Using Factor Analysis to Identify Effective Factors to Implement Solar Dryers: A Case Study

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Abstract

Solar is a kind of renewable, and clean energy that has been implemented in different countries since ancient time. An application of solar energy is solar dryer, which is for drying the agricultural products, fruits and food products. Different kinds of solar dryers have been designed and manufactured in the past. Different factors are effective in the process of designing, constructing and using solar dryers in different regions. The purpose of this study is to identify the effective factors and risks which may impact on the use of solar dryers. In this research work, data for Yazd province in Iran was used for analysis. Factor Analysis (FA) methodology was performed using SPSS software; a questionnaire was designed to collect the data and finally the validity and the reliability of acquired data was investigated. Results of analysis reveal that there are six major factors and three risk types impacting the process of designing, constructing and implementation of solar dryer systems in the province.

Keywords
Solar dryer, statistical analysis, factor analysis, risk, Yazd Province.

1. Introduction

With the rapid increase of the world population, fuel consumption rate is now constantly growing. Exceed use of the polluting fuels and particularly fossil fuels not only results in the depletion of the fossil fuel resources, but also exerts negative environmental impacts. Water pollution, air pollution, rupture of the ozone layer , the climate changes and acidic rains are the environmental impacts of using fossil fuel (Panwar et al, 2011; Akella et al, 2009; Sharan, 2009). Hence, the world attention has been, recently attracted to the development of the renewable energies, such as atomic energy, solar energy, hydroelectric energy, geothermal energy and wind energy (Panwar et al, 2011).
Solar energy is a clean, free and environmentally- friendly energy resource, and is also cost- effective, particularly in the countries geographically located at $0°$ to $50°$. Meanwhile, the cost of solar energy has been decreased fast in the recent years, and in the sunny countries, the electronic and thermal solar systems engaging in a tight economic competition with the traditional systems using the fossil fuels (Bilbao et al,2012). However, despite the rapid decreasing of the investment costs and increasing the fossil fuel costs, the solar technologies related to the power generation activities cannot compete with the traditional power generation technologies. Yet, considering the issue environmentally, the solar systems are much better than the fossil fuels; however, these systems may encounter various economic, technological, financial as well as organizational barriers (Timilsina et al, 2012). Therefore, extensive studies should be done to overcome the existing barriers and problems. Furthermore, the government should support and invest in the required infrastructures and strengthen the private sector in order to play a significant role in renewable energy sectors (Mohammadi et al, 2014b). Authors have investigated many different studies toward renewables (Alavi et al, 2016a; Alavi et al, 2016b; Shamshirband et al, 2015a; Mohammadi et al, 2016; Mostafaeipour and Sadeghian, 2005; Shamshirband et al, 2015b; Mostafaeipour et al, 2016b; Qolipour et al, 2016; Erratum to: shamshirband et al., 2016; Hosseini-Ezzabadi et al., 2015; Sajjadi et al., 2016; Shamshirband et al., 2015c).

2. Solar dryer as a renewables source

Many studies have been done on all kind of the renewable energies. Mohammadi et al (2013a) evaluated the wind energy potential and its characteristics in Aligoodarz, Iran. The analysis results showed that there is a nearly stable wind pattern in different hours, which demonstrated that this region is suitable for harnessing wind energy to meet the electricity demand. Mostafaeipour et al. (2013b) evaluated the wind energy potential as a power generation source for electricity production in Binalood, Iran. They found that Binalood has available great wind energy potential. Mostafaeipour (2013b), and Mohammadi et al. (2013a) also evaluated wind energy potential in different parts of Iran. Among all the renewable energies, solar has found a particular importance. Mohammadi et al. (2014a) assessed both solar and wind energy potentials for three zones of Iran; Chabahar, Kish and Salafchegan. The results showed that all regions have great potentials for utilizing different solar energy systems. Khorasanizadeh et al. (2014) evaluated solar energy potential in Tabas, Iran. They established a diffuse solar radiation model for determining the optimum tilt angle of solar surfaces.
Many researches have been performed on designing and building various kinds of renewable energies across the world (Mostafaeipour and Abesi, 2010; Mostafaeipour, 2010; Dinpashoh et al, 2013; Mostafaeipour, 2011; Shamshirband et al, 2015a; Shamshirband et al, 2015b; Mostafaeipour et al, 2014a). Numerous studies also have been done considering the effective factors on the solar dryers' feasibility.
Yazd is geographically located in a suitable zone regarding solar radiation. Therefore, using solar dryers for drying the agricultural products is regarded as a suitable solution to promote the renewable energies and to prevent the environmental impacts due to the extra consumption of the fossil fuels (Mostafaeipour et al, 2014b).

3. Research methodology

In this study, the required data, regarding the effective parameters related to the implementation of the solar dryer system, collected by using a questionnaire. To do this, a questionnaire designed after identifying the factors affecting on the solar dryer projects. These factors have been partly identified through investigating the existing literatures about the solar dryers and experts experiences. For this research work, there is no difference between different kinds of solar dryers considering their effective factors and risks.

