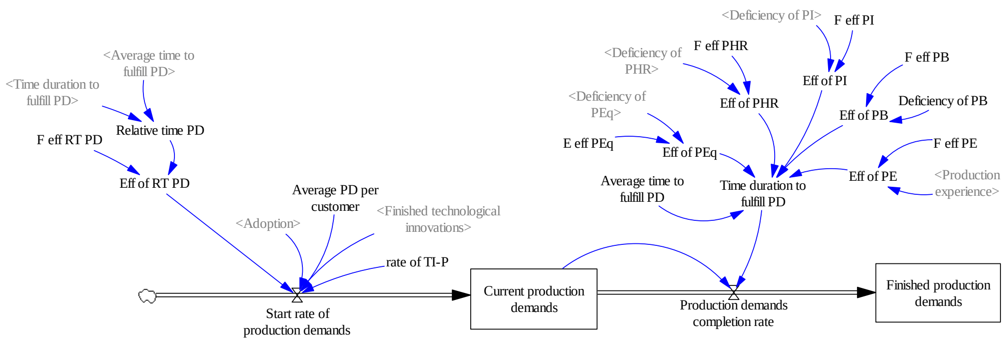

Figure 6. Dynamic modeling of technology manufacturing

6. Patterns analysis of the system

In order to analyze the behavior of the company, at this part, patterns of the main performance indicators after simulation in the company are studied and examined.

6.1.Technological innovation

Knowing the rules and policies of the knowledge-based companies, the company has a relatively good use of these regulations for starting the technological innovation. It has also a relatively good understanding regarding needs of the market due to its presence in the market. This means that by changing the number of potential customers, the start rate of technological innovation will change. As Figure 7 shows, current technological innovations have a significant growth and accordingly, the essential resources should be provided for them.

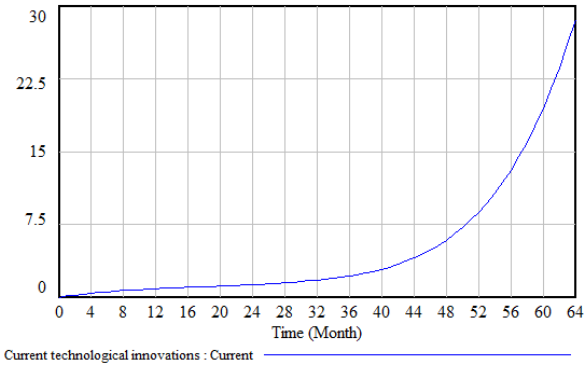

Figure 7. The pattern of current technological innovation (package)

In accordance with Figure 8, as a consequence of significant increase in current technological innovations, the need for resources will rise. And due to the lack of organizational resources at the right time, time duration to fulfill the technological innovations increases. Particularly experiences of technological innovations have no lowering effects on time because of the instability of employees in the SME and the leave rate of the related human resources.

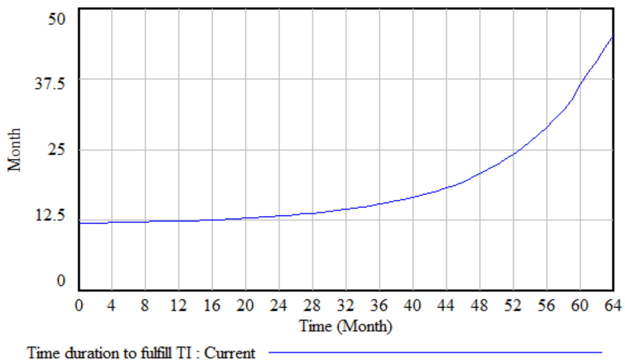

Figure 8. The pattern of time duration to fulfill the technological innovation (month)

With the increase in current technological innovations, completed technological innovations are rising slowly. Because after time duration influenced by the resources and average time duration of projects, the projects are finished. The pattern of completed technological innovations can be seen in Figure 9.

