Exploring the success factors for examining the potential of manufacturing system output

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Abstract

Purpose – The purpose of this paper is to explore the success factors for the assessment of manufacturing system output.

Design/methodology/approach – Exploratory factor analysis and second-order confirmatory factor analysis were used to analyze data and test hypotheses, respectively. A total of 36 observed variables were transformed into nine success factors, namely role of management (ROM), technical strength, employee strength, organizational strength (OS), resources (RS), production system, market research, effective planning, and research and development (RD).

Findings – The finding indicates that only four success factors, namely ROM, RS, OS, and RD, are positively related to all four outputs. Moreover, all nine success factors are positively associated with profit.

Research limitations/implications – The outcomes of the present work provide meaningful implications for researchers and practitioners as well.

Originality/value – Earlier studies have laid focus on single output only in the manufacturing system. In the present study, an effort has been made to focus on four output dimensions, namely final product, customer relationship, reputation, and profit, which are further strengthened by incorporating the concept of performance in manufacturing systems.

Keywords Organizational performance, Supply chain management, Input/output analysis

Paper type Research paper

1. Introduction

A manufacturing system is an approach to produce a valuable product, relation, profit, etc., which are characterized by variables such as cost, reliability, life, appearance, etc. (Efthymiou *et al.*, 2012). The manufacturing system is a combination of manufacturing processes, manufacturing equipment, and human resources bound by the common flow of material and information. The manufacturing system consists of three essential parts such as input parameters like raw material, manpower, etc., process parameters like design, production, etc., and output parameters like final product, profit, etc. (Ostwald and Munoz, 2008). The manufacturing system consists of five basic components such as production method, human power, equipment, material handling, and product. But in the modern manufacturing system more components such as flexibility, automation, etc., could be added to meet the demands of the competitive manufacturing organization (Obi, 2013). The capacity of a manufacturing system depends upon the technical and physical capability of a manufacturing plant. The activities of departments such as production, quality, R&D, marketing, distribution, etc., affect the outputs of the manufacturing system.

In 2013, India's manufacturing output was 223,138 (US Dollar) and was ranked at the tenth position in the world. The manufacturing output of China in 2011 was ten times more

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as compared to manufacturing output of India in 2013 (Worldbank, 2013). The surprising fact indicates that India should focus on growing and implementing the advancement in the manufacturing sector. The adoption of advancements in technology without justifying the needs is not a key element to improving the output manufacturing system (Koc and Bozdag, 2009). The several factors such as social, environmental, economic, etc., influence the output of the manufacturing system. Nowadays manufacturing organizations are trying to become more service centered on improving customer satisfaction (Li *et al.*, 2014). The need of current scenario can be anticipated by doing a deep analysis of market behaviors (Szymanski and Henard, 2001). The research, innovation, and development become an essential part to enhance the outputs of the manufacturing system (Malerba, 2002). The feedback and control and flow of information play a prominent role in improving the performance of the manufacturing system. The both terms feedback and control and flow of information should be imparted on departmental activities in order to improve the outputs of the manufacturing system (Ploegmakers *et al.*, 2007). The manufacturing system consists of two aspects i.e. facilities and manufacturing support systems. The facilities imply that a manufacturing system consists of men, material, and machine. The function of a manufacturing support system is to examine and provide a solution to a technical and quality problem of organizations (Groover, 2010).

Researchers have investigated the factors that influence the performance of a manufacturing system. Due to the involvement of multiple inputs and outputs in the manufacturing system, performance assessment is a complex task. A little work has been reported in the literature for the assessment of parameters to improve the potential of multiple outputs of the manufacturing system. This present research is carried out to enhance the role of success factors on assessment model of multiple outputs. The proposed model provides the guidelines to improve multiple outputs, namely final product, customer relationship, reputation, and profit of a manufacturing system.

The organization of rest of the paper is as follows. In Section 2, the literature review and hypotheses are presented. Section 3 presents the research methodology including data collection; data analysis and hypotheses of present work are also tested. The last section concludes the paper as well as recommendations for further research.

2. Literature review

Kazan *et al.* (2006) made an effort to examine the effect of manufacturing strategies on the financial performance of a manufacturing organization. The regression analysis results have shown that quality and flexibility have a significant impact on financial performance but the rate of delivery has no effect on the financial performance of a manufacturing organization. Chen and Huang (2006) proposed a product capability index and time-cost index to examine and control three key concerns of manufacturing element such as product quality, manufacturing time, and cost. The indexes were used to know the actual status of quality, cost, and process time involved in the manufacturing process. The result showed that key concerns of manufacturing were improved by using indexes. Gomes *et al.* (2006) examined the role of key factor in the performance of manufacturing organization. The questionnaire study consisting 25 performance measures was performed in manufacturing organization having more than 50 employees. The result of factor and cluster analysis showed that high-performers organizations were more emphasizing on customer- and employee-driven policies. Gomes *et al.* (2007) made an attempt to examine the influence of success factor on the performance of manufacturing organizations. Statistical tools were implemented to analyze the opinion of external decision makers in different facets related to the performance of manufacturing organizations. The result indicated that management activities adversely affect the performance of manufacturing organizations. Karim *et al.* (2008) made an attempt to examine competitive strategy in the manufacturing environment for improving the performance of the organization. The questionnaire study was performed to collect data from 1,000 manufacturers in Australia. The results revealed out that product quality and price were strongly important and less important competitive factors, respectively, for case manufacturers. It was suggested to perform failure mode and effect analysis for improving the quality of product and delivery performance.

Rad *et al.* (2014) made an effort to improve the performance of the manufacturing system. The potential problems in a manufacturing system such as high production cycle and idle time, system cost, etc., were examined to enhance the efficiency of the manufacturing system. The simulation and technique for order preference by similarity to ideal solution method were implemented to find best improvements option and later on optimum solution was presented. Efthymiou *et al.* (2014) developed a frame model to examine the reason of fluctuation in the manufacturing performance. The effects of unpredictability on the manufacturing system were thoroughly explained in order to improve production planning of a manufacturing organization. A case problem of automotive industry was demonstrated to show the effectiveness of proposed methodology. An attempt has been made to examine the impact of organizational capability on performance in innovative business operations. The result showed that organizational capability is positively related to profit and customer satisfaction (Lun *et al.*, 2016). Kafetzopoulos *et al.* (2015) developed a path model between factors and multiple performances of manufacturing firms. The SEM was applied to validate the model and test the hypotheses. The result showed that ISO 9001 effectiveness has direct impact on product quality and operational performance.

Huo *et al.* (2016) presented the relationship between different management flow and operational performance. The result of the survey study revealed that human flow management and production flow management are directly associated with the operational performance but information flow management and decision flow management are indirectly associated with operational performance. Nadeem *et al.* (2017) made an attempt to explore the relationship between intellectual capital and firm performance. The results showed that the intellectual capital is significantly related to return on equity and return on assets. The rest of relevant literature is systematically presented in Table I.

2.1 Success factors affecting output of the manufacturing system

Researchers have been identified and examined various factors i.e. parameters that affect the output and performance of a manufacturing system. A list of 36 observed variables (SF001 to SF036) that could affect the output of manufacturing system were sorted out from literature and expert choices. The frame model of present work is shown in Figure 1. The success factors considered in this research work are listed below.

Role of management (ROM). Management is the precious stakeholder of an organization. The task of taking strategic decisions and new policy implementation is driven by top management to improve the output of the manufacturing system. The knowledge and skill of company builder help in improving the competitive advantages of organization (Leung *et al.*, 2003). The role and support of management in various activities makes the system more efficient and productive. The adequate managerial support helps in achieving operational benefits (Asrofah *et al.*, 2010).

Technical strength (TS). The adoption of innovative technology increases productivity and also improves the TS of the manufacturing system. The manufacturing strategy development model based on quality function deployment was presented in order to link competitive factors with manufacturing decision categories (Jia and Bai, 2011). The use of world class manufacturing techniques helps in achieving excellent manufacturing environment.