Various issues are included in the design, construction, implementation, and the exploration of solar dryer systems and the related projects as well; these issues are: performance (Ezkewe, 1981), geographic situation and environmental issues (Chandel et al, 2014; Belessiotis and Delyannis, 2011; Pirasteh et al, 2014), capital, knowledge and infrastructures (Kokate et al, 2014; Aboltins and Palabinskis, 2013; Srivastava et al, 2014; Dina et al, 2015), financial support, social and cultural issues (Sarlak, 2013; Benmarraze et al, 2015), and management and competition . The proposed factors are presented briefly in the figure 3.

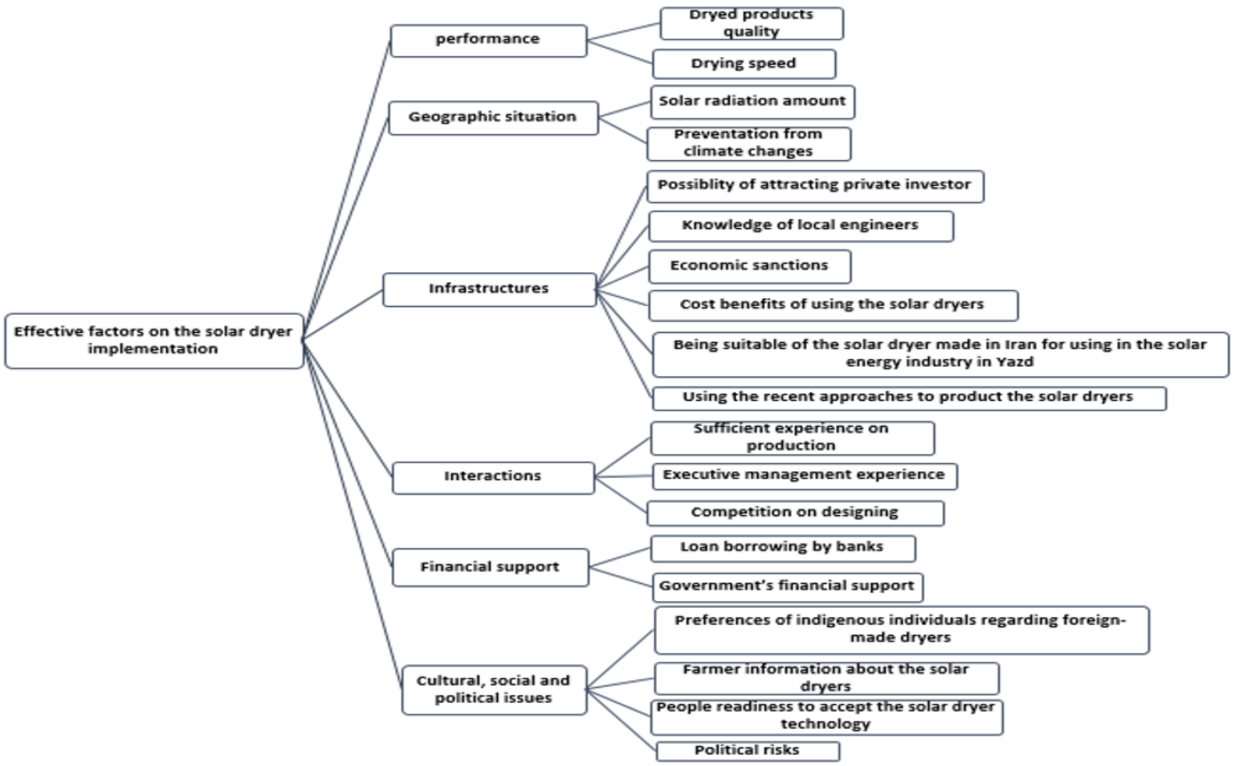

Figure 3. The effective factors on the solar dryer systems implementation

As it can be seen in the figure 3, six factors are included: the first one, performance factor, deals with quality and speed for drying of the agricultural products; the second one geographic situation is about the quality of solar radiation and the application of solar dryer as a mean to prevent climate changes; and infrastructure factor that incorporating different items like infrastructures, the possibility of attracting private investors, knowledge of local engineers, economic sanctions, cost benefits of using the solar dryers in Yazd, being suitable of the solar dryer made in Iran for using in the solar energy industry in Yazd, and using the recent approaches to product the solar dryers. Furthermore, lack of sufficient experience on production, lack of executive management experience for the solar dryer projects implementation, and lack of competition on designing, producing and supplying the solar dryers, as well as other things like loan borrowing and the government's financial support for the related projects are considered as the shortcomings. Finally, farmer information about the solar dryers, the preferences of indigenous individuals regarding foreign-made dryers and their readiness to accept the solar dryer technology, and the political risks all constitute the cultural, social and political issues reflected in the proposed questionnaire

Beside all the prominent factors related to the projects, there are some risks treating the project progress that may cause some problems against the proper accomplishment of related programs. So, in addition to the related factors, the above mentioned risks in three different categories have also been studied; they include: financial, external, and construction risks (Zamanian, 2012). The factors introduced for the risks are presented in figure 4.