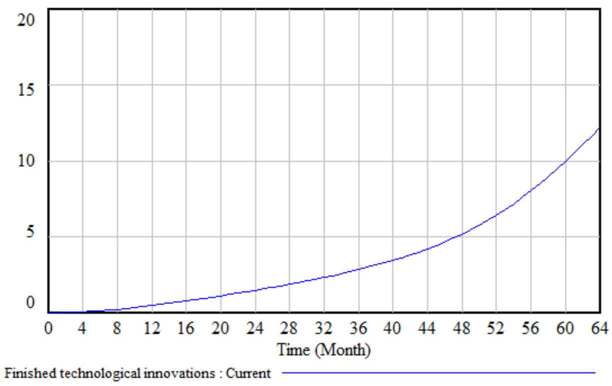

Figure 9. The pattern of finished technological innovations (package)

6.2.Manufacturing

This company is as a newcomer in the field of production. Start rate of production is affected by the completed technological innovations, customers of production, and time duration to fulfill the production. Customers in this sector do not buy on an ongoing basis and their purchase decisions are not predictable. For this reason, fluctuations in a current production, Figure 10, and the time duration of production, Figure 11, can be seen.

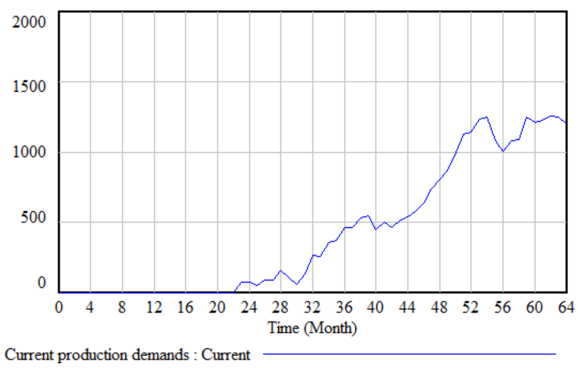

Figure 10. The current production (package)

The time duration of the production is affected by the resources and it is rising over time, although some of the shortages due to the participation in the form of outsourcing are reduced.

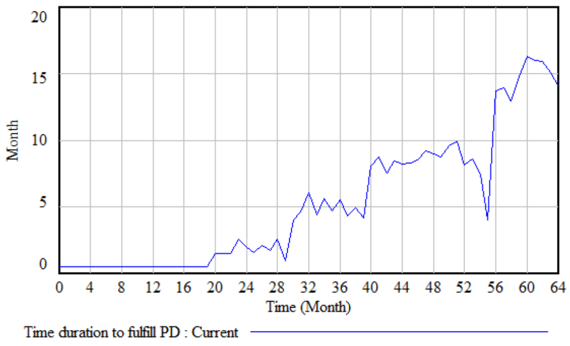

Figure 11. The time duration of the production (month)

Current production through increase in technological innovations and customers is growing and therefore, the completed production shown in Figure 12 is enhanced.

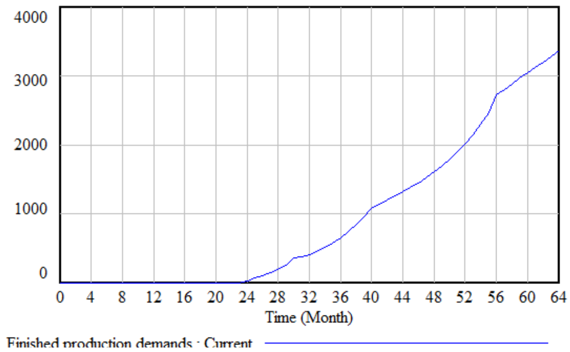

Figure 12. The completed production (package)

6.3.Selling

This company has rather more presence in the market and customers, large ones with high requests volume. In addition, because of having the production process, it sells its own developed and manufactured technologies as well as supplied products. As shown in Figure 13, current sales with little fluctuation are increasing. Volatility in current sale occurs due to the fluctuations in completed production as well as time duration to fulfill sale demands.

