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The Impact of Virtual Enterprise on Sustaining an Agile Manufacturing System

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The main objective of this study is to identify the nature of the relationship between Virtual enterprise and agile manufacturing systems. It proposes modelling the dimensions of virtual enterprise which could impact sustaining an agile manufacturing system. The research targets elaborate the field of virtual enterprise by encompassing a wide range of virtual dimensions to find the best variable which has a significant impact on AGs. study uses an investigative approach through a questionnaire approach, including 100 respondents. The data is processed using statistical analysis, including descriptions of analysing processes, and copies of scientific articles. The research offers experimental visions into how the dimension of virtual enterprise influences the sustaining of an agile manufacturing system. It highlights that there is a positive and significant relationship amongst variables. In addition, there are production capabilities such as information sharing which has a higher correlation with AGS. Due to the chosen study approach, the results cannot be popularised. Hence, researchers are encouraged to further test the proposed propositions. The article contains implications for the choice of virtual enterprise dimensions that could sustain an agile manufacturing system. This article determines the need to examine how virtual enterprise can contribute to the sustainment of an agile manufacturing system.

Key words: *Virtual Enterprise, agile manufacturing system, sharing information, competitive advantage.*

Introduction

To enhance an organisation's performance towards market demand in a competitive environment, organisations are required to concentrate on their core qualifications and join forces with others. Therefore, it is necessary to achieve the requirements of new brands wanted by consumers. Therefore, this research focuses on the terms of influence of virtual enterprise on an agile manufacturing system.

Virtual Enterprise VE

Enterprises can be classified into two categories: traditional and Virtual. Traditional Enterprise (TE) is a steady enterprise construction that improves a weak level of co-partnership (with limited clients and providers) and does not produce a top scale dynamic arrangement.

However, Virtual Enterprises (VE) is characterised by a short lifecycle and demonstrates a great scale of a firm's dynamics construction. Castro et. al. (2012) maintain that co-operation involves sharing knowledge and other intangible wealth such as communication ("producer/ consumer" or brand-related), and collaborative activities. The zone of virtual enterprises has named the subject of a large number of international organisations and other actions.

Depending on the VE model, the industrial process is not run by a sole enterprise but a (temporary) association of co-operative partnering organisations (Afsarmanesh and Camarinha-Matos 2001).

On the other hand, (Smirnov (1999) shows that VE is a temporary consortium with/ for independent industrial projects called "units," each aimed at getting some advantage. (VE) is an association business model amongst multi projects in a value chain (Lotfi Sadigh et al. 2014). Hence, VE is a temporary platform for discrete projects to co-operate, sharing its essential capabilities to achieve customer needs.

(Nikghadam et. al. 2016) note that VE can be viewed as a project, whereas (Ferreira et. al. 2017) & (Popescu, Fistung, and Popescu 2012) show that virtual enterprise is a perception that knows multiple manufacturing approaches which are considered an enterprise of the future. A temporal networked organisation also denoted as a "virtual enterprise" is a stand out firm built on associations amongst organisations, which agree to collaborate in the same value chain for a determined duration (Cantamessa and Villa 2001).

The object of VE is to effectively take advantage of an enterprise's competitive advantage through temporal co-operation and networking (Dao, Abhary and Marian 2014). (VE) is an

interim association of independent, varied and geographically scattered projects that shares essential resources or capabilities with its partners.

Huang, Gao, and Chen (2011) refer to virtual enterprise as a collaboration with/ between business partner with/ to value chains, which became the main model for obtaining competitive advantage under the increasingly fluctuated business environment.

The main purpose of VE is to permit a sum of factories to speedily progress a joint business atmosphere (Kim et. al. 2006). Therefore, managing an organisational group of resources provided by contributing firms to some common targets, because each partner enterprise brings strength as well as essential capabilities to the consortium therefore sustaining enterprise success is based on co-operating as a single unit Martinez et. al. (2001) maintain that virtual enterprise allows for permission to create a partnership between specific projects. Perrin and Godart (2004) clarify that VE is dependent on the capability to create temporal co-operation and comprehend the worth of a short business opportunity that cannot be opposed by business allies on their own (Katzy and Schuh 1998).