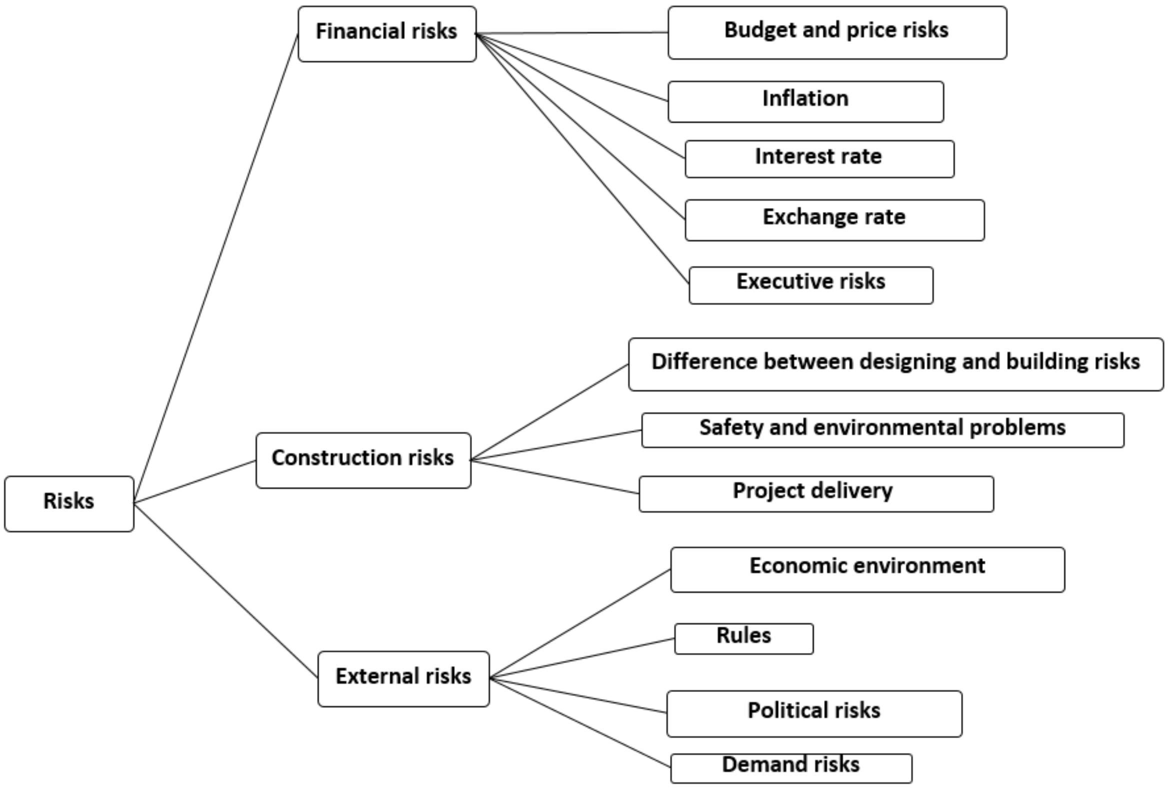

Figure 4. The effective risks on the solar dryer systems implementation

As it can be seen in the figure 4, financial risks deal with budget and price risks, inflation, interest rate, exchange rate, and executive risks. Furthermore, differences between designing and building, safety and environmental problems, and project delivery risks constitute the construction risks. Finally, economic environment, rules, political risks, and demand risks have been proposed as external risks.

The questionnaire's content validity has been confirmed by the experts. The experts in this study included three solar products designer, two solar products manufacturers, and eight university professors, who are active on the solar energy field and solar applications. Then, limited number of the proposed questionnaires distributed among the statistical society, including Yazd residents. Next, the reliability and validity of this questionnaire have been considered and confirmed. Two main questions are usually proposed in evaluation of the questionnaire. First, how accurate the questionnaire indicates the greater range of the questions extracted from it, which means reliability. Second, how the questionnaire is true in accordance with the latent variables, which means validity (Bayazidi, 2012). After applying some required reformations the edited questionnaires have been distributed.