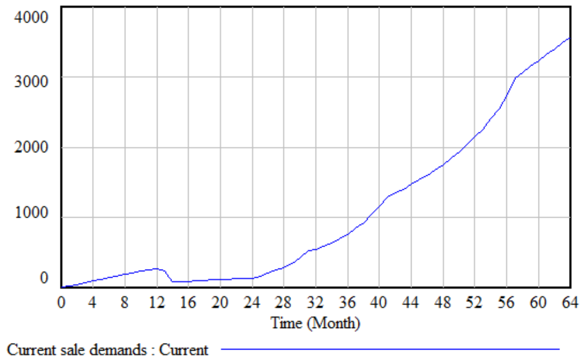

Figure 13. The current sale demands (package)

Time duration to sale demands shown in Figure 14 is influenced by resources and in particular experience. It is declined to the average time with fluctuations over time. For this reason, the current sales are accumulated during about a year, but by reduction in the time duration to sale, it will be reduced. Besides, with the plethora of customers, current sales have ongoing growth.

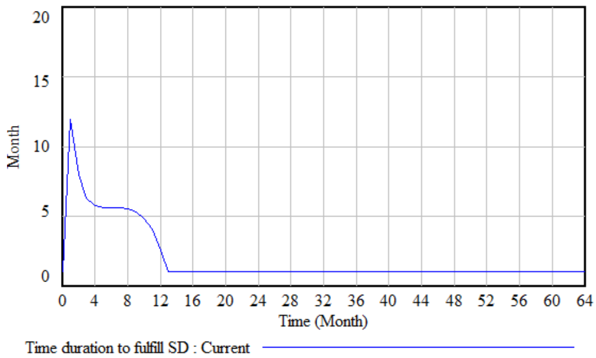

Figure 14. Time duration to fulfill the sale (month)

As it is shown in Figure 15, in accordance with increase in the start rate of sales and performing sales in the specified average time, current sales increase as well as the completed sale demands.

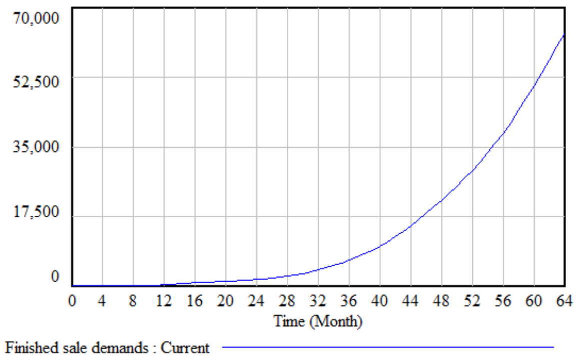

Figure 15. The completed sale demands (package)

6.4.Installation

In the company, the pattern of the start rate of installation is affected by the completed sale demands, customers with demands of installation, and time duration to fulfill the installation. As it is clear from Figure 16, current installation increases by growth of completed sales and customers with requests of installation service.

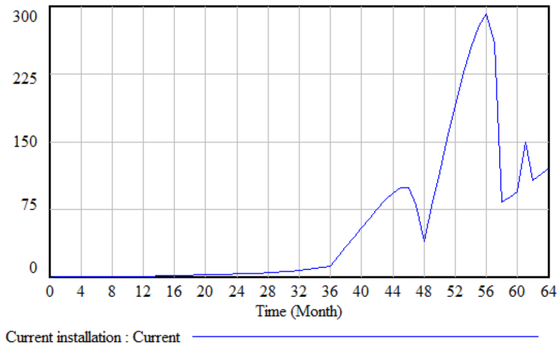

Figure 16. The current installations (package)

Current installation has volatilities because of fluctuations of time duration to fulfill the installation, shown in Figure 17. This pattern of time with fluctuations happens due to the lack of resources.