Table I.
Relevant literature review

S. No.	Author	Parameters	Output/performance dimensions	Tools applied
1	Chavez *et al.* (2017)	Manufacturing capability	Organizational performance	CFA
2	Kaur *et al.* (2017)	Flexibility components	Business performance	SEM
3	Sadeghi *et al.* (2016)	Corporate social element	Financial performance	Multiple regression method
4	Ehie and Muogboh (2016)	Government policies and the adopted manufacturing practices	Manufacturing strategy	Path model
5	Kafetzopoulos and Psomas (2015)	Innovation	Product quality, operational and financial performance	SEM
6	Karabulut (2015)	Innovation types	Financial and business performance	Multiple regression analyses
7	Realyvásquez *et al.* (2015)	Macro-ergonomics element	Manufacturing systems	SEM
8	Lee *et al.* (2014)	Manufacturing strategy	Plant performance	SEM
9	Satish and Srinivasan (2010)	Total quality management	Innovation performance	Multiple regression
10	Kazan *et al.* (2006)	Manufacturing strategies	Financial performance	Regression analyses

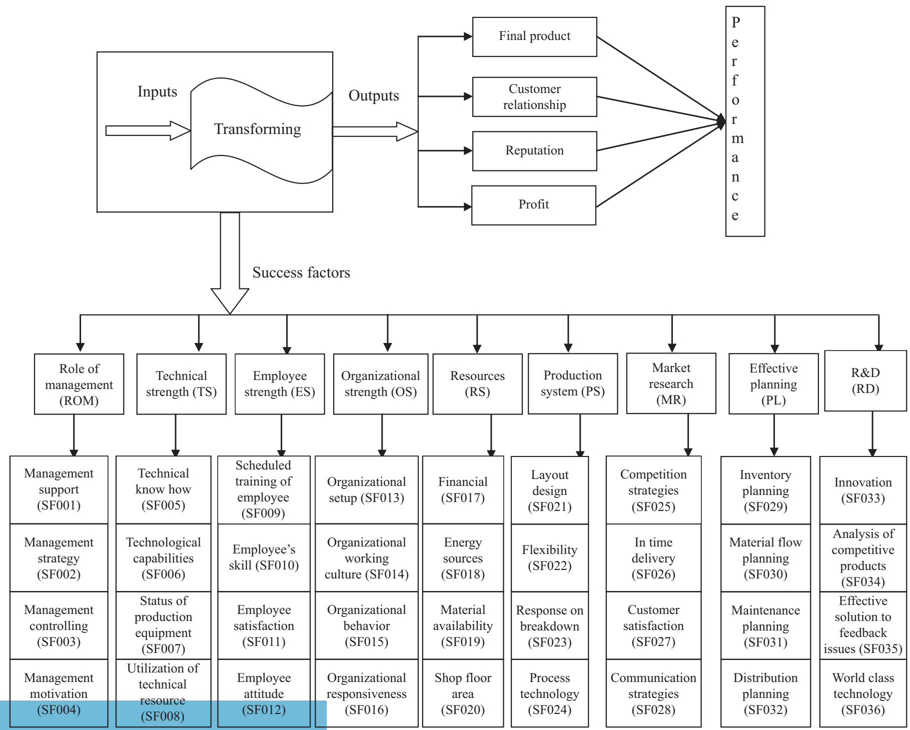

Figure 1.
Frame model of present work

The usage of tool, method, and technique for manufacturing represents the technology involved in the manufacturing environment and problem in manufacturing can be solved by the effective implementation of technology. The manufacturing strategy has a significant role in redesigning the manufacturing system and improves the productivity as well as profit of organization (DeWeck *et al.*, 2014). The technology management strategy is directly associated with the financial performance of manufacturing organizations (Mandal and Bagchi, 2016).

Employee strength (ES). The efficiency of completing the assigned work in time, without compromising the quality of a product or process, represents employee's strength. Employee skill should be upgraded by providing the training to meet the expectations of the market (Lyons, 2005). Employee development is significantly correlated with the performance of an organization (Sarfaraz *et al.*, 2015). Employee attitude is intangible variable and management should make special efforts to address problems related to attitudes such as negativity and laziness. The education level of employee has positive impact on management performance (Agarwal *et al.*, 2013). The employee's attitude is a key factor which affects job performance and positive attitude helps in attaining competitive advantages (Procter and Randall, 2015). The talent management concept was presented in order to get maximum output by utilizing employee's emotional, intellectual capabilities, and experiences (Karatop *et al.*, 2015). Employee creativity helps in improving work performance and enhancing the competitive advantages (Lasrado *et al.*, 2017).

Organizational strength (OS). The functional activities of the organization affect the outputs of manufacturing systems. The organizational support is a key success factor in improving the performance of the organization (Chung and Lee, 2005). Organizational factors explain more variance than economic factors in firm profit (Hansen and Wernerfelt, 1989). The working culture of an organization affects the ability of worker and performance of the system. The organization's behavior should be in favor to create a supporting workplace setup around the employees (Snell *et al.*, 2015). Organizational culture represents a way of thinking and modes of operating to achieve expected results (Wong, 2007).

Resources (RS). Effective resource-based strategy helps organizations to improve operational capabilities. The overall resource effectiveness factor such as men and material availability affects the performance of the manufacturing system (Eswaramurthi and Mohanram, 2013). The utilization of RS such as men and machine influences the capacity and performance of the manufacturing system. Total shop floor area must be arranged efficiently at all shop levels as policy and decision of every level influences the performance of production system (PS) (Endrass, 2013). The investments in manufacturing system increase the efficiency of processes and overall performance (Lee *et al.*, 2015). The effective design and management are required to improve the quality of products while reducing the use of RS (Colledani *et al.*, 2014).

PS. The flexibility in manufacturing environment improves customer relationship and shows the positive impact on the performance of manufacturing system (Swink *et al.*, 2005). Flexibility in manufacturing environment affects the organizational activities and improves the performance of the manufacturing system (Lloréns *et al.*, 2005; Baykasoğlu and Özbakır, 2008). The manufacturing method and technology involved in PS affects the performance of the organization (Bellgran and Säfsten, 2004). In present era, manufacturing organizations are in favor to set up effective and robust PS to achieve competitive advantages. The layout design of PS should be effectively arranged to ensure proper utilization of RS (Singholi *et al.*, 2010). The flexibility in the PS is expected to manufacture a variety of products at low cost, in less time span with high quality to improve the performance of the system (Nayak and Ray, 2013). The flexibility and responsiveness are needed in manufacturing systems in order to improve performance (Shin *et al.*, 2009).

Market research (MR). MR helps to identify and examine the need of consumers. The customer loyalty can be improved by customer satisfaction and positively related to profit (Helgesen, 2006). The MR, especially in forecasting of demand, helps in maintaining efficient control on production and inventory (Karaesmen *et al.*, 2004). The linkage between MR and performance was presented and provided managerial implication in order to improve performance (Dubey *et al.*, 2014). The result of manufacturing companies in Australia showed that effective supplier relation has a positive impact on manufacturing performance (Karim *et al.*, 2008). The information gathered from the market study is very useful to anticipate the needs of products in the future and redesign the products as per customer needs (Obi, 2013). Human resource management has a significant impact on customer satisfaction and organizational performance (Gómez-Cedeño *et al.*, 2015).

Effective planning (PL). The planning helps in maintaining the control of the manufacturing system. The planning of operations activities according to existing performance measurement systems is a beneficial aspect of the manufacturing system. The impact of strategic planning was thoroughly explained and the importance of planning in manufacturing environment was presented (Shields *et al.*, 2002). The adequate planning of material flow helps in achieving better inventory control and performance (Jonsson and Mattsson, 2008). The logistics system is linked with global manufacturing strategy and logistic activities must be optimized to survive in globalized scenario (Tzeng and Huang, 2012). The concept of advanced planning and scheduling (APS) with outsourcing was explained and an APS model was presented to meet the customer expectation (Lee *et al.*, 2002).

Research and development (RD). Nowadays innovation has become an essential element to accelerate the growth of manufacturing system. The R&D department is always engaged in developing innovative activities to reap profits of organization (Malerba, 2002). The main barriers in R&D are the lack of knowledge and skills in the manufacturing organization (Chandran *et al.*, 2009). The functional innovation in the product should be effective in relation to manufacturing process and cost. Innovation activities have positive impact on productivity growth of the manufacturing system (Storm *et al.*, 2013). The empirical research results revealed that the level of innovation is directly related to financial performance (Bigliardi, 2013).

2.2 Research model and hypotheses development

The proposed research model represents the relationship between success factors and outputs of the manufacturing system as shown in Figure 2. The proposed research model consists of 36 observed variables, nine success factors, and four outputs related to manufacturing systems. The function of a manufacturing system is to produce valuable products. The raw material is transformed into tangible output i.e. final product of the manufacturing system. The specifications of final product meet the expectation of consumers. The quality, durability, and reliability are main characteristics of a product and continuous effort is needed to maintain the same.

The hypotheses related to final product are given below:

H1a. ROM is positively related to final product.

H1b. TS is positively related to final product.

H1c. ES is positively related to final product.

H1d. OS is positively related to final product.

