HOW SOCIALIZATION TRENDS CONTRIBUTES TO CHANGES IN ADVANCED MANUFACTURING SYSTEMS (AMS): A FOCUS ON KAZAKHSTAN

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ABSTRACT

Socialization is a key factor in the changing landscape of manufacturing because of the evolving preferences of consumers, supply and demand factors, and growth in the information and technology sector. Advanced manufacturing systems depend on the aspects of socialization and cultural factors of a society in relation to how they are integrated and practiced to attain success despite the uniqueness of human behavior. The current study focuses on Kazakhstan, a middle income economy, which has not fully integrated technology into its manufacturing industry. Reviewed literature shows that advanced manufacturing systems a function of both human factors and information technology, which need to be combined to attain the goal of improving the productivity of manufacturing industries while satisfying the varying needs of consumers. To study how Kazakhstan is pursuing the use of technology to building advanced manufacturing systems, the research obtains economic indicators data of investment on research and development, patent application, and manufacturing innovative goods for export. The results of the study showed that there is a positive and statistically significant relationship between an increase in the investment in R&D by the government and innovative technologies and manufacturing. The findings are useful for economists and policymakers to apply in Kazakhstan with the aim of becoming an Industry 4.0 economy.

Keywords: Socialization, Advanced Manufacturing Systems, Manufacturing Industry, Innovative Technologies.

JEL Classification: O14, O33.

INTRODUCTION

Manufacturing is evolving rapidly, simultaneously with changes in information technology. Various technology- and demand-driven aspects have spurred the current trends in manufacturing to attain the characteristics of agility, networking, and social manufacturing, among others. Making the manufacturing sector to adapt to the social and technological evolution, and to comply with the growth in IT, innovative designing of products and the process of production, and efficient and sustainable use of scarce resources, various advanced manufacturing systems have been studied. The components of advanced manufacturing systems that change with the changes in socialization trends include, computer-integrated manufacturing, sustainable manufacturing, service-oriented manufacturing, and cloud-based manufacturing (Cheng et al., 2016).

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In the last 50 years, with the rapid growth in manufacturing, management, and information technologies, the social aspects related to manufacturing have experienced significant changes through competition in the global market and the changing demands of customers. In response to the changing social environment, the manufacturing sector is investing in agile, networked, service-oriented, eco-friendly, social-focused, and other manufacturing features that focus on the triple bottom-line (Tao et al., 2017). The embracing of ICT in manufacturing is one of the key changes in socialization of industrial systems.

Recently, new systems have been undergoing development in ICT, having similarities with complex nature of association between the various stakeholders, focusing on market coordination. For example, social networking, web development, and cloud computing, among others, play an important role in improving the free interaction of people and their information technology tools with the aim of exchanging value in the marketplace. The new technologies have, thus, compelled the manufacturing industry's actors to find innovative ways of improving production in addition to providing them with means to convert the ICT-provided opportunities to social processes in a manner that shifts from the way of thinking in the traditional marketplace (Leijten, 2009). Research and technology in the past 2-3 decades have thus changed the manner in which socialization occurs, which have, in turn, changed the approaches to manufacturing. The current paper will study the socialization and technological changes that have occurred in Kazakhstan and how they have influenced the nation's embracing of advanced manufacturing systems.

REVIEW OF LITERATURE

Supply-Demand and Advanced Manufacturing Systems

Cheng et al., (2016) states that in resources' supply-demand matches the advanced manufacturing systems. The resource providers and consumers are all part of the society, thus their participation shows that the 'dual' sociality of supply and demand. The authors add that the supply-demand's sociality results in social creation, differentiation, and sharing of value and utility through the collaboration of social enterprises. For the supply side, Cheng et al., (2016) indicate, there are various features with difference performance and social distribution of manufacturing resources and capabilities. For the demand side, there are various dynamics, concurrency, and randomness of roles and the uncertainty of the processes of execution. Thus, according to Cheng et al., (2016), matching supply and demand is a complex process because of the involved tasks, both dependent and independent. In their conclusion, the authors state that socialization of manufacturing causes the application and implementation of the matching of supply and demand in advanced manufacturing systems to become complex (Cheng et al., 2016).