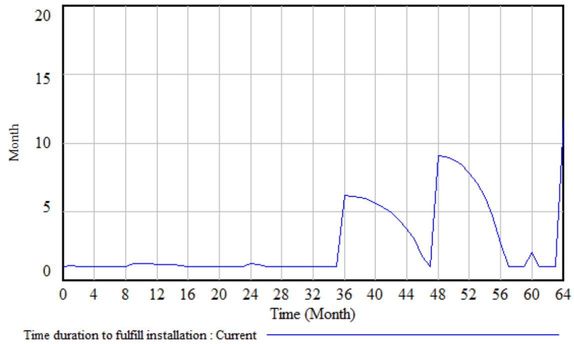

Figure 17. The time duration to fulfill installations (month)

According to the patterns of current installation and time duration to install, completed installation grows with volatilities. The pattern of completed installation can be seen in Figure 18.

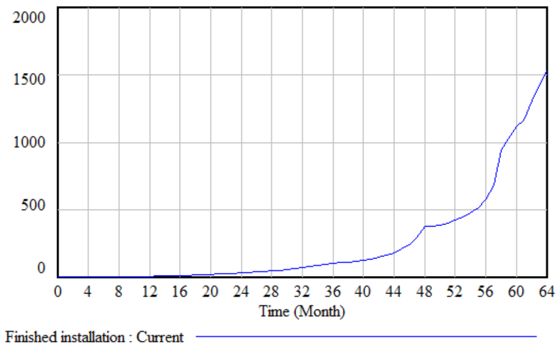

Figure 18. The completed installations (package)

6.5.Customer acquisition

The number of potential customers increases due to the micro and macro environmental factors, and the performance of the company. As it is clear from Figure 19, the number of potential customers is growing.

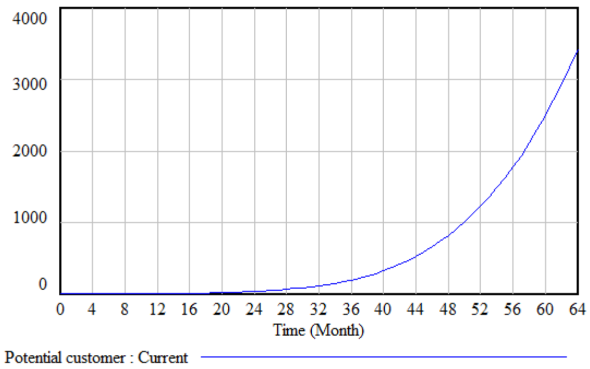

Figure 19. The potential customers (person)

Since time duration to fulfill each function is increasing over time, adoption rate, shown in Figure 20, tends to a constant value that leads to the decline of the rise in the customer base.

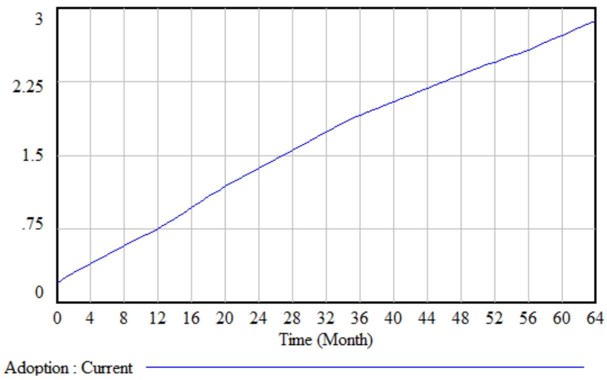

Figure 20. The adoption rate

Customer base in the company, shown in Figure 21, grows through the growth of potential customers.