Agile Manufacturing System (AMS)

The economic status of the 21st era is categorised by global market competition, decreased innovation, product life duration and high consumer demand for modified goods. To stay ahead in a market under competition , producers want to mark their plants' industry systems with flexibility and multi-uses creating systems for being able to rapidly adopt to a new situation for fluctuating market demands (Ollinger, Schlick, and Hodek 2011).

Uçaktürk, Uçaktürk, and Yavuz (2015) describe agile manufacturing as a very important contribution to transforming the ambiguity surrounding organisations' opportunists.

The system of agile manufacturing boosts customer direction and enables a quick action to change market circumstances, however it also creates difficulties for the task of sequence and arrangement orders for producing products of factories (Fritzsche 2018).

On the other hand, (Iqbal, Huq, and Bhutta (2018) refer to concentrating on elasticity and awareness along with quality and delivery reliability of products.

(AM) has received substantial discrimination and satisfactoriness amongst industrial engineers during the past decades (Kumar Potdar and Routroy 2018).

AM is the ability to flourish in an environment categorised by constant and not to predict change (Ã 2007). Growing complexity and mutuality in manufacturing projects need an agile

manufacturing system (Deif and ElMaraghy 2007). Agile systems permit speedy introduction to new goods and services models on/ after the class and require slightly increased investment charge to deliver novelty models. Tools, equipment and industry items support reconfigurations and adjustment (within the product class), however they have less interest in general objective machining applications than those of a flexible system (Elkins, Huang, and Alden 2004).