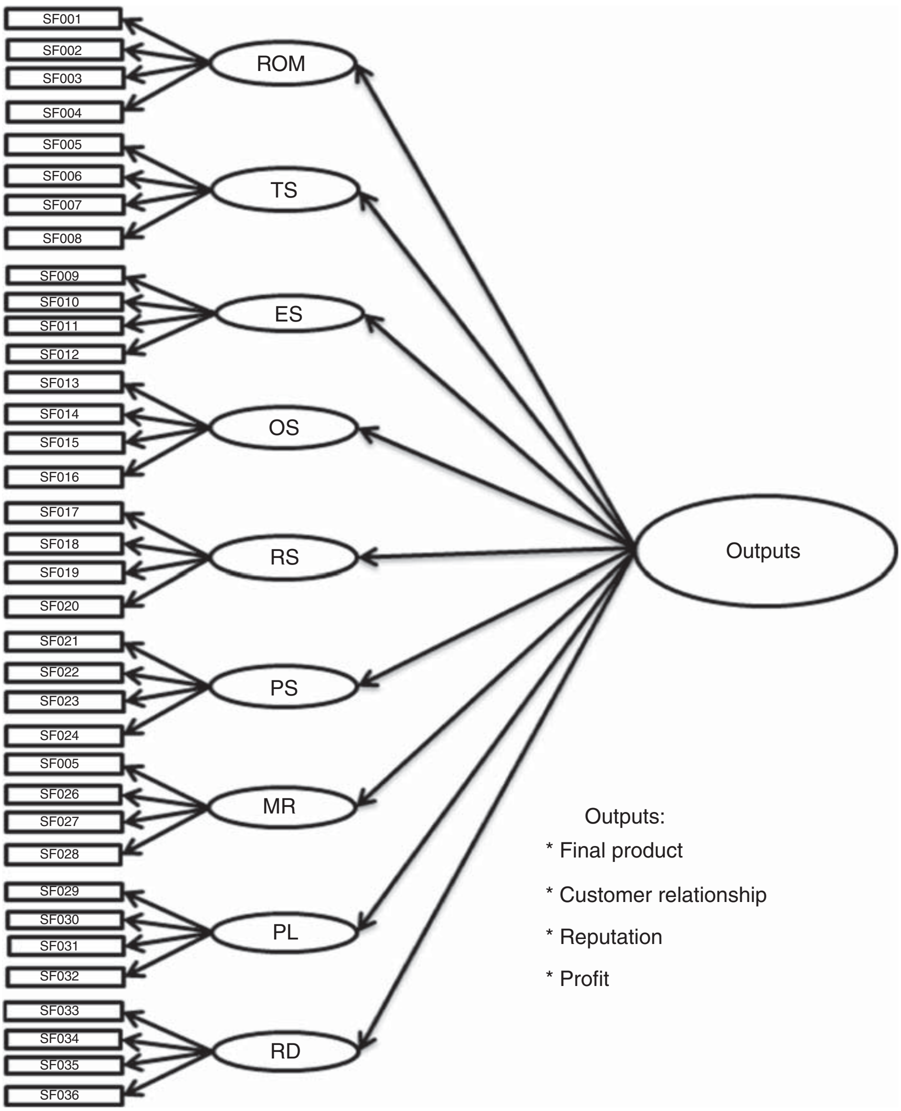

Figure 2.
Research model of present study

H1e. RS is positively related to final product.

H1f. PS is positively related to final product.

H1g. MR is positively related to final product.

H1h. PL is positively related to final product.

H1i. RD is positively related to final product.

Organizations are trying to satisfy the needs of the customer to make a healthy relationship. The comfort relationship with customer helps to build confidence in the management of the organization. The assessment of enablers linked with customer relation is more important to survive in the competitive era. The strength of customer relation becomes more effective with the passage of time and helps to run the business in the globalized world for the long time span. The hypotheses related to customer relationship are given below:

H2a. ROM is positively related to customer relationship.

H2b. TS is positively related to customer relationship.

H2c. ES is positively related to customer relationship.

H2d. OS is positively related to customer relationship.

H2e. RS is positively related to customer relationship.

H2f. PS is positively related to customer relationship.

H2g. MR is positively related to customer relationship.

H2h. PL is positively related to customer relationship.

H2i. RD is positively related to customer relationship.

The reputation is hard earned and easily lost key element in the manufacturing business. Good reputation fascinates new customer and improves relation with existing customers (Lee and Roh, 2012). The systematic effort from the beginning is required to make good reputation in the market. The hypotheses related to reputation are given below:

H3a. ROM is positively related to reputation.

H3b. TS is positively related to reputation.

H3c. ES is positively related to reputation.

H3d. OS is positively related to reputation.

H3e. RS is positively related to reputation.

H3f. PS is positively related to reputation.

H3g. MR is positively related to reputation.

H3h. PL is positively related to reputation.

H3i. RD is positively related to reputation.

The profit i.e. financial performance is essential output which is required for smooth running of the manufacturing organization. The incentives and relaxations given to employees depend on the financial outcome of the manufacturing organization. Quality and flexibility have significant impact on financial performance (Kazan *et al.*, 2006). The hypotheses related to profit are given below:

H4a. ROM is positively related to profit.

H4b. TS is positively related to profit.

H4c. ES is positively related to profit.

H4d. OS is positively related to profit.

H4e. RS is positively related to profit.

H4f. PS is positively related to profit.

H4g. MR is positively related to profit.

H4h. PL is positively related to profit.

H4i. RD is positively related to profit.

3. Research methodology

The aim of the present methodology is to measure the normality, unidimensionality, reliability, and testing of hypotheses. The SPSS software package and AMOS 21 was used to perform exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), respectively. The four outputs have been considered, thus four different models have been developed and analyzed separately through factor analysis. The first-order CFA models were analyzed to verify the construct validity and second-order CFA models have been developed to test the hypotheses. Second-order CFA Model 1 was developed to test the hypotheses related to final product. Similarly, second-order CFA Model 2, second-order CFA Model 3, and second-order CFA Model 4 were developed to test the hypotheses related to customer relationship, reputation, and profit, respectively.

3.1 EFA

Step 1: data collection. A pilot survey study was performed with the help of researcher and industrial profession to evaluate the survey questionnaire on its wording, clarity, and relevance. The importance of 36 observed variables on outputs was measured by using a five-point Likert scale, ranging from extremely important $=1$ to extremely unimportant $=5$. The unit of analysis for this study is manufacturing managers. The modified version of the questionnaire was sent to 1,025 peoples working at the managerial level in manufacturing firms of Northern India selected randomly from Directorate of Industries and membership of the Confederation of Indian Industry. Most of the information, however, has been collected by making individual visits to the organizations. After the gentle follow-up, a total of 274 responses were received. The surveys having missing values were eliminated and, finally, the survey involved a total of 252 (response rate of 24.6 percent) valid questionnaires, all from companies located in northern region of India. The breakdown of responses is presented in Table II.

Step 2: testing of normality. The skewness and kurtosis values of collected data have been calculated to examine the distribution of data. The maximum and minimum values of skewness and kurtosis were fallen in the range of acceptable (univariate skewness <2, kurtosis <7) as directed by Curran *et al.* (1996).

Step 3: testing for unidimensionality. In EFA, the principal component method cum varimax rotation was used for extraction the factors. The weak observed variables having factor loading less than 0.55 on their latent variable or cross-loading higher than 0.4 on more than one latent factor were dropped from further data analysis (Hair *et al.*, 2010). The seven observed variables, namely SF006, SF015, SF018, SF023, SF026, SF029, and SF035 were dropped from Model 1 due to weak loading variables. The result of EFA for Model 1 is shown in Table III. Similarly, EFA was applied on rest of three models. The eight observed variables,

Types of manufacturing unit	No. of manufacturing unit	No. of respondents
Small scale	76	172 (68%)
Medium scale	54	80 (32%)

Table II. Responses breakdown

	ROM	ES	RS	OS	RD	TS	PL	PS	MR
SF001	0.833								
SF002	0.769								
SF003	0.843								
SF004	0.791								
SF005						0.731			
SF006			0.417			0.565			
SF007						0.732			
SF008						0.712			
SF009		0.810							
SF010		0.806							
SF011		0.783							
SF012		0.732							
SF013				0.921					
SF014				0.818					
SF015				0.496					
SF016				0.922					
SF017			0.659						
SF018			0.575				0.412		
SF019			0.854						
SF020			0.839						
SF021								0.724	
SF022								0.730	
SF023		0.372						0.343	
SF024								0.670	
SF025									0.800
SF026									0.532
SF027									0.664
SF028									0.813
SF029	0.417						0.556		
SF030							0.796		
SF031							0.752		
SF032							0.693		
SF033					0.829				
SF034					0.784				
SF035					0.524				
SF036					0.620				

Notes: Factor analysis: principal component method; rotation method: varimax; KMO value =0.777; percentage of non-redundant residuals = 13 percent; rotation converged in 7 iterations

Table III.
Result of exploratory factor analysis

namely SF003, SF008, SF012, SF015, SF018, SF022, SF027, and SF036 from Model 2, seven observed variables, namely SF001, SF012, SF016, SF020, SF024, SF027, and SF034 from Model 3, and six observed variables, namely SF005, SF013, SF017, SF027, SF032, and SF033 form Model 4 dropped due to weak loading variables.

3.2 CFA for first-order constructs

Step 1: testing for internal reliability. Cronbach's α is the most popular technique used to test the internal reliability of multiple-indicator constructs (Hair *et al.*, 2010; Bryman and Bell, 2007). The reliability value of 0.7 or higher is an acceptable value for survey research (Nunnally, 1978). The values of Cronbach's α of all latent construct are fall in an acceptable range as shown in Table IV.

