Investigating the effect of integrated systems on production flexibility through data mining (SaramAra Qazvin Manufacturing Industries Company)

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Abstract

Due to the high variability of the business markets, the diversity of customers in their demands, and the rapid obsolescence of products over time, manufacturers concluded that they could compete in these flexible environments with mass production systems. The approaches used to continue the profitability of companies in these conditions were generally based on the production of new products or enhancing the quality of current products. In both cases, production systems were needed that meet the varied market demands with the short product lifetimes and the uncertain demands of customers with high quality by relying on their flexibility. This study is analytical, descriptive, and applied concerning its purpose. The research method is also field and library concerning the data collection methods. In this study, the indicators were first identified with the opinion of experts, and research hypotheses were developed based on these indicators. Finally, using data mining techniques and the CRISP method, the results were analyzed with software. The results showed that the speed in transforming the production processes is effective in the system flexibility performance and system ordering level. The results showed that the capability to change the production planning is effective in the system ordering level and the technology level of the integrated system. Also, speed is effective in transforming production processes to the technology level of the integrated system.

Keywords:Integrated systems, Production flexibility, Data mining, Manufacturing industry company

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Introduction

Due to the growth of competition among today's organizations and the threats and opportunities for all organizations at different domestic and international levels, the concept of flexibility in production has become especially crucial for this type of company. Also, the problems and concerns of manufacturing companies regarding flexibility and changes in production are due to the current market conditions. However, the study requires the use of integrated systems to increase the flexibility of production to maintain its business position in the market due to the material and diversity in the products of the tile and ceramic industry, and the presence of competitors. Flexible production has a different philosophy in which the relationship between price, quantity, quality, and profit is established, which is different from past thinking. The ability to create a relative and competitive advantage in today's dynamic and changing industry environment is considered a value, and flexible manufacturing is a relatively new policy used by successful companies to develop and increase competition.

Flexible production makes it possible to produce a variety of products that are appropriate to the customer's needs. Workers respond to flexible production only when there is a sense of mutual commitment. In flexible production, resource management is such that maximum productivity can be achieved with the least use of resources. This means that the available human resources,

the space required for production, the capital spent on tools, the engineering force required creating a new product, and the time required to make a new product will reduce all of them significantly. Also, the amount of the required inventory is significantly reduced. Also, one of the primary problems of companies is the optimal use of resources. For this purpose, integrated information systems are used to manage resources. It is very crucial to use resources through integrated systems to increase production flexibility, increase efficiency, increase production speed, and reduce waste. Integrated systems are used to manage all the process affairs so they can achieve the goals of the organization and balance the goals of their stakeholders**.**

Now, the primary question of the present study is to what extent the use of integrated systems can be effective in the system production flexibility. There are various methods in the literature to investigate this issue and find the right answer to the study question. One of the most powerful of these methods is the data mining technique. The technique of data mining or extracting unknown and hidden patterns from the mass of raw data can identify the relationships between variables and different factors of a phenomenon or system and examine the effect of these factors on each other with a futuristic perspective. One of the well-developed methods for implementing data mining techniques in industrial and production units is the Cross Industry Standard Process for Data Mining or CRISP-DM method. CRISP-DM method is an abbreviation for managers' decision-making. Thus, in this study, the effect of using integrated systems on production flexibility is investigated using the CRISP-DM data mining technique**.**

Theoretical foundations of research

Integrated management system

In the mid-1960s, market competition became very intense and costs became crucial. However, quality was prioritized later. When the speed of receiving the products and services became important for customers, the market became more complex. A new strategy was set and it could improve the system based on customer needs. Companies had to adapt to the environment in all their work, to be more flexible in their actions, and to be satisfied in different parts of the labor market. Nowadays, what is crucial for manufacturers is agility. An agile manufacturer is the fastest in the labor market, does the work with the lowest cost, and has the most capability to retain its customers. Simply, FMS is a solution that enables manufacturers to achieve customer retention. In studying FMS, we need to remember why Peter Drucker stated: "We should be managers of technology, not just users of technology." Since FMS is a technology, it has been well set to environmental needs and we need to manage it successfully (Hajipour and Moradi, 2018).