The collected data have been analyzed using the SPSS software. Then, the factor analysis method has been used to identify the effective factors and risks. The factor analysis method is a multi-variable statistical method, which includes a larger set of the variables looking for a way to decrease the data volume or summarize the factors or the variables into a smaller set (Suhr, 2012; Liau et al, 2011). In factor analysis, it is assumed that the measured variables are ordinal, with normal distribution and they have a linear relationship with each other (Suhr, 2012). In the factor analysis basic model, the standard variable (Z_j) value is obtained from equation (1):

$$Z_j = a_{j1}.F_{1i} + a_{j2}.F_{2i} + \ldots + a_{jm}.F_{mi} \quad (1)$$

Where, a_{jp} indicates the weight of F_{pi} , and n is the observed variables number (Afandizade and Rahimi, 2010). According to this model, Z_{ji} is a linear combination of n variables and is obtained from equation (2).

$$Z_{ji} = \left(\frac{X_{ji} - \bar{X}_j}{\sqrt{V_j}} \right) \quad (2)$$

Where;

$$V(z_j) = \frac{\sum_{i=1}^{n} {z_{ji}}^2}{n} = 1 \quad (3)$$

It means that the standard variable (Z_j) variance equals one. By apply some changes in the equation (1) ,th e equation (4) would be obtained:

$$V(z_j) = \frac{\sum_{i=1}^{n} {z_{ji}}^2}{n} = 1 \quad (4)$$

Where, ${u_j}^2$ and ${a_j}^2$ are variances; u_j is a particular factor, which indicates the X_j variable share in the Z_j, and so it would be considered as zero in the principal component analysis and therefore:

$$\sum {a_j}^2 = 1 \quad (5)$$

One task in the factor analysis is to determine that what does each factor measures; ${a_j}^2$ will be sufficient for this purpose. ${a_j}^2$, which is actually the factor loading, indicates that in a particular factor, which variables have the least and the most share (Afandizade and Rahimi, 2010).

Factor analysis is usually done in three major steps. First step is to consider whether the data are suitable for analysis or not. There ae some measures to do this, such as sample volume or correlation between the variables. Kaser-Mayo- Elkin method and Bartlet test are the main methods to determine that the sample volume is enough or not (Pallant and Rezaei, 2010). The next step is to extraction the factors. In this step, the extraction method should be determined at the first and then the number of the factors should be extracted to explain the basic structure of data ought to be determined. There are various methods to extract the factors; such as principle component, un-weighted least squares, generalized least squares, maximum likelihood, principal axis factoring, Alpha factoring, and image factoring (Pallant and Rezaei, 2010; Sadeghpour and Moradi, 2010). Third and final step in factor analysis is to interpret the extracted factors. Since the variables, which correlate with the factors extracted before, may be ignored, the interpretation would be difficult. So, the factors are rotated to facilitate this task. There are two main way to rotate the factors; orthogonal rotation and angular rotation factoring (Pallant and Rezaei, 2010).

There are two principal approaches for factor analysis; exploratory factor analysis and confirmatory factor analysis. Exploratory factor analysis is usually used at the primary research stages and is mostly used to collect data about the internal relationships between the variables. On the other hand, confirmatory factor analysis is mostly used to test the hypothesis made as the infrastructure of variables. This kind of analysis usually aims to test the theories or examine the variables (Suhr, 2012; Liau et al, 2011). There are some special terms related to the factor analysis that researchers should be aware of. Factors are the real identified components obtained directly from correlation matrix; the important factors are identified by the extraction process; eigenvalues show how much of the total data are explained by the assumed factor; factor loading is computed for the combination of the variable and the extracted factor, which shows the correlation coefficient between the variable and the factor; the larger the factor loading would be the more important is the role of the component in making the related factors (Suhr, 2012). Before doing the factor analysis, it is necessary to assure that the sample volume is sufficient; Kaiser-Meyer-Olkin (KMO) measure and Bartlet test are usually used for this purpose. KMO measure examines the nominal correlations between the variables and indicates whether the considered variances of variables are influenced by some latent common variance or not. This criterion varies between 0 and 1. Factor analysis is not recommended for the values below 0.49; however, it is relatively appropriate and highly proper for the values between 0.5 and 0.69 and for the values up to 0.7 respectively (Suhr, 2012).

In this study confirmatory factor analysis has been used to extract the effective factors from the proposed questionnaire; results obtained in this regard are discussed later.

4. Results and discussion

4.1. Validity and reliability

The questionnaire reliability has been considered using the Cronbach alpha coefficient by SPSS software. The Cronbach alpha coefficient computed as 0.789 for whole the questionnaire, showing the questionnaire is reliable. Construct validity of the questionnaire also has been considered using the factor analysis method by the SPSS software. As the result, six factors have been identified from 20 proposed items in the questionnaire, which explained 51.258% of the whole questionnaire. Also, three types of risk have been identified, which explained 52.032% of the whole questionnaire. So, the obtained results confirmed the questionnaire validity.

The statistical sample size has been estimated using Cochran formula. Cochran formula is presented in equations (6) and (7) (Zahrakar and Delavar, 2008):

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad (6)$$

$$n_0 = \frac{\frac{Z^2_{\frac{\alpha}{2}} p(1-p)}{}}{E^2} \quad (7)$$

Where:
n= sample size;
N= statistical society size;
Z= percentage of acceptable confidence coefficient error;
P= proportion of the population having certain characteristics;
Q= proportion of the population lacking certain characteristics; and
E= reliability or possibly accuracy.
α, p, q and E have been considered as 8%, 0.5, 0.5 and 0.05, respectively. Statistical society in this study include Yazd residents, which is estimated as 660.000 people (N=660.000) . Therefore, the sample size has been estimated as 144 people (n=144). By predicting a margin of error, 150 questionnaires distributed among the statistical society, and finally, 145 ones were returned.