Step 2: testing for construct validity and reliability. The first-order CFA models were analyzed to test construct validity. The both convergent and discriminant validity

	CR	AVE	MSV	ASV	Cronbach's α
First-order CFA Model 1					
ROM	0.849	0.584	0.171	0.053	0.846
TS	0.757	0.511	0.312	0.117	0.757
ES	0.831	0.553	0.201	0.078	0.829
OS	0.746	0.506	0.046	0.011	0.784
RS	0.890	0.736	0.128	0.043	0.874
PS	0.822	0.618	0.312	0.127	0.777
MR	0.927	0.814	0.125	0.052	0.711
PL	0.834	0.628	0.136	0.041	0.714
RD	0.875	0.705	0.160	0.093	0.887
First-order CFA Model 2					
ROM	0.916	0.789	0.182	0.042	0.937
TS	0.850	0.654	0.097	0.022	0.846
ES	0.760	0.522	0.248	0.071	0.737
OS	0.875	0.700	0.341	0.129	0.887
RS	0.912	0.776	0.192	0.035	0.815
PS	0.771	0.529	0.207	0.071	0.718
MR	0.766	0.522	0.341	0.120	0.794
PL	0.857	0.624	0.192	0.033	0.856
RD	0.858	0.675	0.098	0.062	0.909
First-order CFA Model 3					
ROM	0.791	0.563	0.191	0.059	0.767
TS	0.810	0.516	0.304	0.108	0.809
ES	0.822	0.606	0.081	0.021	0.832
OS	0.877	0.705	0.304	0.127	0.892
RS	0.882	0.720	0.093	0.062	0.926
PS	0.894	0.748	0.181	0.028	0.836
MR	0.940	0.842	0.213	0.055	0.938
PL	0.831	0.552	0.223	0.073	0.829
RD	0.953	0.872	0.181	0.034	0.764
First-order CFA Model 4					
ROM	0.855	0.596	0.213	0.100	0.853
TS	0.820	0.607	0.241	0.148	0.819
ES	0.818	0.531	0.142	0.080	0.816
OS	0.777	0.538	0.251	0.163	0.802
RS	0.939	0.840	0.212	0.087	0.792
PS	0.833	0.556	0.251	0.099	0.833
MR	0.759	0.517	0.061	0.023	0.759
PL	0.827	0.620	0.226	0.069	0.788
RD	0.753	0.508	0.191	0.084	0.763

Table IV. Convergent validity of first-order constructs

were checked to ensure construct validity. Hair *et al.* (2010) and Götz *et al.* (2010) suggested the acceptable range of composite reliability (CR) > 0.7 for reliability and average variance extracted (AVE) > 0.5 for convergent validity. The threshold value for discriminant validity is AVE > maximum shared variance (MSV); AVE > average shared variance (ASV) and the square root of AVE must be greater than bivariate correlation with the other constructs. The results indicate that the value of CR is greater than 0.7 as recommended. The result show the good level of validity as the values of AVE fall above 0.5 and also AVE is greater than both MSV and ASV. The values of AVE, ASV, CR, and MSV are shown in Table IV. The results of discriminant validity show that square root of AVE is greater than bivariate correlation with the other constructs as presented in Table V. The results ensure that there is no validity concern in the present work.

Step 3: goodness of fit for the first-order construct. Lee *et al.* (2010) and Koufteros and Marcoulides (2006) suggested the acceptance range of statics variables such as relative χ^2 (χ^2 value (CMIN)/degree of freedom (df)) < 2; comparative fit index (CFI) $\geqslant 0.90$; root mean square error of approximation (RMSEA) $\leqslant 0.10$; and root mean residual (RMR) $\leqslant 0.05$. It was suggested to follow above-mentioned range for an acceptable fit statics model. The values of CMIN, df, CFI, RMR, and RMSEA have been calculated for first-order CFA Model 1,

Table V. Discriminant validity of first-order CFA models

	ROM	TS	ES	OS	RS	PS	MR	PL	RD
First-order CFA Model 1									
ROM	*0.764*								
TS	0.414	*0.715*							
ES	0.203	0.427	*0.743*						
OS	0.003	0.111	0.025	*0.711*					
RS	0.112	0.262	0.157	0.068	*0.858*				
PS	0.342	0.559	0.448	0.105	0.229	*0.786*			
MR	0.180	0.195	0.246	0.027	0.228	0.354	*0.902*		
PL	0.101	0.232	0.200	0.105	−0.027	0.204	0.202	*0.768*	
RD	0.202	0.308	0.272	0.214	0.358	0.400	0.259	0.376	*0.840*
First-order CFA Model 2									
ROM	*0.888*								
TS	0.005	*0.809*							
ES	0.143	0.066	*0.722*						
OS	0.427	0.006	0.467	*0.837*					
RS	0.118	0.071	0.072	0.040	*0.881*				
PS	0.245	0.163	0.182	0.455	0.058	*0.727*			
MR	0.153	0.172	0.498	0.584	0.195	0.400	*0.722*		
PL	0.014	0.117	0.001	0.015	0.438	0.030	0.145	*0.790*	
RD	0.199	0.311	0.200	0.282	0.155	0.282	0.313	0.189	*0.822*
First-order CFA Model 3									
ROM	*0.750*								
TS	0.437	*0.719*							
ES	0.058	0.207	*0.778*						
OS	0.421	0.551	0.009	*0.840*					
RS	0.193	0.296	0.285	0.305	*0.848*				
PS	0.003	0.123	0.073	0.054	0.137	*0.865*			
MR	0.179	0.168	0.035	0.462	0.280	0.040	*0.918*		
PL	0.169	0.401	0.153	0.472	0.279	0.023	0.259	*0.743*	
RD	0.041	0.185	0.089	0.042	0.142	0.426	0.146	0.052	*0.934*
First-order CFA Model 4									
ROM	*0.772*								
TS	0.369	*0.779*							
ES	0.237	0.377	*0.729*						
OS	0.398	0.491	0.376	*0.734*					
RS	0.241	0.460	0.275	0.428	*0.916*				
PS	0.462	0.261	0.345	0.501	0.118	*0.746*			
MR	0.134	0.246	0.034	0.159	0.080	0.164	*0.719*		
PL	0.247	0.475	0.208	0.336	0.243	0.022	0.173	*0.788*	
RD	0.308	0.316	0.249	0.437	0.301	0.310	0.135	0.139	*0.713*

Notes: Off diagonals are bivariate correlations; italic main diagonals are square root of corresponding AVE first-order CFA Model 2, first-order CFA Model 3, and first-order CFA Model 4. The results showed that values of the goodness of fit for first-order constructs are falling in the acceptable range as presented in Table VI.

3.3 CFA for second-order constructs

Step 1: goodness of fit for the second-order construct. The values of CMIN, df, CFI, RMR, and RMSEA have been calculated for second-order CFA models and the result showed that all values are falling in the acceptable range as shown in Table VI.

Step 2: testing of hypotheses. The second-order CFA models have been analyzed to test all the hypotheses developed in the present study. The results of second-order CFA Model 1 showed that eight hypotheses, namely *H1a*, *H1b*, *H1c*, *H1d*, *H1e*, *H1f*, *H1h*, and *H1i* are supported and *H1g* is not supported in the present work. The results of second-order CFA Model 2 showed that seven hypotheses, namely *H2a*, *H2c*, *H2d*, *H2e*, *H2f*, *H2g*, and *H2i* are supported and *H2b* and *H2h* are not supported in the present work. The results of second-order CFA Model 3 showed that seven hypotheses, namely *H3a*, *H3b*, *H3d*, *H3e*, *H3g*, *H3h*, and *H3i* are supported and *H3c* and *H3f* are not supported in the present work. The results of second-order CFA Model 4 showed that all nine hypotheses, namely *H4a*, *H4b*, *H4c*, *H4d*, *H4e*, *H4f*, *H4g*, *H4h*, and *H4i* are supported in the present work. The values of path coefficient are summarized in Table VII and path diagram results of second-order CFA models are shown in Figures 3-6.

3.4 Results and discussions

This study investigates the associations between success factors and multiple outputs of the manufacturing system. The analysis of Model 1 showed that MR is not significantly related to final product. But the researchers have provided evidence that MR has strong impact on the performance of the business organization (Ayuba and Kazeem, 2015; Adewale *et al.*, 2013). Our finding is not inconsistent with published result as MR may have mediating effect through any other output on performance. The analysis of Model 2, Model 3, and Model 4 showed that MR is directly related to customer relationship, profit, and reputation of the manufacturing organization. This finding is consistent with the literature (Hart and Diamantopoulos, 1993; Adewale *et al.*, 2013).

The result showed that the customer relationship explains about 66 percent of the variance in OS and 53 percent of the variance in MR. The analysis of Model 2 showed that TS and PL are not directly related to customer relationship. The somewhat similar statement was made by Nilsson *et al.* (2001) that in manufacturing organizations, process orientation has no direct effect on customer satisfaction but it has mediated effect through a firm's customer orientation on customer satisfaction.