Kazakhstan AMS

The changes in socialization through ICT and the need to match supply and demand has necessitated Industry 4.0, which features changes in manufacturing and industrial trends through the incorporation of technology (smart). Shaiholla et al., (2019) assessed the status of industries and manufacturing in Kazakhstan and noted that the country's current state of industrial progress is in transition from Industry 2.0 to Industry 3.0. Further, the researchers state that only approximately 3 percent of the country's enterprises operate on Industry 3.0. Whereas the rest of Europe, particularly Germany has adopted Industry 4.0, adopting and applying the components of Industry 4.0 requires an understanding of social factors of Kazakhstan (Shaiholla et al., 2019). The current state of industrial progress of the Kazakhstan, analyzed using the Ministry for Investment and Development statistics, (2017) shows that 80

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percent of all the enterprises use semi-automated manufacturing systems (Industry 2.0), 17 percent are on a transition stage (semi-automated to automated, Industry 2.0 to 3.0), and 3 percent of all the industries use automated manufacturing systems of Industry 3.0 (Shaiholla et al., 2019). Redefinition of the industrial and manufacturing model in Kazakhstan need to focus on various aspects, which include modernization, digitization of enterprise, and implementation of integrated technology systems.

Saberi et al., (2010) reviewed the advanced manufacturing technologies requirements and found that organization structure and culture are among the key aspects, alongside technology, which are important in appropriate integration of advanced manufacturing systems in economies. Organizational culture and structure, including human resource and the operational strategy of enterprises, are important social aspects and trends that have guided the evolution of advanced manufacturing systems. Scientific innovation and technological development are the main pathway to the attainment of advanced manufacturing systems in the industries of a country. Since Kazakhstan is still in the transition stage toward the incorporation of smart technologies in their manufacturing, there is need for scientific innovation. Yessengeldin et al., (2016) mentions the Statistical Committee of the Republic of Kazakhstan data of 2014, which indicates that between 2009 and 2014, the nation's expenditure on research and development (R&D) as a portion of the GDP has decreased. In 2009, the expenditure on R&D was 0.23 in 2009, reduced to 0.15, and from 2011 to 2013, the rate of expenditure on R&D to Kazakhstan has averaged at 0.17.

Yessengeldin et al., (2016) states that the spending on R&D and on scientific innovations in Kazakhstan is so low that it does not create the adequate conditions that will facilitate converting intellectual production in the systematic management of various processes for the growth of the business sector and profitability. Advanced manufacturing systems also require the integration of advanced organizational management and cultures as part of the socialization of the nation and its culture. As stated by Tao et al., (2017), social-focused approaches in management are keys to the success of the use of information and communication technology that are needed in successful AMS. According to Nurgaliyeva et al., (2020) managerial accounting, as a factor of the socialization aspects of AMS, include maintaining high-quality accounting work, use of reliable accounting systems, and pricing of products and services. The results of the study by Nurgaliyeva et al., (2020), which focused on the retail sector in Kazakhstan, showed that price of goods does not represent the aspects of quality and quantity as well as timely delivery, which have major effects of the operations of organizations in the country. From a socialization perspective, Kazakhstan's organizational operations culture does not place much emphasis on factors that align them to providing value to their buyers, in quality, quantity, and pricing and other aspects of value. Accordingly, to attain the Industry 4.0 status, the retail firms in Kazakhstan should align their operations to the sociocultural aspects of the society in terms of organizational management while pursuing the use of ICT in improvement of industrial production.

THEORETICAL FRAMEWORK

There are three main views that have been fronted to understand the socialization aspect of advanced manufacturing systems. The first view involves sharing of resources for effective and efficient use of the scarce resources amid increasing competition (Samaddar et al., 2005). Resource sharing happens in three phases: within an enterprise (Kalpakjian & Schmid, 2006), among enterprises (Yao et al., 2010), and among various sectors and across regions (Meier et al., 2010). The second view involves the creation of value as the main objective of manufacturing, and advanced manufacturing systems being developed to improve creation of value and systems that focus on the addition of value (Ueda et al., 2009).