4.2. Demographic data analysis
After collecting the primary data, the collected data have been analyzed using SPSS software. Demographically, the females constituted 46.2% of the whole respondents and the male constituted the remaining; 53.8%. The gender of participants may influence on their opinion about the feasibility and hence various factors dominate the implementation process. Therefore, the gender's influence on the proposed factors have been studied using t- test; The t- test is usually used to compare the differences between the averages of the two different groups or conditions (Suhr, 2012). This test is the most common statistical tool used for the analysis, conducting using the casual-comparative method. According to the obtained results, the gender issue influences on some proposed factors including performance, the geographical situation, the financial risk, the construction risk, and the external risk. The participants were between 19 and 55 years old and their average age was 32.01 years old. In this study, t-test has been used to find out the effect of the participants' age on the quality of their responses against the proposed questions. To do this, the participant's age has been divided into two different ranges; young (below 30 years) and middle age (up to 30 years). According to these categories, 48.97% of the participants are young and 51.03% are middle aged. According to the obtained results, the age of the people influences on their opinion about some of the proposed factors; such as performance, the geographical situation, infrastructures, and the external risks.

4.3. Factor analysis
As mentioned before, in this study the effective factors on the possibility of the implementation of the solar dryers in Yazd has been studied using the factor analysis method. To consider the sufficiency of the sample volume the KMO criterion and the Bartlet test have been used. The obtained results from these two tests for all the proposed variables are presented in the table 2.

Table 2. KMO and Bartlet test for the proposed variable

Variables	**KMO**	**Bartlet test**		
		Chi Square	**Freedom degree**	**Significant value**
Performance	0.5	25.00	1	0.00
Geographic situation	0.5	5.808	1	0.016
Infrastructures	0.529	200.789	21	0.00
Interactions	0.618	117.461	3	0.00
Financial support	0.5	68.807	1	0.00
Social, cultural and political problems	0.518	24.315	6	0.00
Financial risk	0.645	210.622	10	0.00
External risk	0.68	79.092	6	0.00
Construction risk	0.68	83.475	3	0.00

As it can be seen in the table 2, KMO measure, as a suitable value, for all the proposed variables is above 0.5; it shows that the variances of all the variables related to every component are influenced by the common variance of some of the latent and critical factors. Therefore, applying the factor analysis for all proposed components is OK. The significant values obtained from the Bartlet test are below 0.05 for all the components, showing appropriateness of the extracted factors from the related component. So, according to the results presented in the table 1, the proposed factors are suitable for building the components. This method is used after assuring the worthiness of applying the factor analysis method to extract the variables from the proposed components. The obtained factor loadings actually show the variable role in constructing the related component. The values up to 0.5 and the values between 0.3 and 0.5 are very suitable and suitable respectively. But, the variables with factor loading below 0.5 may be excluded. The component coefficient shows the variable impact. The component coefficient for all the identified components and the factor loadings for the components are presented in the table 3.

Table 3. The factor loadings and the component coefficients for the proposed factors

Variable	Item	Factor loading	Component coefficient
Performance	a) Quality of dried products in solar dryers is higher than the products dried in traditional dryers.	0.837	0.597
	b) Speed of product drying in solar dryers is high.	0.837	0.597
Geographic situation	a) Appropriate solar radiation in Yazd is a positive point for building solar dryer there.	0.775	0.645
	b) Using solar dryers in Yazd is a suitable solution to prevent climate changes.	0.775	0.645
Infrastructures	a) Yazd has required infrastructures (such as necessary knowledge, equipment and so on) to build solar dryers.	0.655	0.289
	b) It is possible to attract private investors to build solar dryers in Yazd.	0.569	0.247
	c) Yazdian engineers have sufficient knowledge, information and equipment to design solar dryers.	0.613	0.224
	d) Economic sanction in Iran is the major barrier to solar dryer implementation	-0.539	-0.234
	e) Using solar dryer technique in Yazd is cost- effective.	0.454	0.197
	f) The solar dryers made in Iran are appropriate for solar dryer industry.	0.613	0.266
	g) Yazd enjoy from a better future based on previous approaches to build solar dryers.	0.632	0.274
Interactions	a) There is no enough experience to build solar dryers in Yazd.	0.888	0.445
	b) There is no management experience regarding solar dryer projects in Yazd.	0.852	0.427
	c) There is no competition for design, construction and supply of the solar dryers in Yazd.	0.692	0.347
Financial support	a) Banks do not devote loans to the solar dryer projects.	0.901	0.555
	b) The government does not devote enough budgets to the solar projects.	0.901	0.555
Social, cultural and political issues	a) Farmers do not have sufficient knowledge about solar dryers and their benefits.	0.763	0.527
	b) People trust to foreign made solar dryers more than home-made ones.	-0.343	-0.237
	c) Yazdian people are ready to accept the usage of the solar dryers.	0.637	0.440
	d) The existing political risks in Iran are the major barrier for external investors to invest in solar projects.	0.586	0.405
Financial risk	a) Inflation	0.908	0.377
	b) Exchange rate	0.762	0.316
	c) Interest rate	0.767	0.318
	d) Price and budget risk	0.647	0.268
External risk	e) Project delivery	0.807	0.337
	a) Economic environment	0.631	0.338
	b) Rules	0.631	0.314
	c) Demand risk	0.353	0.263
	d) Political risk	0.753	0.147
Construction risk	a) Difference between designing and building's risk	0.862	0.479
	b) Safety and the environment	0.702	0.390
	c) Executive risk	0.750	0.417