Flexible production systems

In today's industrial world, production is viewed as a competitive weapon. The characteristics of production organizations are increased competitive pressures, product diversity, changes in social expectations, and increased customer expectations. The changes taking place in the field of production activities are the result of the extensive and comprehensive use of information technologies in this field. They have caused organizations and production companies to pay more attention to the issue of information and technologies related to it. This study was conducted to explain the above issue and try to depict the role and impact of information technology in the current state of production of goods. The importance of this study is because the increase in the number of production units and thus the relative realization of the competitive environment has caused the attention of producers and industrial companies to the quality of products, increasing market share, and the issue of exports. Therefore, it seems that knowing the changes taking place in the productive sectors of advanced societies can be effective in determining and better understanding the path that the country's manufacturing and industrial organizations must take to improve their competitiveness. This article will describe how recent developments in the area of information technology, especially artificial intelligence and expert systems, have transformed the production situation in industrial societies (Pourzmani and Karimi, 2019).

Research background

Rafiei et al. (2008) investigated the three-level production planning and control method in flexible workshop production systems. In the first level, using a mathematical model, the planning period is obtained and transferred to the next

level. The other two levels were in practice a production control system working based on the three principles of separation between delivery deadlines and operational considerations and the full efficiency of cell flexibility. A simulation model was developed to examine the performance of their proposed three-level system. Classical loading laws were defined using the concept of balanced workload and the results showed that these laws had the same behavior as classical laws. Sajjadi et al. (2015) stated that the scheduling of flexible production systems is one of the most significant and practical topics in the area of scheduling problems of production systems, which are affected by many characteristics and issues**.**

Kheirkhah and Ghajari (2018) integrated the design of cellular production systems and production planning with a balanced production approach. They presented a mixed integer non-linear mathematical model for the design of cellular production systems, in which various features such as dynamic production planning, multiple production paths, reconfiguration, similar machines, production volume segregation, workload balance between cells and between the machines of each cell, the production limit of each cell, and the flow of materials between the machines were considered. Yavari and Emadi (2017) investigated the process-oriented integration of industrial information systems based on the principles of lean production. The information system of the studied company included several designed software and systems. Bahramian et al. (2012) evaluated integrated information systems in the Ministry of Energy and its subsidiaries. The purpose of their article was to evaluate the success rate of the integrated information system of the Ministry of Energy and its subsidiaries based on the modified success evaluation model. Based on the results, they concluded that although the quality of the system and the quality of services of the integrated information system of Iran Water and Power Resources Development Company is a suitable predictor for evaluating user satisfaction and increasing the acquisition of individual and organizational benefits from the information system, the quality of the information obtained from the system has only affected the desire to use the mentioned system**.**

Nemati and Moinipour (2014) presented a conceptual model to explain the integration of information systems. This model spread in a network of organizations. By aggregating the cognitive propositions extracted from their model, a preliminary theory about the integration of inter-organizational information systems can be obtained. RafieiRashtabadi et al. (2016) examined the impact of technological dynamics on operational efficiency through the mediation of production flexibility. The results revealed that by increasing flexibility, it is possible to respond more effectively to technological changes resulting from the environment and achieve better operational efficiency**.**

Rapnick and Jaklick" (2009) presented the application of data mining in processes and used the Crisp standard. Ghatas et al. (2016) used data mining methods to present a semi-automated approach to improve performance based on decisions in previous processes. Peek et al. (2016) presented an approach for implementing data mining in processes, which includes phases of evaluation, redesign, modeling, and implementation capability of data mining results. Benitez et al. (2018) stated that although mergers and acquisitions (M&A) are a common strategy to reduce costs and pursue growth, the difference in returns from M&A is very high. They investigated how the flexibility of information technology (IT) infrastructure affects M&A. They used a combination of secondary survey data and matched pairs from 100 medium-sized companies in Spain to investigate this relationship**.**

Empirical analysis revealed that IT infrastructure flexibility affects M&A through two key pathways: (1) a flexible IT infrastructure facilitates the development of business flexibility that provides responsiveness to take advantage of M&A and acquisition opportunities, and (2) it facilitates a flexible IT infrastructure. Arnold et al. (2015) investigated the development of ERM or enterprise risk management on two aspects of organizational performance, strategic flexibility, and supply chain performance. They have been designed to examine conflicting views on the impact of increasing levels of governance on organizations' flexibility and supply chain performance and to determine whether ERM capability affects the different observed effects. They developed a theory of ERM as an enabler of IT integration, flexibility, and performance by relying on the theories related to the perspective

of electronic information integration and company agility and the role of knowledge integration in enabling the link between strategic flexibility and performance.