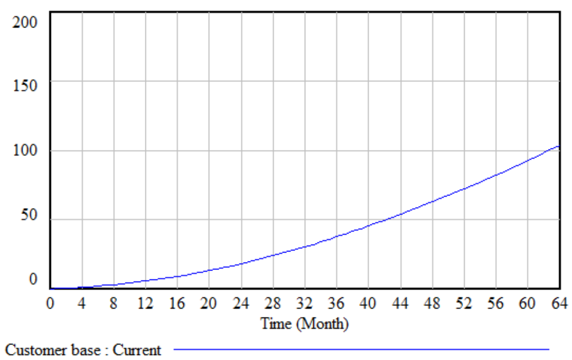

Figure 21. The customer base (person)

7. Model validation

In addition to the check model in the ‘Vensim’ software, following three methods are used for model validation: 1) structure verification test, 2) behavior reproduction test, and 3) behavior prediction test (Forrester and Senge, 1979).

Test of model structure refers to comparing structure of a model directly with structure of the real system that the model represents. That is to pass the structure verification test, the model structure must conform to the structure of the real system. Therefore, it bears comparing model assumptions with managers and decision makers. In this case, according to the viewpoints of managers of the companies, the model structure matches the real life of the companies.

Moreover, behavior reproduction test examines how the behavior of the model is consistent with the observed behavior of the real system. For example, the symptom generation test examines whether a model represents the symptoms of complication that motivated the modeling or not. In this regard, the most important difficulty of the system is lack of resources. In accordance with this problem in each sector, the model shows the problem by growth in time duration to fulfill each function. Additionally, the model behavior adapts to past two–year data.

Behavior prediction test examines whether a model creates qualitatively correct patterns of future behavior or not. The model behaves the same as the forecasting patterns up to three years by managers.

8. Policy making

In each sector, some policies were proposed which are examined in this part.

8.1. Partnership with other companies

The company collaborates with another company in production sector to share labor, and equipment. However, it could have used the positive influence of partnership in other functions to better absorb its potential customers. In this analysis, without changing the structure of the model such as adding partnership effect in the other sectors, the effect of partnership is increased and its considerable impacts on the performance indicators in the company are shown in Table 1.

Table 1. Impact of the increase in partnership on the performance

Increase in the partnership effect	Without change	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80%	90%	100%
Current production (package)	1194	1190	1185	1180	1175	1170	1165	1160	1155	1150	1145
Time duration to fulfill production (month)	14	13.9	13.8	13.8	13.7	13.7	13.6	13.6	13.5	13.5	13.4
Finished production (package)	3363	3367	3372	3377	3382	3387	3392	3397	3402	3408	3413
Current sale (package)	3564	3569	3573	3578	3583	3588	3593	3599	3604	3609	3614

Finished sale (package)	63753	63816	63880	63944	64008	64073	64138	64205	64271	64338	64406
Current installation (package)	120	121	121	121	121	121	121	121	121	122	122
Finished installation (package)	1534	1535	1536	1537	1538	1539	1540	1541	1542	1543	1544

8.2.Increasing financial resources

This policy can be examined by reducing the effect of deficiency of budget on the time duration to fulfill each function. As it is clear from Table 2, decline in the deficiency of budget influences related performance indicators in the company considerably.

Table 2. Impact of increase in financial resource on the performance

Decline in the deficiency of budget of each sector	Without change	10 percent	20 percent	30 percent
Potential customer (person)	3423	3597	3860	4038
Customer base (person)	103	104	105	106
Current technological innovations (package)	28	29	31	32
Time duration to fulfill technological innovations (month)	45	46	47	48
Finished technological innovations (package)	12	12	12	12
Current production (package)	1194	887	374	541
Time duration to fulfill production (month)	14	10	5	3
Finished production (package)	3363	3711	4268	4154
Current sale (package)	3564	3918	4501	4319
Finished sale (package)	63753	68338	76410	77263
Current installation (package)	120	129	144	146
Time duration to fulfill installation (month)	11	2	1	1
Finished installation (package)	1534	1606	1710	1797

8.3.Increase market research

Better understanding the needs of the market helps improve the performance of the company. This impact on the performance of the company is significant because of having high potential customers, shown in Table 3. Additionally, since the leave rate of labor and subsequently the decrease rate of experience in the technological innovation sector are high, increasing the start rate of technological innovations makes time duration to fulfill technological innovation worse.