According to what has been explained from factor analysis (table 3), it can be concluded that there are six major components influencing the implementation of the solar dryer project in Yazd: performance, geographic situation, infrastructures, interactions, financial support, and finally social-cultural and political issues. Also, some risks regarding the implementation of this project are being categorized as financial, external, and construction risks. Every identified component composes various elements and factors playing a particular role in the success of this project. Table 4 shows the components and factors identified based on the factor analysis conducted in the present study.

Table 4. Summary of the effective factors and risks regarding solar dryer implementation in Yazd

Variable	Factor
	Effective factors
Performance	a) Quality of dried products
	b) Speed of drying
Geographic situation	a) Solar radiation
	b) Prevent climate changes
infrastructures	a) Required infrastructure
	b) Possibility of attracting private investors
	c) Required knowledge, information and equipment for appropriate design
	d) Economic sanction
	e) Cost- effectiveness of solar dryers
	f) Suitability and applicability of Iran's made solar dryers in Yazd
	g) Suitable history of solar dryers' approaches
Interactions	a) Lack of experience in construction of solar dryer
	b) Lack of management experience of solar projects
	c) Lack of competition in design, construction and implementation of solar dryers
Financial support	a) Bank loans
	b) Government budget
Social, cultural and political issues	a) Farmer information about solar dryers
	b) Preference of foreign solar dryers comparing to home- made ones
	c) People acceptance of solar dryers
	d) Political risks
	Risks
Financial risk	a) Inflation
	b) Exchange rate
	c) Interest rate
	d) Price and budget risk
External risk	a) Project delivery
	b) Economic environment
	c) Rules
	d) Demand risk
	e) Political risk
Construction risk	a) Difference between design and build risk
	b) Safety and the environment
	c) Executive risk

As it can be seen from table 4, there are six major factors and three types of risks influencing the proper application of solar dryers in Yazd.

5. Conclusions

Since in Iran and particularly in Yazd the solar radiation is really good, this great energy is regarded as the best alternative solution and replacement of fossil fuels. One of the applications of the thermal solar energy, which has been studied in this paper is solar dryer. Various factors and risks are included in the designing, construction, implementation, and exploration stages of the solar dryer systems, which can impact on the success or failure of the related projects. In this study, through using factor analysis, all factors and risks influencing these projects have been identified. A summary of the research results is presented as follows:

- A questionnaire has been designed and has been distributed among 145 people from Yazd residents.
- Validity and reliability of the questionnaire has been considered using SPSS software. The alpha Cronbach coefficient has been computed as 0.789, which is almost a good value and show that the questionnaire is reliable. The questionnaire content validity has been confirmed by the experts. The construct validity also has been confirmed using SPSS software; six factors and three risks have been identified from the proposed factors, which explain 51.258% and 52.032% of the whole questionnaire respectively.
- 67% of the participants were female and the remaining 78% were male.

- The respondents were between 19 and 55 years old, with an average of 32.01; 48.97% were young and under 30 years and 51.03% were middle that is up to 30 years old.
- In order to get confidence about the suitability of factor analysis for extracting related factors, KMO measure and Bartlet test have been used.
- The factor loadings and component coefficients of each factor and component have been computed and analyzed. Based on the obtained results, it can be concluded that there are six major effective factors regarding solar dryer implementation; such as performance, geographical situation, infrastructures, financial support, social, cultural and political problems, and interactions.
- Every identified factors are composed of the following components:
    - The quality and speed of drying constitute the performance factor;
    - Amount of solar radiation and preventing of climate changes constitute geographical situation factor;
    - Required infrastructure, the possibility of attracting private investors, sufficient knowledge, information and equipment required for appropriate design, economic sanction, cost-effectiveness of solar dryer usage, the suitability of Iran-made solar dryer for using in the solar energy industry in Yazd and the history of previous approaches are the components made the infrastructures factor;
    - Lack of experience and competition in solar dryer design and construction management has been considered as interactions factor;
    - Loans and government budget for the related projects are the major components of financial support factor;
    - Farmer knowledge about solar dryers, people trust to the foreign solar dryers more than home-made solar dryers, people readiness for accepting solar dryers and political risks constitute social, cultural and political factor.
- The risks impact on the construction and implementation of solar dryers can be categorized into three major categories; financial risks, external risks, and construction risks.
- The components causing the identified risks can be explained as follows:
    - Inflation, exchange rate, interest rate, and price and budget risk constitute financial risks;
    - Project delivery, economic conditions, rules, demand risk, and political risk are components of external risk;
    - Difference between design and construction, executive risk, safety and environment made construction risk.