A cross-sectional field study of six companies indicated mutual relationships. Further tests were conducted using the data of 155 audit executives. The results revealed that a strategic approach based on integrated ERM increases flexibility and strengthens the relationship between flexibility and performance. Their study results also provided evidence that advanced information integration is a mechanism through which ERM enhances both flexibility and performance. Pervan et al. (2019) analyzed how the implementation of integrated information systems (IIS) in organizations affects management accounting. Results based on data collected from 108 Croatian companies confirmed that IIS implementation caused significant changes in management accounting. Estimated regression models showed that the most significant characteristic of IIS is analytical capabilities since it positively affects the management accounting changes in the four dimensions of internal reporting, budgeting, application of new accounting techniques, and management accounting staff jobs. The quality of IIS implementation significantly and positively affects the changes related to data collection and internal reporting.

In the budgeting department, the quality of implementation of specialized budgeting software showed a positive and significant effect. The only negative correlation found in this regard was related to the correlation between the uncertainty of the business environment and the adoption of modern accounting techniques. González-Galgu et al. (2015) examined the direct impacts of information and communication technology (ICT) and integrated information systems (IS) capabilities on company performance. They also investigated the moderating role of IS integration and the supply chain in the relationship between external ICT and business capabilities and performance. Data from 102 large Iberian companies from Spain and Portugal were used to test their research model. Hierarchical multiple regression analysis was used to test the proposed direct effects and moderating relationships. The results revealed that external and internal ICT capabilities are significant drivers of company performance. However, merely having an integrated IS does not lead to better company performance. Moreover, a moderating effect of IS integration is found in the relationship between ICT capabilities and business performance, although this integration contributes to company performance only when it is directed to relationships with suppliers or customers rather than integrating the entire supply chain

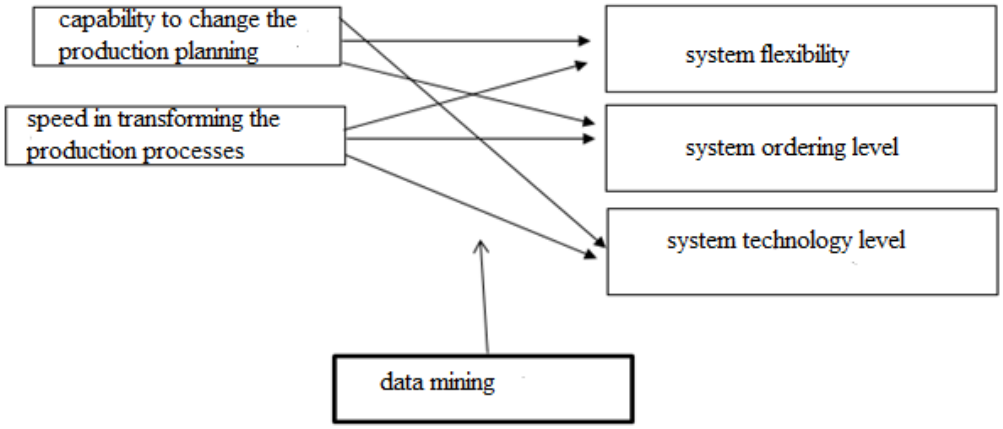

Figure 1: Conceptual model of the research Source: researcher-made

Research Methodology

This research is analytical, descriptive, and applied concerning its purpose. The research method is also field and library concerning the data collection methods. In terms of the research method, it is a descriptive and survey type. The statistical population of this study consists of all company personnel. SeramAra Qazvin Company includes 160 personnel and users of integrated ERP systems for the general ledger, finance,

treasury, warehouse, sales and logistics procurement, and service compensation departments. The administrative staff includes 12 people, the production staff includes 34 people (questionnaire for 30 people), and others include 25 people (currently). The method of data collection in this study is library and field research. The data collection tools are a researcher-made questionnaire and interviews with company managers. To examine the validity of the questionnaire, the opinions of professors and experts were used. Also, to determine the reliability of the questionnaires, the questionnaire was first submitted to 30 people from the statistical sample, and the reliability value was determined using Cronbach's alpha. Table 1 presents the results.