	χ^2	df	CMIN/DF	CFI	RMR	RMSEA	GFI
CFA first-order constructs							
First-order CFA Model 1	608.374	341	1.784	0.936	0.028	0.056	0.858
First-order CFA Model 2	581.226	314	1.851	0.938	0.026	0.058	0.854
First-order CFA Model 3	538.091	341	1.578	0.961	0.027	0.048	0.873
First-order CFA Model 4	671.151	369	1.819	0.923	0.30	0.057	0.857
CFA second-order constructs							
Second-order CFA Model 1	665.477	368	1.808	0.928	0.340	0.570	0.847
Second-order CFA Model 2	699.856	341	2.052	0.917	0.400	0.650	0.830
Second-order CFA Model 3	647.002	368	1.758	0.945	0.042	0.055	0.849
Second-order CFA Model 4	739.632	396	1.868	0.912	0.036	0.059	0.845

Table VI. Goodness of fit for first-order and second-order constructs

Success factors	Regression weights	Standardized regression weights	SE	CR	*p*-value
Second-order CFA Model 1 (success factors – final product)					
ROM	1.000	0.436			
TS	1.355	0.697	0.281	4.823	***
ES	0.984	0.559	0.216	4.557	***
OS	1.411	0.449	0.32	4.416	***
RS	0.838	0.360	0.218	3.845	***
PS	1.026	0.771	0.218	4.710	***
MR	0.190	0.130	0.124	1.534	0.125
PL	0.392	0.327	0.125	3.134	0.002**
RD	0.770	0.551	0.172	4.468	***
Second-order CFA Model 2 (success factors – customer relationship)					
ROM	1.000	0.413			
TS	0.160	0.117	0.110	1.454	0.146
ES	0.909	0.548	0.197	4.617	***
OS	1.382	0.810	0.260	5.306	***
RS	0.241	0.166	0.115	2.103	0.035*
PS	0.553	0.540	0.126	4.390	***
MR	0.988	0.730	0.202	4.951	***
PL	0.182	0.104	0.131	1.395	0.163
RD	0.692	0.417	0.163	4.243	***
Second-order CFA Model 3 (success factors – reputation)					
ROM	1.000	0.484			
TS	1.510	0.676	0.315	4.788	***
ES	0.288	0.140	0.172	1.680	0.093
OS	2.254	0.819	0.444	5.073	***
RS	1.294	0.441	0.303	4.267	***
PS	0.371	0.122	0.230	1.614	0.107
MR	1.760	0.479	0.393	4.482	***
PL	1.166	0.560	0.260	4.493	***
RD	0.341	0.162	0.165	2.065	0.039*
Second-order CFA Model 4 (success factors – profit)					
ROM	1	0.550			
TS	0.984	0.712	0.165	5.962	***
ES	0.680	0.506	0.135	5.030	***
OS	0.911	0.770	0.154	5.929	***
RS	1.338	0.534	0.235	5.699	***
PS	0.719	0.511	0.141	5.103	***
MR	0.231	0.246	0.082	2.806	0.005**
PL	0.814	0.464	0.171	4.767	***
RD	0.571	0.521	0.121	4.729	***

Notes: *,**,***Significance at $p < 0.05$, $p < 0.01$, and $p < 0.001$ respectively

Table VII.
Results of second-order CFA

The result of Model 3 showed that the reputation explains about 67 percent of the variance in OS and 46 percent of the variance in TS. The analysis part showed that ES and PS are not directly associated with the reputation of the company. The training of employee has direct impact on the quality of final product (Dubey and Gunasekaran, 2014) and customer satisfaction (Sadikoglu and Olcay, 2014). The training of employee may have a mediating effect of final product/customer satisfaction on the reputation of the manufacturing organization. The result of Model 4 showed that all success factors are positively significant with respect to the profit of the manufacturing organization. The OS and TS have higher path coefficient with respect to profit. The result showed

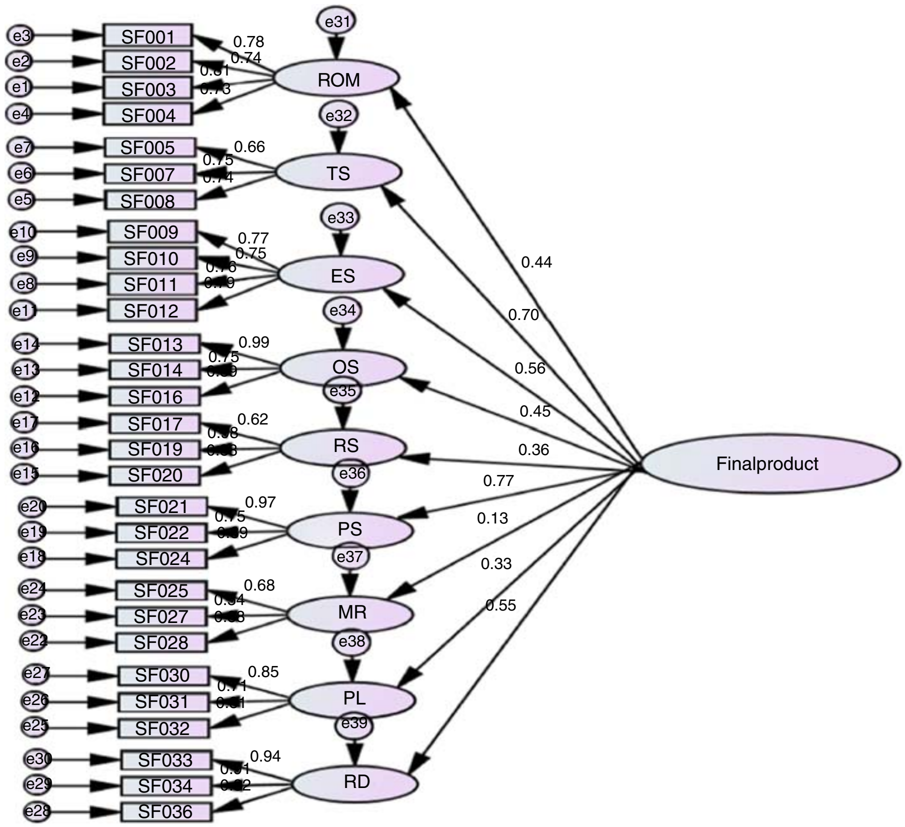

Figure 3.
Result of second-order
CFA Model 1

that the profit explains about 59 percent of the variance in OS and 51 percent of the variance in TS.

The results of the present study provide significant research gap in order to examine the mediating effect of success factors on multiple outputs of manufacturing. The rejected hypotheses provide a new insight into the development of a new path model in which success factor could be examined by developing various mediating linkage between success factor and outputs of the manufacturing system. The mediating effect of TS between the PS and reputation could be explored for establishing new evident.

4. Conclusions

The systematic literature review provides the list of success factors that are important for improving the outputs of the manufacturing system. The present research work highlights the role of success factors in improving the multiple outputs of manufacturing organizations. The analysis of research models confirms the significance of success factors as every success factor is positively related to at least one output dimension of the manufacturing system. Furthermore, the present study suggests that four success factors, namely ROM, RD, RS, and OS must be taken into account to enhance multiple outputs of the manufacturing organization. The notable finding is that TS has higher path coefficient in final product, reputation, and profit, but at the same time, it is not positively related to the customer relationship.

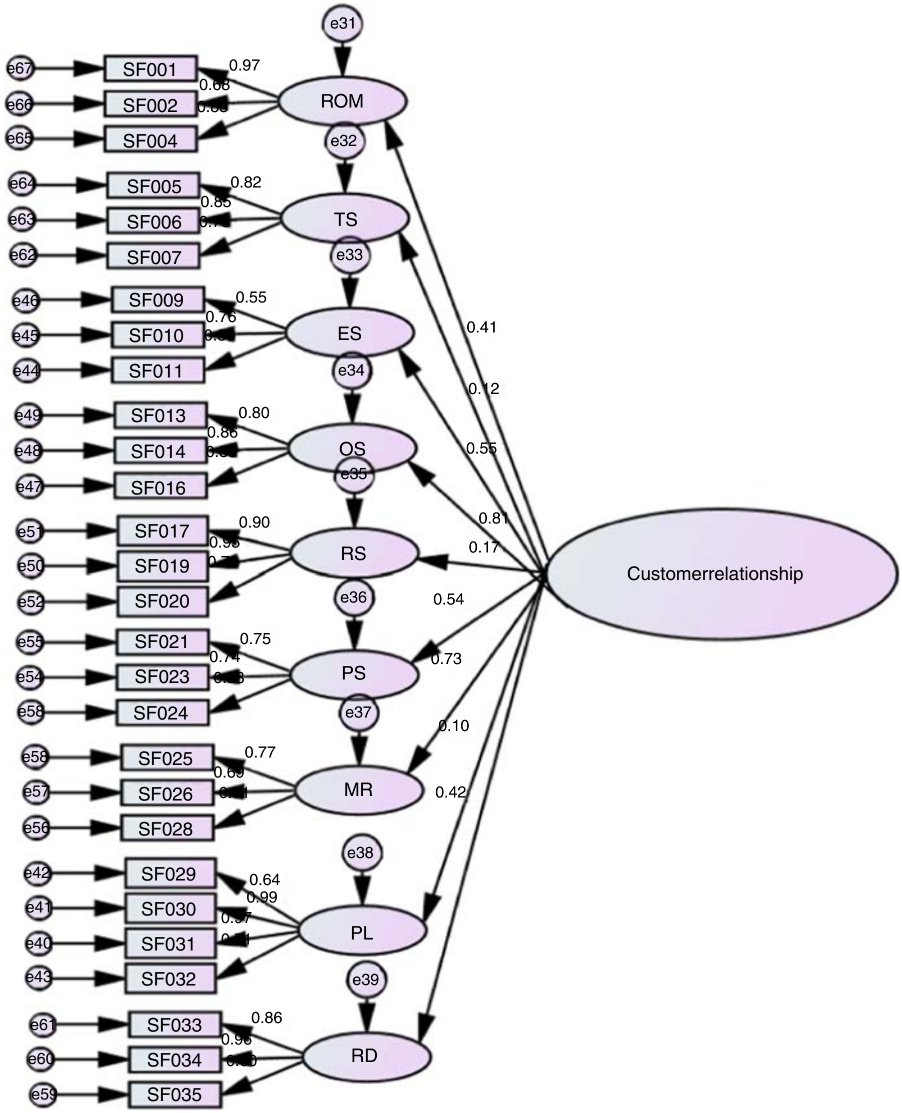

Figure 4.
Result of second-order
CFA Model 2

4.1 Managerial implications
The empirical findings of present work provide meaningful implications for researchers and practitioners as well. From theoretical perspective, the proposed research model contributed to existing research by presenting a better understanding of success factors for assessment of multiple outputs of the manufacturing system. Also, the CFA models provide some evidence for the positive relation between success factor and outputs of the manufacturing system. The present study offers clear practical implications for manufacturing practitioners who desire to improve the output dimensions of the manufacturing system. The outcome of validated models assists managers in