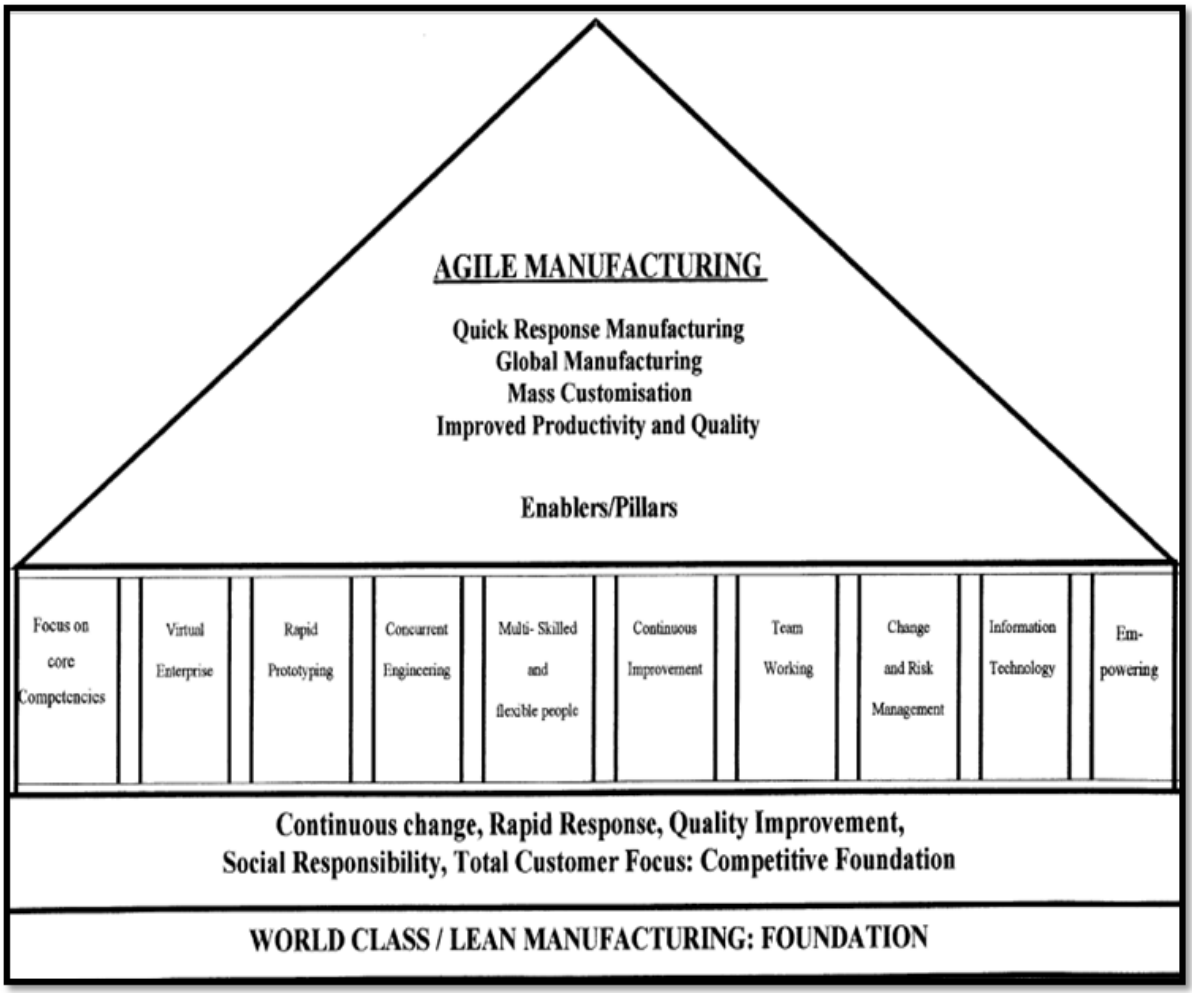
AM is an industrialised regime with elastic technology, fit and trained employees, and link information that responds to increased fluctuation changes in consumers' needs and wants as well as market demand. The essential perception of agile manufacturing include essential capabilities management, virtual enterprise, ability to re-configurate and knowledge-driven projects (Elmoselhy 2013). Globalisation, increased product diversity, therefore increased need for enhancing productivity and quality require continuously higher agility of manufacturing systems (Ollinger, Schlick, and Hodek 2011). Agile manufacturing (AM) has attained significant achievements for joint enterprises by overcoming concerns resulting from the rapid market change, shortening product life , diverse customer needs and negligent technologies.

Adopting a new perception in manufacturing systems enhances the competitiveness of various enterprises ranging from the production to the service sector (Potdar, Routroy, and Behera 2017). The AM system consists of less changes in soft and hard applications required by a trade-off between the manufacturing system of varying enterprises (Cao and Dowlatshahi 2005).

Conceptual Model

In general, agility is constructed based on the enterprise substance of lean manufacturing approaches, joined by an enterprise that is physically, technically, and administratively founded on fast and unpredictable change.

Figure 1. The relation between virtual enterprise and agile manufacturing system.



According to Sharp, Irani, and Desai (1999) we have used a questionnaire to support the theoretical model shown in Fig. 1. completed by Iraqi industrial companies, which is recognised by the Ministry of Industry and Minerals, as practitioners of agile manufacturing practices. In doing so, we are evaluating whether company models are making progress in achieving agile manufacturing systems. Consequently, a study tool was selected.

In addition to the above model, the theoretical model of agility manufacturing has three elements:- (Sharifi and Zhang 1996)

1- "Agility drivers'" refers to the fluctuations in a business environment that require a firm to examine novel ways of conducting business in order to sustain competitive advantage.
2- "Agility capabilities'" refers to the core capabilities required by the company to positively respond to its business environment and take advantage of fluctuations.
3- "Agility providers'" refers to a company's ability to gain

At the same time, Vernadat and Saulcy (1999) refer to dimensions of AM which can be characterised by three critical dimensions:

1- Organisational aspects: covering organisational structure, collective competencies and people empowerment.
2- Technological aspects: covering product and process-related business , technology and integration-related imperatives.
3- Human aspects: covering teaming aspects, individual competencies and people's attitudes.