References

Aboltins, A., Palabinskis, J., New types of air heating solar collectors and their use in drying agricultural products Argonomy Research, vol. 11, no. 2, pp. 267-274, 2013.

Alavi, O., Sedaghat, A., Mostafaeipour, A., Sensitivity analysis of different wind speed distribution models with actual and truncated wind data: A case study for Kerman, Iran, *Energy Conversion and Management*, vol. 120, pp. 51-61, 2016a.

Alavi, O., Mostafaeipour, A., Qolipour, M., Analysis of hydrogen production from wind energy in the southeast of Iran, *International Journal of Hydrogen Energy*, pp. 1-14, 2016b.

Afandizade, S., Rahimi, A., Factor analysis model to choose the effective factors on the travel demand by pubilc transit buses, *Journal of transport*, vol. 1, 2010.

Akella, A., Saina, R., Sharma, M., Social, economical and environmental impacts of renewable energy systems, *Renwable Energy*, vol. 34, pp. 390-396, 2009.

Bayazidi, E., Owladi, B., Abasi, N., Questionnaire data analysis using SPSS software, *Abed publication* 2012.

Belessiotis, V., Delyannis, E., Solar drying, *Solar Energy*, vol. 85, pp. 1665-1691, 2011.

Benmarraze, S., Itskhokine, D., Benmarraze, M., Alasis, E., Tawlbeh, M., Shain, W., Status of implementation of the first Linear Fresnel solar thermal power plant in the Middle East – WECSP solar project in the

Kingdom of Jordan, *International Conference on Concentrating Solar Power and Chemical Energy Systems, Solar PACES* 2014, Energy Procedia 2015.

Bilbao, J., Bravo, E., Garcia, O., Varela, C., Rodriguez, M., Gonzalea, P., The Next future of solar energy generation, *IJTPE*, vol. 4, no. 12, 2012.

Chandel, M., Agrawal, G., Mathur, S., Mathur, A., Techno-economic analysis of solar photovoltaic power plant for garment zone of Jaipur city, *Case Studies in Thermal Engineerings*, vol. 2, pp. 1-7, 2014.

Dina, S. F., Ambarita, H., Napitulpulu, F. H., Kawai, H., study on effectiveness of continuous solar dryer integrated with desiccant thermal storage for drying cocoa beans, *Case Studies in Thermal Engineerings*, vol. 5, pp. 32-40, 2015.

Dinpashoh, Y., Mirabbasi, R., Jhajharia, D., Abianeh, HZ., Mostafaeipour, A., Effect of short-term and long-term persistence on identification of temporal trends, *Journal of Hydrologic Engineering*, vol. 19, no. 3, pp. 617-625, 2013.

Erratum to: Shamshirband, S., Mohammadi, K., Tong, C.W., Petcock, D. , Porcu, E., Mostafaeipour, A., Ch, S., Sedaghat, A., Application of extreme learning machine for estimation of wind speed distribution, *Climate Dynamics*, vol. 46, no., (5-6), pp. 1893-1907, 2016. DOI 10.1007/s00382-015-2682-2

Ezkewe, C., Crop drying with solar air heater in tropical Nigeria, *Perfamon press*, Nigeria, 1981.

Hosseini-Ezzabadi, J., Saryazdi, M.D., Mostafaeipour, A., Implementing Fuzzy Logic and AHP into the EFQM model for performance improvement: A case study, *Applied Soft Computing*, vol. 36, pp. 165-176, 2015.

Khorasanizadeh, H., Mohammadi, K., Mostafaeipour, A., Establishing a diffuse solar radiation model for determining the optimum tilt angle of solar surfaces in Tabass, Iran, *Energy Conversion and Management*, vol. 78, pp. 805-814, 2014.

Kokate, D., Kale, D., Korpale, V., Shinde, Y., Panse, S., Deshmukh, S., Pandit, A., Energy Conservation Through Solar Energy Assisted Dryer For Plastic Processing Industry, *4th International Conference on Advances in Energy Research* 2013, ICAER 2013. Energy Procedia 2014.

Liau, A., Tan, T., Khoo, A., Scale Measurement: Comparing Factor Analysis and Variable Clustering, *in SAS Global Forum* 2011.

Mohammadi, K., Mostafaeipour, A., Dinpashoh, Y., Pouya, N., Electricity generation and energy cost estimation of large-scale wind turbines in Jarandagh, Iran, *Journal of Energy* 2014b.

Mohammadi, K., Mostafaeipour, A., Economic feasibility of developing wind turbines in Aligoodarz, Iran, *Energy Conversion and Management*, vol. 76, pp. 645-653, 2013a.