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According to Baines et al., (2009), the concept of "*servitization*" is an important concept in understanding advanced manufacturing technologies because it refers to the change from the sale of products to the sale of an integrated, combined services and products with the aim of value creation. The author adds that "*servitization*" is a competitive strategy among manufacturers that focuses on service, and offers increases revenues and margins, in addition to providing an opportunity for the differentiation of products obtained from economies of low costs (Baines et al., 2009). The third view focuses on the level to which users participate in the process of production. The manufacturing cycle has both starting and endpoints, innovation and users, respectively, which play a key role in the success of the process and products in the market. Thus, advanced manufacturing systems require the recognition of the end users through facilitating their participation, which improves the competitiveness of the manufacturing industry (Hollman et al., 2000). Hu, (2013) further states that advanced manufacturing systems combine mass production, mass customization to focus on the end user, and personalization to meet the unique needs of different consumers. Thus, the manufacturing industry's adoption of advanced manufacturing systems should focus on the aforementioned aspects of socialization to ensure effective competition through leveraging ICT.

DATA COLLECTION

Data was gathered from the World Bank database on Kazakhstan's investment in research and development (R&D) (Research and development expenditure (% of GDP)) as the main indicator for the growth of production in the country. The other variable is the patent application among residents and the manufacture of merchandise for export (%). The data was collected in the period between 1998 and 2017 because of the availability of data on the 20-year period, allowing for the trend analysis of the time series data to determine the relationship between the independent variable, Kazakhstan's investment in R&D and how it relates to the dependent factors of patent application of the residents and manufacturing of innovative merchandise for export.

An ordinary least squares regression model has been used in estimating the relationship between the independent variable and the two dependent variables identified to answer the research question about how investment in research development contributes to Kazakhstan's embracing of advanced manufacturing systems that involve the use of information and communication technology.

The model that has been developed to test the nature of the relationship between the variables is an ordinary least squares regression model:

$$R\&D = \beta 0 + \beta 1 * Patent_{Application} + \beta 2 * Manufactures_{Export}$$

RESULTS

Table 1
DESCRIPTIVE STATISTICS

	N	Minimum	Maximum	Mean	Std. Deviation
Kazakhstan Research and development expenditure (% of GDP)	20	.12286	.28361	.1948245	.04661817
Patent applications, residents	20	993	1824	1481.20	225.101
Manufactures exports (% of merchandise exports)	20	88.02767	94.24471	90.6570770	2.33830256
Valid N (listwise)	20				