According to Dao, [partner selection and transportation scheduling are critical to the success of a Virtual Enterprise (Dao, Abhary, and Marian 2014).

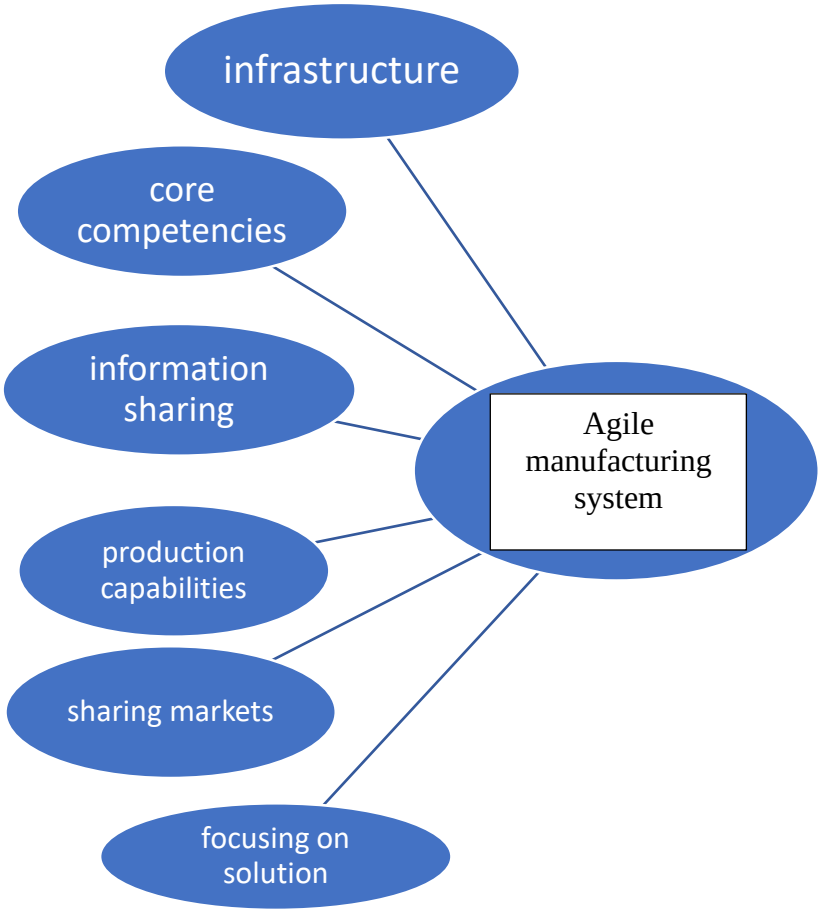
The dimensions of AM that have been chosen by researchers include sharing infrastructures, R&D and resources, linking complementary core competencies, reducing concept-to-cash time through information sharing, increasing production capabilities, gaining access to markets and sharing markets or customer loyalty as well as migrating from selling products to selling solutions.

Furthermore, Cao and Dowlatshahi (2005) refer to virtual enterprise dimensions as well as agile manufacturing systems as shown below:-

Table 1: Variable dimensions

No.	Virtual Enterprise Dimensions VE	Agile Manufacturing system dimensions AM
1	Sharing infrastructure, R&D, financial resources (VE1)	Critical relation of suppliers(AM1)
2	Linking complementary core competencies (VE2)	Competitor circumstances (AM2)
3	Reducing the concept of cash time through information sharing(VE3)	Technology changing situations (AM3)
4	Expanding production capabilities (VE4)	Market place nature (AM4)
5	Gaining access to markets and sharing markets (VE5)	Customer requirement levels and rates (AM5)
6	Focusing on solutions rather than selling products (VE6)	Social/ cultural changes (AM6)
7		Products/ process complexity(AM7)

Figure 2. Conceptual framework between VE and AMs



Research Methodology

Formulating a Questionnaire

The study uses a two-part research design to increase the reliability and authenticity of the data gathered:-

1- Firstly constructing a questionnaire included reviewing previous and current literature and conducting interviews with active AM employees of Etihad Food Industries Co. Ltd.
2- Secondly, the survey was directed to supervisors whose titles include Operations Manager, Production Manager and others.