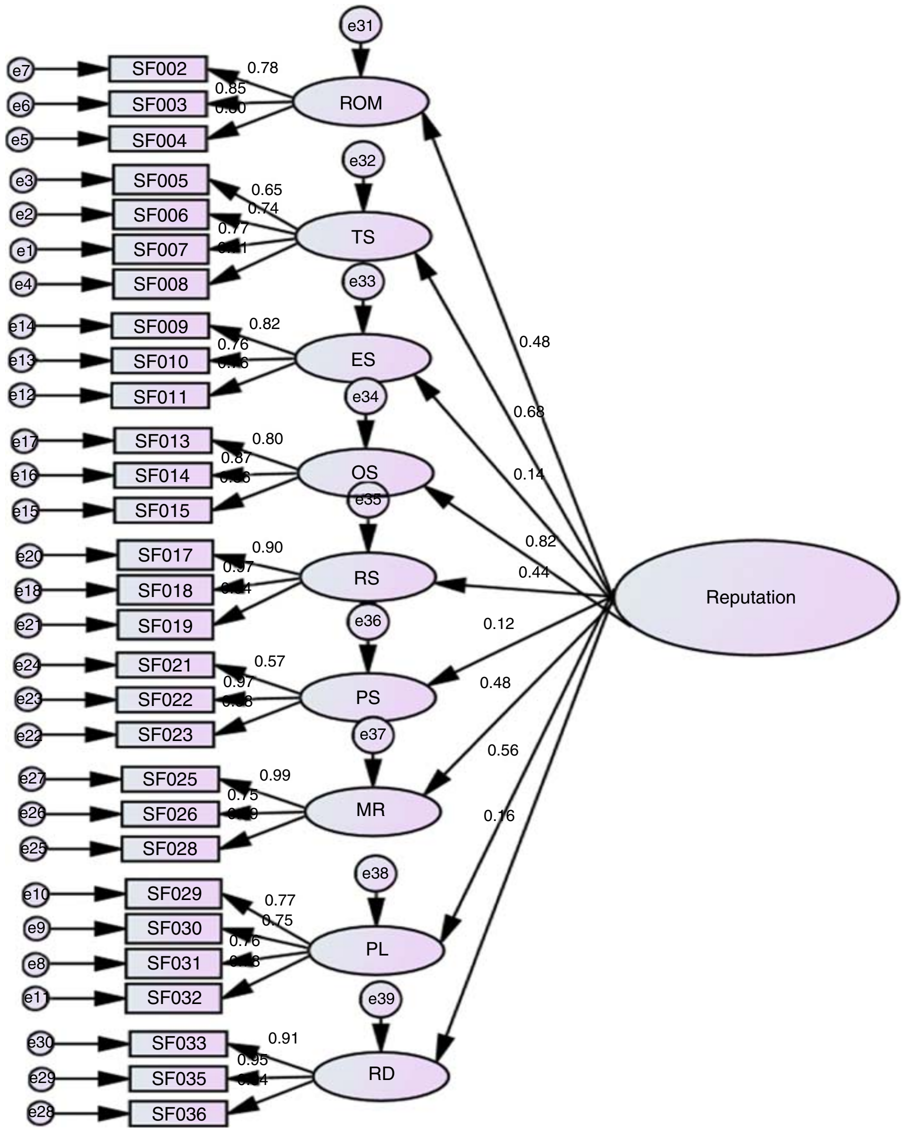

Figure 5.
Result of second-order
CFA Model 3

making decisions so that manager should focus on only those parameters that produce the significant improvement of required output and redundant practices can be abandoned.

4.2 Research limitations and future research

However, the present study has a number of limitations that provide direction for future research. The outcome of present study depends upon the sample of the respondent that is limited to the manufacturing firms. Therefore, this study could be expanded for the assessment of multiple outputs of service companies and process industry. Second, the

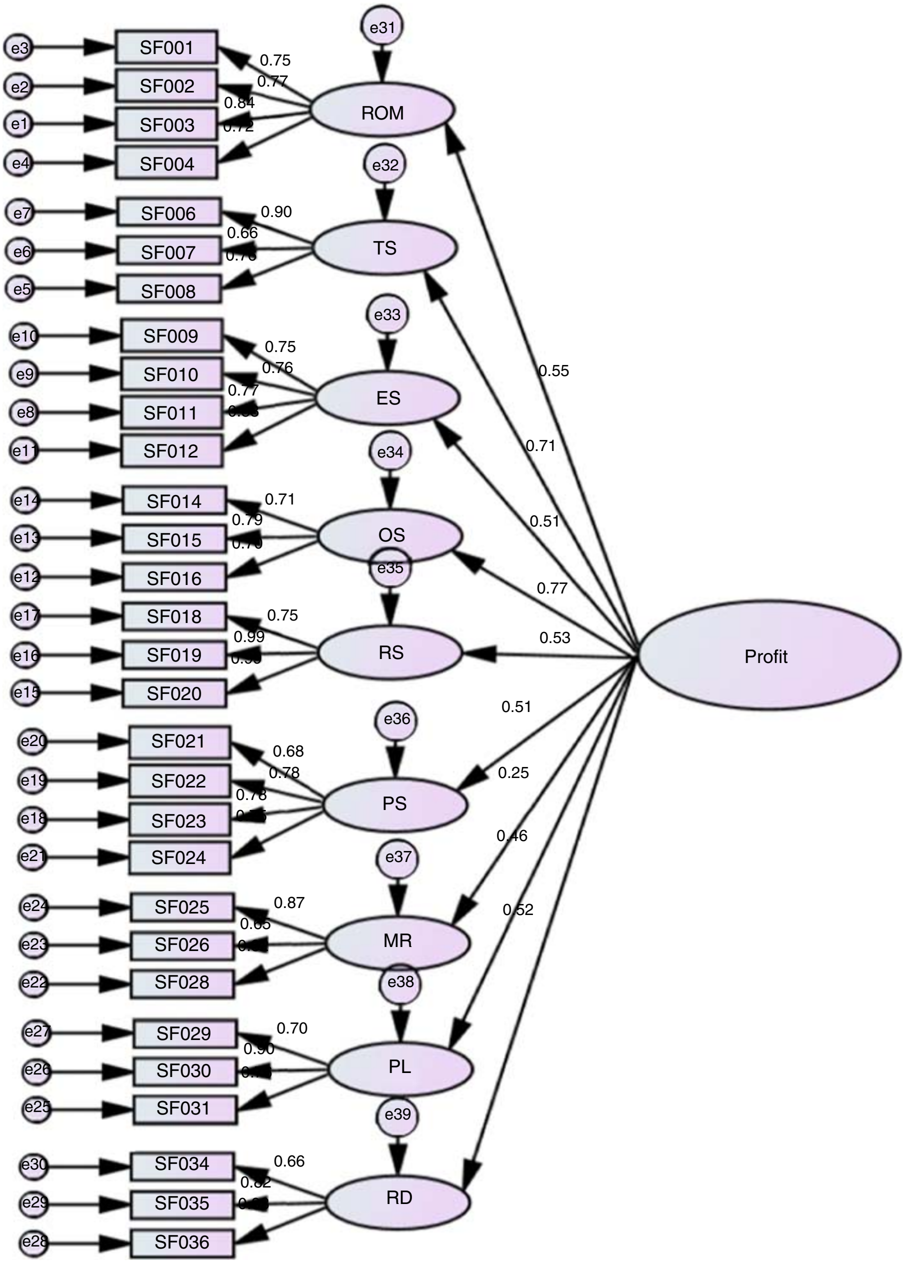

Figure 6.
Result of second-order CFA Model 4

effect of government policies and cultural issues is not considered in this research work that can be another issue for future research work. Future research could also investigate the direct and mediate impact of success factors on multiple performance dimensions of the manufacturing system.

References

Adewale, G., Adesola, M.A. and Oyewale, I.O. (2013), "Impact of marketing strategy on business performance a study of selected small and medium enterprises", *IOSR Journal of Business and Management*, Vol. 11 No. 4, pp. 59-66.

Agarwal, R., Green, R., Brown, P.J., Tan, H. and Randhawa, K. (2013), "Determinants of quality management practices: an empirical study of New Zealand manufacturing firms", *International Journal of Production Economics*, Vol. 142 No. 1, pp. 130-145.