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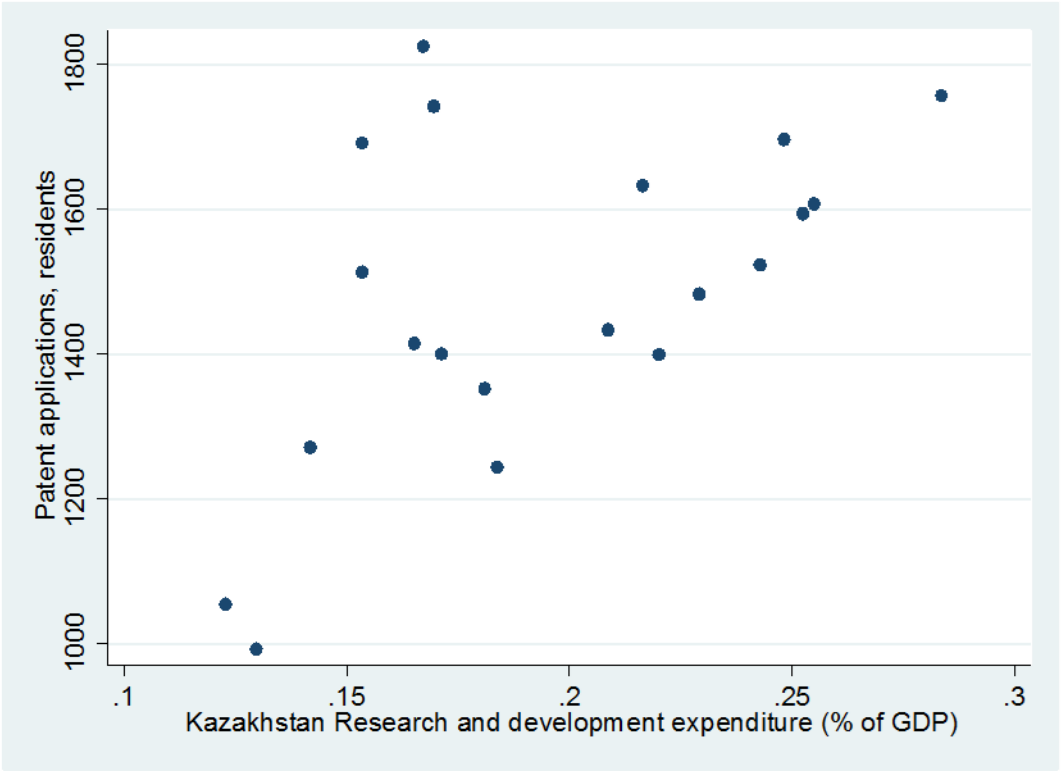

Figure 1
SCATTERPLOT ON KAZAKHSTAN R&D EXPENDITURE AND PATENT APPLICATIONS OF THE RESIDENTS

A Pearson's correlation coefficient was conducted to test the correlation between the variables. The correlation coefficient between R&D % of GDP and patent applications is r = 0.544, p > 0.05. The coefficient of R&D and manufacturing for export is r = 0.690, p < 0.01. Table 1 and Figure 1. The results that show that the relationship between R&D and manufacturing for export in the country is positive at statistically significant compared to the correlation between R&D expenditure and patent application, which is positive but statistically insignificant. Patent application and manufacturing for exports in Kazakhstan has a statistically insignificant relationship p > 0.05, r = 0.677 Tables 2 - 9.

Table 2
CORRELATIONS

		Kazakhstan Research and development expenditure (% of GDP)	Patent applications, residents	Manufactures exports (% of merchandise exports)
Kazakhstan Research and development expenditure (% of GDP)	Pearson Correlation	1	.544*	.690**
	Sig. (2-tailed)		.013	.001
	N	20	20	20
Patent applications, residents	Pearson Correlation	.544*	1	.099
	Sig. (2-tailed)	.013		.677
	N	20	20	20
Manufactures exports (% of merchandise	Pearson Correlation	.690**	.099	1
	Sig. (2-tailed)	.001	.677	

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exports)	N	20	20	20
*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).				