Table 1: Reliability of the questionnaire based on Cronbach's alpha

Selected components	Variable type	Sample size	Cronbach's alpha
capability to change the production planning	Dependent	30 people	-
Speed in transferring production processes	Dependent	30 people	-
Flexibility of system	Independent	30 people	-
System ordering level	Independent	30 people	-
Integrated system technology level	Independent	30 people	-
Total reliability		30 people	0.810

The test result indicated that the total calculated alpha value for each of the variables is accepted. This means that the reliability and internal consistency of the research questionnaire questions are acceptable. In this study, we use the data mining technique based on the CRISP-DM method to investigate the impact of integrated systems on production flexibility. This technique has 6 steps including 1. Business understanding, 2. Data understanding, 3. Data preparation, 4. Modeling, 5. Evaluation, and 6. Development. After implementing the first 5 steps and ensuring the accuracy of the method's performance, it can be developed for practical purposes. This method is a step-by-step data mining standard and has been analyzed using SPSS software.

Results

Table 2 presents the descriptive statistics of the research variables, including the statistical indices of mean, standard deviation, etc.

Table 2: Descriptive statistics of research variables

Selected variable	N	Min	Max	Mean	SD	Variance
capability to change the production planning	30	2	5	4.7856	0.8743	0.767
Speed in transferring production processes	30	2	5	3.5773	0.7943	0.677
Flexibility of system	30	4	5	3.7832	0.9348	0.877
System ordering level	30	3	5	3.8734	0.8087	0.766
Integrated system technology level	30	3	5	4.1298	0.7688	0.512

Table 3: Measurement of sample adequacy

Test		Statistic
Kaiser-Meyer-Olkin *(*KMO*)*	Measurement of sample adequacy	0.901
Bartlett's test *of* Sphericity	Chi-square approximation	14363.9823
	Degrees of freedom	30
	Significance	0.001

Since the KMO index value is 0.901, the number of samples is adequate for the analysis, and the significance value of Bartlett's test is less than 0.05, the desired analysis is suitable for identifying the structure of the model (Table 3).

Table 4: Correlation matrix of research variables

Variables	capability to change the production planning	Speed in transferring production processes	Flexibility of system	System ordering level	Integrated system technology level
capability to change the production planning	1				
	0.266	1			
Speed in transferring production processes					
Flexibility of system	0.377	0.322	1		
	0.657	0.599	0.326	1	
System ordering level					
	0.711	0.655	0.744	0.409	1
Integrated system technology level					

As shown in Table 4, all the correlations between the variables are significant at the 0.05 level. These correlation analyses provide insight into the bivariate relationships between the research variables.

Table 5: Statistics related to the model goodness of fit

Fit indices		Criterion	values	result
X2/DF		3	2.11	Good fit
Root mean square error of approximation	RMSEA	0-8	0.05	Good fit
Goodness of fit index	GFI	0.9	0.95	Good fit
Adjusted goodness of fit index	AGFI	0.9	0.90	Good fit
Comparative fir index	CFI	0.9	0.91	Good fit
Incremental fit index	IFI	0.9	0.95	Good fit
Normalized fit index	NFI	0.9	0.94	Good fit
Non-normalized fit index	NNFI	0.9	0.04	Good fit

The goodness of fit indices including GFI, AGFI, and RMSEA show that the results of the model are reliable. Both the GFI and AGFI indices are more than the criterion of 0.90. Also, X2/df shows a suitable value. The RMSEA was estimated at 0.05, which was smaller than the permissible limit of 0.08. Based on the estimates, it can be concluded that the tested model had a relatively good and acceptable fit. Therefore, the results of the research model show that the model used in the present study had a good fit (Table 5).

Table 6: Summary of research results

hypotheses	Path coefficients	Statistic t	Statistic level	Result
The capability to change the production planning is effective in the flexibility of the system	0.630	9.548	000.0	Confirmed
The speed in transforming the production processes is effective in the flexibility of the system.	0.203	2.486	0.001	Confirmed

The capability to change the production planning is effective in the ordering level of the system.	0.363	2.645	0.000	Confirmed
Speed in transforming production processes is effective in the ordering level of the system.	0.270	3.967	0.000	Confirmed
The capability to change the production planning is effective in the integrated system technology level	0.009	1.326	0.002	Rejected
The speed in transforming the production processes is effective in the integrated system technology level	0.994	2.545	0.000	Confirmed

The results indicate that the highest coefficient of influence for the relationship between the variables of speed in transferring production processes at the technology level of the integrated system is 0.994, the t-value is 2.545, and the lowest coefficient is for the relationship between the capability to change the production planning and the integrated system technology level is 0.009 and the t-value is 1.326.