Asrofah, T., Zailani, S. and Fernando, Y. (2010), "Best practices for the effectiveness of benchmarking in the Indonesian manufacturing companies", *Benchmarking: An International Journal*, Vol. 17 No. 1, pp. 115-143.

Ayuba, B. and Kazeem, K.O. (2015), "The role of marketing research on the performance of business organizations", *European Journal of Business and Management*, Vol. 7 No. 6, pp. 148-156.

Baykasoğlu, A. and Özbakır, L. (2008), "Analysing the effect of flexibility on manufacturing systems performance", *Journal of Manufacturing Technology Management*, Vol. 19 No. 2, pp. 172-193.

Bellgran, M. and Säfsten, K. (2004), "Production system design & evaluation for increased system robustness", *Second World Conference on POM and15th Annual POM Conference, Cancun*.

Bigliardi, B. (2013), "The effect of innovation on financial performance: a research study involving SMEs", *Innovation: Organization & Management*, Vol. 15 No. 2, pp. 245-255.

Bryman, A. and Bell, E. (2007), *Business Research Methods*, Oxford University Press, New York, NY.

Chandran, V.G.R., Rasiah, R. and Wad, P. (2009), "Malaysian manufacturing systems of innovation & internationalization of R&D", Working Paper Series Working Paper No. 11, Centre for Business & Development Studies, Frederiksberg.

Chavez, R., Yub, W., Jacobs, M.A. and Fengd, M. (2017), "Manufacturing capability and organizational performance: the role of entrepreneurial orientation", *International Journal of Production Economics*, Vol. 184, pp. 33-46.

Chen, K.S. and Huang, M.L. (2006), "Performance measurement for a manufacturing system based on quality, cost and time", *International Journal of Production Research*, Vol. 4 No. 11, pp. 2221-2243.

Chung, S.H. and Lee, D.H. (2005), "Impacts of TQM activities on employee's satisfaction in the support of task process, and on business performance in medical service industry", *The Korea Service Management Society*, Vol. 6 No. 1, pp. 57-85.

Colledani, M., Tolio, T., Fischer, A., Lung, B., Lanza, G., Schmitt, R. and Váncza, J. (2014), "Design and management of manufacturing systems for production quality", *CIRP Annals – Manufacturing Technology*, Vol. 63 No. 2, pp. 773-796.

Curran, P.J., West, S.G. and Finch, G.F. (1996), "The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis", *Psychological Methods*, Vol. 1 No. 1, pp. 16-29.

De Weck, O., Reed, D., Sarma, S. and Schmidt, M. (2014), "Trends in advanced manufacturing technology innovation", in Locke, R.M. and Wellhausen, R. (Eds), *Production in the Innovation Economy*, MIT Press, Cambridge, p. 235, available at: www.wilsoncenter.org/../Emerging_Global_Trends_in_Advanced_Manufacturing.pdf

Dubey, R. and Gunasekaran, A. (2014), "Exploring soft TQM dimensions and their impact on firm performance: some exploratory empirical results", *International Journal of Production Research*, Vol. 53 No. 2, pp. 371-382.

Dubey, R., Singh, T., Ali, S.S., Venkatesh, V.G. and Gupta, O.K. (2014), "Exploring dimensions of firm competencies and their impact on performance: some exploratory empirical results", *Benchmarking: An International Journal*, Vol. 21 No. 6, pp. 1003-1022.

Efthymiou, K., Pagoropoulos, A., Papakostas, N., Mourtzis, D. and Chryssolouris, G. (2012), "Manufacturing systems complexity review: challenges & outlook", *Procedia CIRP*, Vol. 3, pp. 644-649.

Efthymiou, K., Pagoropoulos, A., Papakostas, N., Mourtzis, D. and Chryssolouris, G. (2014), "Manufacturing Systems Complexity an assessment of manufacturing performance indicators unpredictability", *CIRP Journal for Manufacturing Science & Technology*, Vol. 7 No. 4, pp. 324-334.

Ehie, I. and Muogboh, O. (2016), "Analysis of manufacturing strategy in developing countries: a sample survey of Nigerian manufacturers", *Journal of Manufacturing Technology Management*, Vol. 27 No. 2, pp. 234-260.

Endrass, F. (2013), "Performance measurement using shop floor data", master thesis, KTH Industrial Engineering and Management, p. 81, available at: www.diva portal.org/smash/get/diva2:666022/FULLTEXT01.pdf

Eswaramurthi, K.G. and Mohanram, P.V. (2013), "Improvement of manufacturing performance measurement system and evaluation of overall resource effectiveness", *American Journal of Applied Sciences*, Vol. 10 No. 2, pp. 131-138.

Gomes, C.F., Yasin, M.M. and Lisboa, J.V. (2006), "Key performance factors of manufacturing effective performance: the impact of customers and employees", *The TQM Magazine*, Vol. 18 No. 4, pp. 323-340.

Gomes, C.F., Yasin, M.M. and Lisboa, J.V. (2007), "An assessment of the key success factors of manufacturing performance from the perspective of external decision-makers", *International Journal of Business & Systems Research*, Vol. 1 No. 2, pp. 148-161.

Gómez-Cedeño, M., Castán-Farrero, J.M., Guitart-Tarrés, L. and Matute-Vallejo, J. (2015), "Impact of human resources on supply chain management & performance", *Industrial Management & Data Systems*, Vol. 115 No. 1, pp. 129-157.

Götz, O., Liehr-Gobbers, K. and Krafft, M. (2010), "Evaluation of structural equation models using the partial least squares (PLS) approach. ", in Esposito, V., Chin, W.W., Henseler, J. and Wang, H. (Eds), *Handbook of Partial Least Squares: Concepts, Methods and Applications*, Springer, Berlin, pp. 691-711.

Groover, M.P. (2010), *Fundamentals of Modern Manufacturing: Materials, Processes, & Systems* 4th ed., John Wiley & Sons, NJ.

Hair, J.F., William, C. Black, Barry, J.B. and Rolph, E.A. (2010), *Multivariate Data Analysis. A Global Perspective*, 7th ed., Pearson Education, Inc., NJ.

Hansen, G.S. and Wernerfelt, B. (1989), "Determinants of firm performance: the relative importance of organizational and economic factors", *Strategic Management Journal*, Vol. 10 No. 5, pp. 399-411.

Hart, S. and Diamantopoulos, A. (1993), "Marketing research activity and company performance: evidence from manufacturing industry", *European Journal of Marketing*, Vol. 27 No. 5, pp. 54-72.

Helgesen, Ø. (2006), "Are loyal customers profitable? Customer satisfaction, customer (action) loyalty and customer profitability at the individual level", *Journal of Marketing Management*, Vol. 22 Nos 3/4, pp. 245-266.

Huo, B., Gu, M. and Prajogo, D. (2016), "Flow management and its impacts on operational performance", *Production Planning & Control*, Vol. 27 No. 15, pp. 1233-1248.

Jia, G.Z. and Bai, M. (2011), "An approach for manufacturing strategy development based on fuzzy-QFD", *Computers & Industrial Engineering*, Vol. 60 No. 3, pp. 445-454.

Jonsson, P. and Mattsson, S. (2008), "Inventory management practices and their impact on planning performance", *International Journal of Production Research*, Vol. 46 No. 7, pp. 1787-1812.

Kafetzopoulos, D. and Psomas, E. (2015), "The impact of innovation capability on the performance of manufacturing companies: the Greek case", *Journal of Manufacturing Technology Management*, Vol. 26 No. 1, pp. 104-130.

Kafetzopoulos, D.P., Psomas, E.L., Katerina, D. and Gotzamani, K.D. (2015), "The impact of quality management systems on the performance of manufacturing firms", *International Journal of Quality & Reliability Management*, Vol. 32 No. 4, pp. 381-399.

Karabulut, A.T. (2015), "Effects of innovation types on performance of manufacturing firms in Turkey", *Procedia – Social and Behavioral Sciences*, Vol. 195 No. 3, pp. 1355-1364.

Karaesmen, F., Liberopoulos, G. and Dallery, Y. (2004), “The value of advance demand information in production/inventory systems”, *Annals of Operation Research*, Vol. 126 No. 1, pp. 135-157.

Karatop, B., Kubat, C. and Uygun, O. (2015), “Talent management in manufacturing system using fuzzy logic approach”, *Computers & Industrial Engineering*, Vol. 86, pp. 127-136.

Karim, M.A., Smith, A.J.R. and Halgamuge, S. (2008), “Empirical relationships between some manufacturing practices & performance”, *International Journal of Production Research*, Vol. 46 No. 13, pp. 3583-3613.

Kaur, S.P., Kumar, J. and Kumar, R. (2017), “The relationship between flexibility of manufacturing system components, competitiveness of SMEs and business performance: a study of manufacturing SMEs in Northern India”, *Global Journal of Flexible Systems Management*, Vol. 18 No. 2, pp. 123-137.

Kazan, H., Özer, G. and Çetin, A.T. (2006), “The effect of manufacturing strategies on financial performance”, *Measuring Business Excellence*, Vol. 10 No. 1, pp. 14-26.