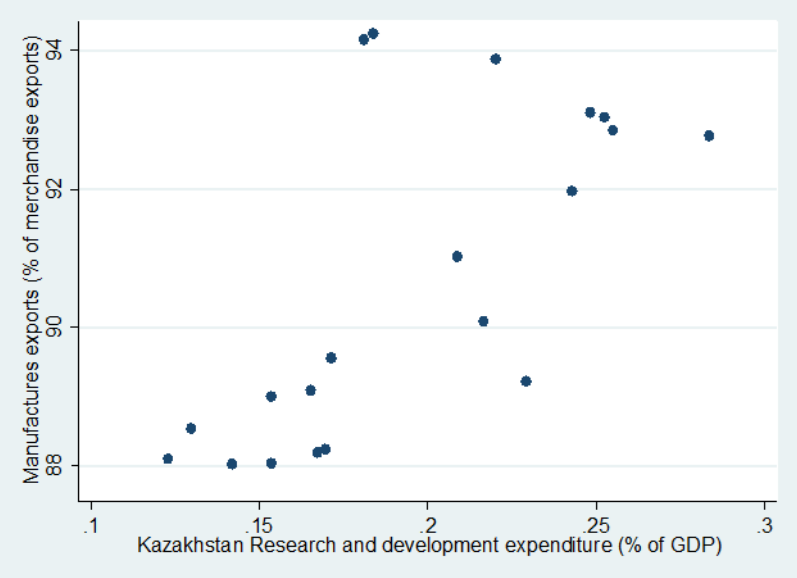

Figure 2
SCATTERPLOT ON KAZAKHSTAN R&D EXPENDITURE AND MANUFACTURING OF EXPORTS % OF MERCHANDISE

Table 3
MODEL SUMMARY[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.544[a]	.296	.256	194.103
a. Predictors: (Constant), Kazakhstan Research and development expenditure (% of GDP) b. Dependent Variable: Patent applications, residents				

A linear regression analysis was conducted between R&D investment as a % of the GDP of Kazakhstan and patent applications. The F-test showed F (1, 18) = 7.553, p = 0.013.

Table 4
ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	284567.644	1	284567.644	7.553	.013[b]
	Residual	678167.556	18	37675.975		
	Total	962735.200	19			
a. Dependent Variable: Patent applications, residents b. Predictors: (Constant), Kazakhstan Research and development expenditure (% of GDP)						

Table 5
COEFFICIENTS[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	969.749	191.093		5.075	.000
	Kazakhstan Research and	2625.190	955.213	.544	2.748	.013

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	development expenditure (% of GDP)					
a. Dependent Variable: Patent applications, residents						

The coefficient of the linear model show:

$$Patent_{application} = 969.75 + 2625.19 * R\&D$$

The relationship of the model is significant at $p < 0.01$, showing that for an increase in 1% of R&D increases the number of patent applications in Kazakhstan in the 1998-2017 period by 2625 patent applications among the residents.

Table 6
RESIDUALS STATISTICS[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1292.28	1714.28	1481.20	122.382	20
Residual	-317.288	415.267	.000	188.926	20
Std. Predicted Value	-1.544	1.905	.000	1.000	20
Std. Residual	-1.635	2.139	.000	.973	20
a. Dependent Variable: Patent applications, residents					

The scatterplot of the residuals against the dependent variable shows that there is a positive and statistically significant relationship between an increase in the investment in research and development and new patents in the country. The indication is that as the investment in R&D increases, the residents of Kazakhstan become more innovative in scientific research and development of new products Figures 2-4.

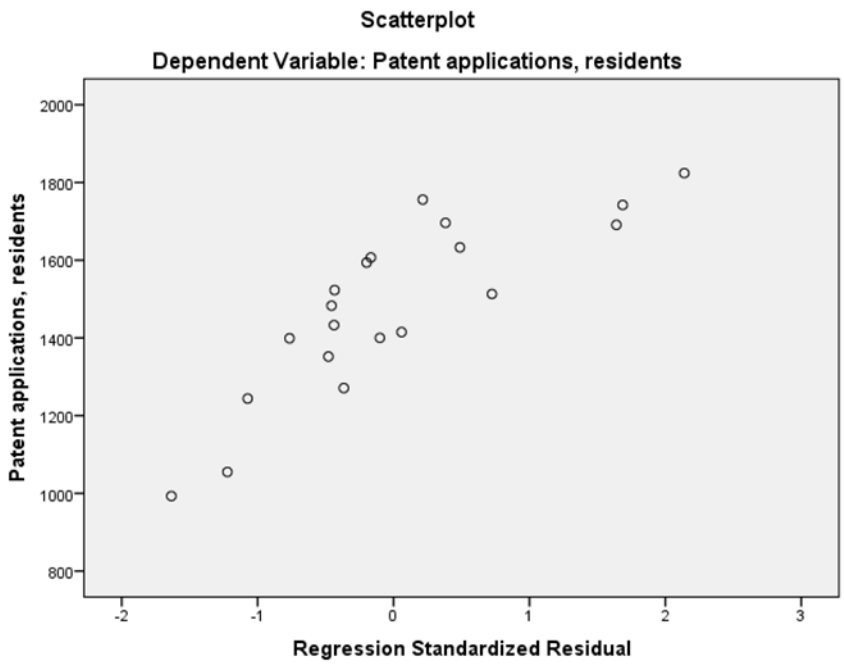

Figure 3
SCATTERPLOT

A regression analysis was conducted between the country's investment in R&D and

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the manufacturing of commodities for export.