Mohammadi, K., Mostafaeipour, A., Sabzpooshani, M., Assessment of solar and wind energy potentials for three free economic and industrial zones of Iran, *Energy*, vol. 67, pp. 117-128, 2014a.

Mohammadi, K., Mostafaeipour, A., Using different methods for comprehensive study of wind turbine utilization in Zarrineh, Iran, *Energy Conversion and Management*, vol. 65, pp. 463-470, 2013b.

Mohammadi, K., Alavi, O., Mostafaeipour, A., Goudarzi, N., Jalilvand, M., Assessing different parameters estimation methods of Weibull distribution to compute wind power density, *Energy Conversion and Management*, vol. 108, pp. 322-335, 2016.

Mostafaeipour, A., Abesi, S., Wind Turbine Productivity and Development in Iran, Biosciences (BIOSCIENCESWORLD), *International Conference on Cancun Mexico*, pp. 112-118, 2010.

Mostafaeipour, A., Bardel, B., Mohammadi, K., Sedaghat, A., Dinpashoh, Y., Economic evaluation for cooling and ventilation of medicine storage warehouses utilizing wind catchers, *Renewable and Sustainable Energy Reviews*, vol. 38, pp. 12-19, 2014b.

Mostafaeipour, A., Economic evaluation of small wind turbine utilization in Kerman, Iran, *Energy Conversion and Management*, vol. 73, pp. 214-225, 2013a.

Mostafaeipour, A., Historical background, productivity and technical issues of qanats, *Water History*, vol. 2, no. 1, pp. 61-80, 2010.

Mostafaeipour, A., Jadidi, M., Mohammadi, K., Sedaghat, A., An analysis of wind energy potential and economic evaluation in Zahedan, Iran, *Renewable and Sustainable Energy Reviews*, vol. 30, pp. 641-650, 2014a.

Mostafaeipour, A., Productivity and development issues of global wind turbine industry, *INTECH Open Access Publisher*, 2011.

Mostafaeipour, A., Sedaghat, M., Ghalishooyan, M., Dinpashoh, Y., Mirhosseini, M., Sefid, M., Pour-rezaei, M., Evaluation of wind energy potential as a power generation source for electricity production in Binalood, Iran, *Renewable Energy*, vol. 52, pp. 222-229, 2013b.

Mostafaeipour, A., Khayyami, M., Sedaghat, A., Mohammadi, K., Shamshirband, S., Sehati, MA., Gorakifard, E., Evaluating the wind energy potential for hydrogen production: A case study, *International Journal of Hydrogen Energy*, vol. 41, no.15, pp. 6200-6210, 2016a.

Mostafaeipour, A., Sadeghian, A., Development of wind turbine in Iran. Proc, *World wind energy conference, WWEC Press*, Melbourne, Australia, 2005.

Mostafaeipour, A., Qolipour, M., Mohammadi, K., Evaluation of installing photovoltaic plants using a hybrid approach for Khuzestan province, Iran, *Renewable and Sustainable Energy Reviews*, vol. 60 pp. 60–74, 2016b.

Pallant, J., Rezaei, A., Analysis of the behavioral sciences data by SPSS, *Forouzesh publication*, 2010.

Pirasteh, G., Saidur, R., Rahman, S., Rahim, N., A review on development of solar drying applications, *Renewable and Sustainable Energy Reviews*, vol. 31, pp. 133-148, 2014.

Qolipour, M., Mostafaeipour, A., Shamshirband, S., Alavi, O., Goudarzi, H., Evaluation of wind power generation potential using a three hybrid approach for households in Ardebil Province, Iran, *Energy Conversion and Management*, Vol. 118, pp. 295-305, 2016.

Sajjadi, S., Shamshirband, S., Alizamir, M., Yee, L., Mansor, Z., Manaf, A.A., Altameen, T.A., Mostafaeipour, A., Extreme learning machine for prediction of heat load in district heating systems, *Energy and Buildings*, vol. 122, pp. 222-227, 2016.

Shamshirband, S., Mohammadi, K., Tong, C W., Petković, D., Porcu, E., Mostafaeipour, A., Sedaghat, A., Application of extreme learning machine for estimation of wind speed distribution, *Climate Dynamics*, vol. 46, no. 5, pp. 1893-1907, 2015a.

Shamshirband, S., Mohammadi, K., Yee, L., Petković, D., Mostafaeipour, A., A comparative evaluation for identifying the suitability of extreme learning machine to predict horizontal global solar radiation, *Renewable and Sustainable Energy Reviews*, Vol. 52, pp. 1031-1042, 2015b.

Shamshirband, S., Mohammadi, K., Yee, L., Petković, D. and Mostafaeipour, A., A comparative evaluation for identifying the suitability of extreme learning machine to predict horizontal global solar radiation. *Renewable and Sustainable Energy Reviews*, vol. 52, pp.1031-1042, 2015c.

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