Table 3. Impact of market research on the technological innovation

Increase in the effect of potential customers	Without change	2 times	3 times	4 times
Potential customer (person)	3423	3426	3427	3688
Customer base (person)	103	103	103	103
Current technological innovations (package)	28	59	92	137
Time duration to fulfill technological innovations (month)	45	72	99	135
Finished technological innovations (package)	12	16	19	21
Effect of product development	1.25	1.6	1.9	2.2

8.4.Using better the knowledge-based legislation

Better knowing and using the regulations of technological innovation contribute to improve the performance of the company, seen in Table 4. Additionally, since the rate leave of labor and subsequently the decrease rate of experience in the technological innovation sector are high, increasing the start rate of technological innovations causes time duration to fulfill technological innovations worse.

Table 4. Impact of more exploitation of knowledge-based legislation

Increase in the exploitation of knowledge-based legislation	Without change	10 percent	20 percent	30 percent
Potential customer (person)	3423	3683	3767	4232
Customer base (person)	103	103	104	104
Current technological innovations (package)	28	31	32	37
Time duration to fulfill technological innovations (month)	45	48	49	53
Finished technological innovations (package)	12	12	13	14
Effect of product development	1.25	1.3	1.37	1.47

8.5.Capture and reuse the project knowledge and experience in the company

As shown in previous strategies, increase in the start rate of technological innovations causes time duration to fulfill the function higher even through removing resources constraints. The reason of this growth in time is because of the effect of experience. Experience withdrawal rate is higher than the rate of entry of experience in to the organization. For example, Figure 22 compares the experience related to technological innovations before and after capturing and reusing project knowledge and experience, and their associated time duration to fulfill the function. It is supposed that the rate of experience retention is 0.75.

As it can be seen from Figure 22, by decline of experience, time duration to fulfill technological innovation is increasing.

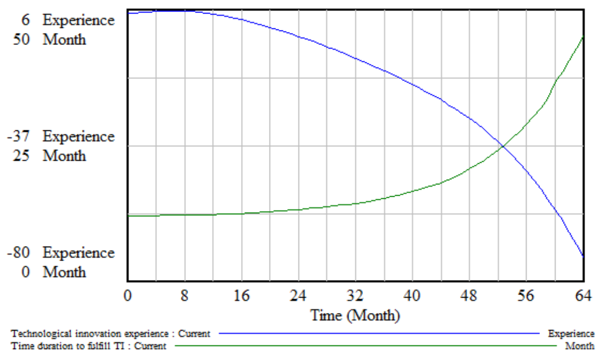

Figure 22. Experience and time duration of technological innovations before applying the policy

By applying this policy, experience will be increased over time which causes a significant decline in rise of the time duration to fulfill the technological innovations, shown in Figure 23.

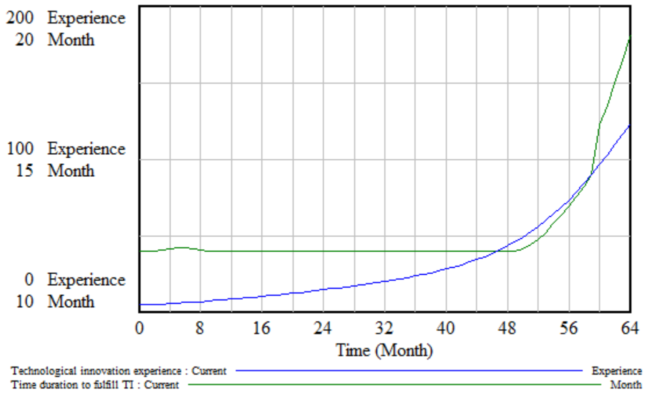

Figure 23. Experience and time duration of technological innovations after applying the policy

Table 5 compares the results of applying the policy of capturing and reusing project knowledge and experience in the company which is considerably helpful for the improvement of the related performance indicators.