Table 7
MODEL SUMMARY[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.690[a]	.476	.447	1.73950134

a. Predictors: (Constant), Kazakhstan Research and development expenditure (% of GDP)
b. Dependent Variable: Manufactures exports (% of merchandise exports)

Table 8
ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	49.420	1	49.420	16.333	.001[b]
	Residual	54.466	18	3.026		
	Total	103.886	19			

a. Dependent Variable: Manufactures exports (% of merchandise exports)
b. Predictors: (Constant), Kazakhstan Research and development expenditure (% of GDP)

The F-test showed F (1, 18) = 16.33, p = 0.001.

The regression model for the output showed:

Manufacture_export=83.917+34.595*R&D

The output of the model indicates that for every increase in the expenditure on R&D from the GDP by 1%, the manufacturing industry boosts its merchandise for export by 34.595%. The scatterplot shows that nature of the relationship, although there are various outlier data points in the scatterplot. However, the relationship is positive and statistically significant.

Table 9
COEFFICIENTS[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	83.917	1.713		49.002	.000
	Kazakhstan Research and development expenditure (% of GDP)	34.595	8.560	.690	4.041	.001

a. Dependent Variable: Manufactures exports (% of merchandise exports)

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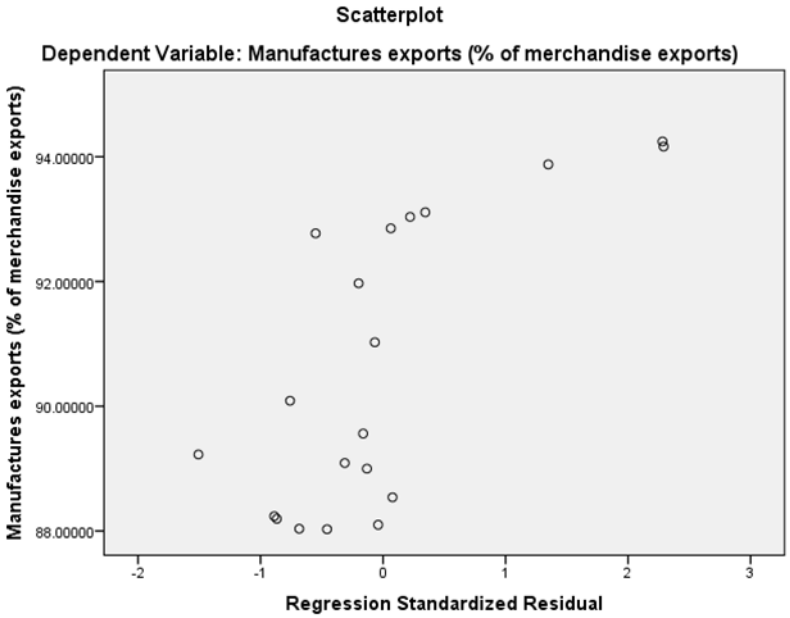

Figure 4
SCATTERPLOT

CONCLUSION

Kazakhstan's investment in research and development will play a key role in the increase its scientific innovations and integration of ICT in building advanced manufacturing systems. The aspects of socialization, related to demand and supply and management of the organization to create value for consumers will also enable the country complete its transition from Industry 3.0 to Industry 4.0. Data from the World Bank has shown that there is a positive relationship between investment in R&D and patent registration and manufacturing for exports. According the findings of the current study, it is important to increase the expenditure on research and development for the country to attain advanced manufacturing systems. Future studies should consider including the socialization trends variable (qualitative) to determine how the local population perceives advanced manufacturing systems and how they can play a role in its success in Kazakhstan.

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