Conclusion

The purpose of this study is to investigate the impact of integrated systems on production flexibility through data mining. The results revealed that the capability to change the production planning is effective in the performance of the system flexibility. The beta coefficient is 0.630 and the t-value is 9.548, and the significance level is less than 0.05. Thus, it can be stated that the capability to transform production planning has a positive and significant impact on the flexibility of the system. These results are in line with those of studies by Davari (2017) and Allen et al. (2017). They believe that the capability to change production planning plays a significant role in the performance of organizations. In explaining the results of the above hypothesis, it can be stated that the capability to change production planning means the level of an organization's capability to adapt to important changes in the environment. As much as the organization can adapt to the conditions, it can achieve better performance and finally achieve high productivity, indicating the significance of change management in the form of flexibility of the system. The results showed that the speed in transforming the production processes is effective in the system flexibility performance. It can be stated that the beta coefficient is 0.203, the t-value is 2.846, and the significance level is less than 0.05. Thus, it can be stated that the speed in transferring production processes has a positive and significant impact on the system's flexibility performance. The results are consistent with those of studies conducted by Sajjadi et al. (2017) and Allen et al. (2017), as they stated that production flexibility can improve the performance of an organization. In explaining the results of the above hypothesis, it can be stated that the production system has a certain level of flexibility that allows it to show the reaction of the system to changes. This can improve organizational performance and ultimately lead to an increase in organizational productivity. The results showed that the capability to change the production planning is effective in the system ordering level. It can be stated that the beta coefficient is 0.363, the t-value is 2.645, and the significance level is less than 0.05. Hence, it can be stated that the capability to change production planning has a positive and significant impact on the ordering level of the system. The results are consistent with the results of studies conducted by Hassan (2017) and Allen et al. (2017). In explaining the results of the above hypothesis, it can be stated that the ordering level of the system is the capability of an order to react quickly to the changes in the market and customer needs, which should be considered in strategic planning. As the capability to change the production planning increases according to the environmental conditions, the ordering level of the system will also increase. The results revealed that the speed in transferring production processes is effective in the system ordering level. It can be stated that the beta coefficient is (0.270), the t-value is 3.967, and the significance level is less than 0.05. Thus, it can be stated that the speed in transferring production processes has a positive and significant impact on the level of the system ordering. The results are consistent with those of studies conducted by Sajjadi et al. (2017) and Vani et al. (2015). It can be stated that to obtain an order in the changing business environment, companies should coordinate with

suppliers and customers to make their operations efficient and cooperate to obtain an acceptable level. Subsequently, system ordering can adequately respond to the changes that occur in the working environment, in which production flexibility plays a significant role.

The results revealed that the capability to change the production planning is not effective in the technology level of the integrated system. The beta coefficient is 0.009 and the t-value is 1.326, and the significance level is less than 0.05. Thus, it can be stated that the capability to change the production planning is not effective in the technology level of the integrated system. These results are consistent with those of studies by Chi (2018) and Allen et al. (2017). In explaining the results of the above hypothesis, it can be stated that managers should accept uncertainty to be able to change the production planning and organize and develop a suitable strategy to coordinate supply and demand with acceptable costs. Speed is effective in transforming production processes on the technology level of the integrated system. It can be stated that the beta coefficient is 0.994, the t-value is 2.545, and the significance level is less than 0.05. Thus, it can be stated that the speed in transferring production processes is effective in the technology level of the integrated system. The results of this hypothesis are consistent with the results of studies by Chapman (2009) and Allen et al. (2017). In the interpretation of the results, it can be stated that companies nowadays seek to gain competitive advantages to adapt to the changing conditions in the market, so they can provide the conditions for their survival in the turbulent environment and show better performance. Flexibility and speed in the exchange of production processes are considered a competitive capability for the company and provide the conditions for accepting unpredicted conditions and rapid changes in the environment. In manufacturing organizations, the flexibility of the production mix is a cost-effective solution that can absorb the risk of imbalance between supply and demand to a large extent. Future researchers are recommended to conduct similar studies with more diverse indicators and a wider statistical population in other organizations. Also, given the potential of this industry in presenting the colors and the taste of customers in tiles and ceramics, they can use more equipped printing devices with lower efficiency and cost. Researchers can investigate other subjects by integrating the desired subject.