Koc, T. and Bozdag, E. (2009), “The impact of AMT practices on firm performance in manufacturing SMEs”, *Robotics & Computer-Integrated Manufacturing*, Vol. 25 No. 2, pp. 303-313.

Koufteros, X.A. and Marcoulides, G.A. (2006), “Product development practices and performance: a structural equation modeling-based multi-group analysis”, *International Journal of Production Economics*, Vol. 103 No. 1, pp. 286-307.

Lasrado, F., Gomiseck, B. and Uzbeck, C. (2017), “Effectiveness of employee suggestion schemes-from critical success factors to outcomes”, *International Journal of Quality and Service Sciences*, Vol. 9 No. 1, pp. 120-136.

Lee, D., Lee, S.M., Olson, D.L. and Chung, S.H. (2010), “The effect of organizational support on ERP implementation”, *Industrial Management & Data Systems*, Vol. 110 No. 2, pp. 269-283.

Lee, D.H., Rho, B.H. and Yoon, S.N. (2015), “Effect of investments in manufacturing practices on process efficiency and organizational performance”, *International Journal of Production Economics*, Vol. 162, pp. 45-54.

Lee, J. and Roh, J.J. (2012), “Revisiting corporate reputation and firm performance link”, *Benchmarking: An International Journal*, Vol. 19 Nos 4/5, pp. 649-664.

Lee, W., Rhee, S.K. and Oh, J. (2014), “The relationships between manufacturing strategy process, manufacturing-marketing integration, and plant performance: an empirical study of Korean manufacturers”, *Operations Management Research*, Vol. 7 No. 3, pp. 117-133.

Lee, Y.H., Jeong, C.S. and Moon, C. (2002), “Advanced planning & scheduling with outsourcing in manufacturing supply chain”, *Computers & Industrial Engineering*, Vol. 43 Nos 1/2, pp. 351-374.

Leung, S.H.N., Chan, J.W.K. and Lee, W.B. (2003), “Team leaders, manufacturing strategies and competitive performances”, *Team Performance Management: An International Journal*, Vol. 9 Nos 7/8, pp. 190-198.

Li, L., Liu, F. and Li, C. (2014), “Customer satisfaction evaluation method for customized product development using entropy weight & analytic hierarchy process”, *Computers & Industrial Engineering*, Vol. 77, pp. 80-87.

Lloréns, F.J., Molina, L.M. and Verdú, A.J. (2005), “Flexibility of manufacturing systems, strategic change & performance”, *International Journal of Production Economics*, Vol. 98 No. 3, pp. 273-289.

Lun, Y.H.V., Shang, K.C., Lai, K.H. and Cheng, T.C.E. (2016), “Examining the influence of organizational capability in innovative business operations and the mediation of profitability on customer satisfaction: an application in intermodal transport operators in Taiwan”, *International Journal of Production Economics*, Vol. 171 No. 2, pp. 179-188.

Lyons, P. (2005), “A robust approach to employee skill & knowledge development”, *Industrial & Commercial Training*, Vol. 37 No. 1, pp. 3-9.

Malerba, F. (2002), “Sectoral systems of innovation and production”, *Innovation Systems*, Vol. 31 No. 2, pp. 247-264.

Mandal, P. and Bagchi, K. (2016), "Strategic role of information, knowledge and technology in manufacturing industry performance", *Industrial Management & Data Systems*, Vol. 116 No. 6, pp. 1259-1278.

Nadeem, M., Gan, C. and Nguyen, C. (2017), "Does intellectual capital efficiency improve firm performance in BRICS economies? A dynamic panel estimation", *Measuring Business Excellence*, Vol. 21 No. 1, pp. 65-85.

Nayak, N.C. and Ray, P.K. (2013), "An improved methodology for flexibility design in production system of manufacturing firms", *International Refereed Journal of Engineering & Science*, Vol. 2 No. 12, pp. 29-38.

Nilsson, L., Johnson, M.D. and Gustafsson, A. (2001), "The impact of quality practices on customer satisfaction and business results: product versus service organizations", *Journal of Quality Management*, Vol. 6 No. 2, pp. 5-27.

Nunnally, J.C. (1978), "Assessment of reliability", *Psychometric Theory*, 2nd ed., McGraw-Hill, New York, NY, p. 701.

Obi, S.C. (2013), *Introduction to Manufacturing Systems*, Author House, Bloomington, IN.

Ostwald, P.F. and Munoz, J. (2008), *Manufacturing Processes & Systems*, 9th ed., John Wiley & Sons, NJ.

Ploegmakers, E., Lefeber, J.E. and Rooda, S.E. (2007), "Feedback control for a multi-product flow line", Working Paper No. 2007-01, Eindhoven University of Technology, Eindhoven.

Procter, S.J. and Randall, J.A. (2015), "Understanding employee attitudes to change in longitudinal perspective: a study in UK public services 1996-2007", *Qualitative Research in Organizations and Management: An International Journal*, Vol. 10 No. 1, pp. 38-60.

Rad, M.H., Sajadi, S.M. and Tavakoli, M.M. (2014), "The efficiency analysis of a manufacturing system by TOPSIS technique & simulation", *International Journal of Industrial & Systems Engineering*, Vol. 18 No. 2, pp. 222-236.

Realyvásquez, A., Maldonado-Macías, A.A., García-Alcaraz, J.L. and Blanco-Fernández, J. (2015), "Effects of organizational macroergonomic compatibility elements over manufacturing systems' performance", *Procedia Manufacturing*, Vol. 3, pp. 5715-5722.

Sadeghi, G., Arabsalehi, M. and Hamavandi, M. (2016), "Impact of corporate social performance on financial performance of manufacturing companies (IMC) listed on the Tehran stock exchange", *International Journal of Law and Management*, Vol. 58 No. 6, pp. 634-659.

Sadikoglu, E. and Olcay, H. (2014), "The effects of total quality management practices on performance and the reasons of and the Barriers to TQM practices in Turkey", *Advances in Decision Sciences*, Vol. 23, pp. 1-17.

Sarfaraz, A., Jenab, K. and Bowker, A. (2015), "A view of development in management for increasing profitability in the corporate landscape", *Benchmarking: An International Journal*, Vol. 22 No. 1, pp. 120-134.

Satish, K.P. and Srinivasan, R. (2010), "Total quality management and its impact on innovation performance: a study with respect to large and medium manufacturing organisations in India", *International Journal of Electronic Customer Relationship Management*, Vol. 4 No. 1, pp. 19-32.

Shields, K.E.P., Malhotra, M.K. and Grover, V. (2002), "Strategic manufacturing planning systems and their linkage to planning system success", *Decision Sciences*, Vol. 33 No. 1, pp. 1-30.

Shin, M., Mun, J. and Jung, M. (2009), "Self-evolution framework of manufacturing systems based on fractal organization", *Computers & Industrial Engineering*, Vol. 56 No. 3, pp. 1029-1039.

Singholi, A., Chhabra, D. and Ali, M. (2010), "Towards improving the performance of flexible manufacturing system: a case study", *Journal of Industrial Engineering & Management*, Vol. 3 No. 1, pp. 87-115.

Snell, D., Schmitt, D., Glavas, A. and Bamberry, L. (2015), "Worker stress and the prospect of job loss in a fragmented organisation", *Qualitative Research in Organizations and Management: An International Journal*, Vol. 10 No. 1, pp. 61-81.

Storm, P., Lager, T. and Samuelsson, P. (2013), "Managing the manufacturing-R&D interface in the process industries", *R & D Management*, Vol. 43 No. 3, pp. 252-270.

Swink, M., Narasimhan, R. and Kim, S.W. (2005), "Manufacturing practices and strategy integration: effects on cost efficiency, flexibility, and market-based performance", *Decision Sciences*, Vol. 36 No. 3, pp. 427-457.

Szymanski, D.M. and Henard, D.H. (2001), "Customer satisfaction: a meta-analysis of the empirical evidence", *Academy of Marketing Science Journal*, Vol. 29 No. 1, pp. 16-35.

Tzeng, G.H. and Huang, C.Y. (2012), "Combined DEMATEL technique with hybrid MCDM methods for creating the aspired intelligent global manufacturing & logistics systems", *Annals of Operations Research*, Vol. 197 No. 1, pp. 159-190.

Wong, M. (2007), "The role of culture in implementing lean production system", *International Federation for Information Processing*, Vol. 246, pp. 413-422.

Worldbank (2013), "Manufacturing, value added (current US$) for EU & Eurozone", (accessed February 20, 2013).

Further reading

Hettiararchchi, H.A.H and Jayarathna, S.M.D.Y. (2014), "The effect of employee work related attitudes on employee job performance: a study of tertiary & vocational education sector in Sri Lanka", *IOSR Journal of Business & Management*, Vol. 16 No. 4, pp. 74-83.

Manufacturing, value added (current US$)", available at: https://data.worldbank.org/indicator/NV.IND.MANF.CD (accessed February 20, 2013).

Yinan, Qi, Y., Zhao, X. and Sheu, C. (2011), "The impact of competitive strategy and supply chain strategy on business performance: the role of environmental uncertainty", *Decision Sciences*, Vol. 42 No. 2, pp. 371-389.

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