Table 5. Impact of experience and knowledge management

Decrease in the reduction of experience	Without change	25 percent	50 percent	75 percent
Potential customer (person)	3423	3434	3445	3449
Customer base (person)	103	104	104	105
Current technological innovations (package)	28	27	26	23
Time duration to fulfill technological innovations (month)	45	39	31	19
Finished technological innovations (package)	12	13	15	19
Effect of product development	1.25	1.37	1.57	1.93
technological innovations experience (knowledge package)	-72	-22	38	123

8.6. Having more stable production demands

This policy which is achievable by market penetration and afterwards market development has remarkable effects on time duration to fulfill the production and the other performance indicators, shown in Table 6.

Table 6. Impact of stable and more production demands on the performance of production sector

Stable production demands and increase in the average production demands	Without change	Stable average demands	10 percent
Potential customer (person)	3423	7281	7878
Customer base (person)	103	105	105
Current production demands (package)	1194	997	269
Time duration to fulfill production demands (month)	14	1.4	0.5
Finished production demands (package)	3363	8020	9664
Current sale (package)	3564	8019	8862
Finished sale (package)	63753	145074	158887
Current installation (package)	120	274	300
Time duration to fulfill installation (month)	11	1	1
Finished installation (package)	1534	3170	3419

8.7. Focusing on installation services by increasing the rate of customers

This policy in the category of increasing the rate of potential customers demanding the installation services, as shown in Table 7, has a notable impact on the performance of the company as a result of having high potential customers.

Table 7. Impact of increasing the rate of installation customers

Increase in the rate of installation customers	Without change	10 times
Potential customer (person)	3423	3423
Customer base (person)	103	103
Current installation (package)	28	120
Time duration to fulfill installation (month)	45	11
Finished installation (package)	12	1534

In addition, by increasing the absorb rate of customers who purchased the technologies to installation services, the impacts on performance indicators in the company are considerable, shown in Table 8.

Table 8. Impact of increasing the absorb rate of customers who purchased the technologies

Increase in the absorb rate of customers who purchased the technologies	Without change	10 percent	5 times
Potential customer (person)	3423	3431	3587
Customer base (person)	103	104	106
Current installation (package)	28	133	612
Time duration to fulfill installation (month)	45	6	1
Finished installation (package)	12	1688	7672

9. Conclusion

This study applied SD for the aim of policy making to improve the performance of the manufacturing SME working in the Iranian solar energy sector. By using concepts and principles of SD, working mechanisms of the company which makes the patterns of behavior were determined. Five sectors named as customer acquisition, technological innovation, manufacturing, sale, and installation were identified as well as six resources such as budget, inventories, human resources, equipment, experience, and reputation. Afterwards, a general dynamic model, causal loop diagrams, and dynamic model of the company were defined. Models were simulated based on the status of the company, and validated according to structure verification, behavior reproduction, and behavior prediction tests. Furthermore, more effective policies were discussed and examined.

In other words, this paper tried to develop a generic model for managing renewable and in particular solar energy manufacturing SMEs with the aim to provide a template for managers to develop a SD model of their own firm. The different experiments with the generic model suggested valid policies on the basis of the results of the company which leads to the higher performance or lower time duration to fulfill the functions. These policies can be expressed as followings:

1) Building alliances as joint ventures to undertake the function,
2) Having alliances as mutual investments,
3) Implementing an effective mechanism to capture and use gained knowledge and experience, especially in technological innovation sector,

4) Having more stable and equilibrium in the market demands by market penetration and development,
5) Adding more services to provide more values for customers,
6) Market research to know better the needs of the market, especially in technological innovation sector.

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