References

Bahramian, H, Rahnavard, F, and SalehiSedghiani, J. (2013). Evaluation of integrated information systems in the Ministry of Energy and its subsidiaries. Quantitative Studies in Management, 4(4), 4-47.

Pourzmani, Z, Karimi, A, (2019), the effect of effective risk management and intellectual capital on the level. Journal of Financial Studies, Volume 3, Issue 6, pp. 1-18.

Hajipour, B, Moradi, M, (2018), Organizational flexibility and performance: a case study of manufacturing companies in Arak Industrial District. Quarterly Journal of Improvement and Transformation Management Studies No. 143-162.

Kheirkhah, A, and Ghajari, A. (2018). Integrating the design of cellular production systems and production planning with a balanced production approach. Industrial Engineering and Management (Special Sharif for Engineering Sciences), 34-1(2/1), 53-64**.**

Ali Davari; Moradi Saeed Shahbaz, (2016), identifying the impact of entrepreneurial orientation and organizational factors on business performance (case study: technical companies affiliated to the National Iranian Oil Company), volume 6, number 3, page 125-143.

RafiiRashtabadi, Fatemeh, EbrahimPourazbari, Mostafa, and Akbari, Mohsen. (2015). The impact of technological dynamism on operational efficiency: the mediating role of production flexibility. Industrial Technology Development, 14(27), 55-68.

Sajjadi, SeyedahMehrakh, Ayouq, Ashkan, and SeyedAsfahani, Mirmehdi. (2015). Presenting an integrated model for analyzing and improving the scheduling and dispatching problems of automated guided vehicles in a flexible manufacturing system. Industrial Management Perspective, 6(21), 127-97.

Addressee Rafiei, Farimah, Moataresini, Seyyed Mohammad, and Aghdasi, Mohammad. (1380). An integrated method of production planning and control in a flexible workshop production system. Amirkabir, 13(49), 160-173.

NematiShamsabadi, Hassan Ali, and Moinipour, Ali Asghar. (2014). Integration of inter-

organizational information systems: providing a model to understand the scope of the integration problem. Information Technology Management, 7(3), 675-696.

Yaori, Najmeh, and Emadi, Sima. (2017). Process-oriented integration of industrial information systems according to the principles of lean production. Modeling in Engineering, 16(53), 363-378.

Allenby, B. (2006). The ontologies of industrial ecology?. *Progress in Industrial Ecology, An International Journal*, *3*(1-2), 28-40.

Arnold, V., Benford, T., Canada, J., & Sutton, S. G. (2015). Leveraging integrated information systems to enhance strategic flexibility and performance: The enabling role of enterprise risk management. *International Journal of Accounting Information Systems*, *19*, 1-16.

Benitez, J., Ray, G., &Henseler, J. (2018). Impact of information technology infrastructure flexibility on mergers and acquisitions. *MIS Quarterly: Management Information Systems*, *42*(1), 25-43.

Chae, B., D. Olson, and Sheu, C. (2018), "The impact of supply chain analytics on operational performance: a resource-based view", International Journal of Production Research, Vol. 52 No.16, pp. 4695-4710

Chapman, C. S., &Kihn, L. A. (2009). Information system integration, enabling control and performance. *Accounting, organizations and society*, *34*(2), 151-169.

Gonzálvez-Gallego, N., Molina-Castillo, F. J., Soto-Acosta, P., Varajao, J., &Trigo, A. (2015). Using integrated information systems in supply chain management. *Enterprise Information Systems*, *9*(2), 210-232.

Hasan, H., Smith, S., & Finnegan, P. (2017). An activity theoretic analysis of the mediating role of information systems in tackling climate change adaptation. *Information Systems Journal*, *27*(3), 271-308.

Pervan, I., &Dropulić, I. (2019). The impact of integrated information systems on management accounting: Case of Croatia. *Management: journal of contemporary management issues*, *24*(1), 21-38.

Vanany I, Maryani A, Amaliah B, Rinaldy F, Muhammad F. (۲۰۱۵). Blood Traceability System for Indonesian Blood Supply Chain. Procedia Manufacturing. ۴۲-۴:۵۳۵.