Data Analysis

Questionnaires were sent to Etihad Food Industries Co. Ltd. Correspondence was received from 10 different departments, from which 8 completed the questionnaires.

Data from the questionnaires (all responses to 13 questions per questionnaire) was entered into a spreadsheet, which tabulated the results.

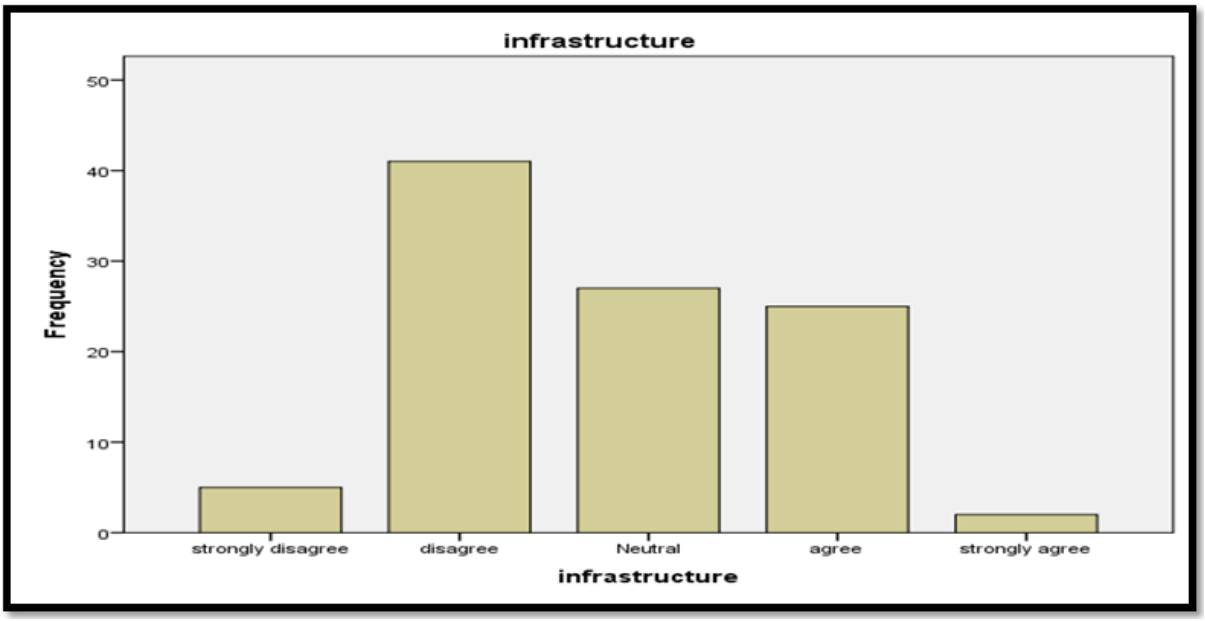
Sharing Infrastructure, R&D, Financial Resources (VE1)

An agile manufacturing system will require a sharing infrastructure, capable of conducting research and development as well as ensuring financial resources.

The result of the data analysis as below:-

a- 05% of respondents strongly disagree that sharing infrastructure will enhance the performance of the agile manufacturing system.
b- 41% disagree that VE1 will positively impact the agile system in the company
c- 27% [text missing] about two variables (sharing infrastructure, R & D, financial resources).
d- 25% agree about the dimension terms (sharing infrastructure, R & D, financial resources) have an impact on an agile manufacturing system.
e- 2% strongly agree that the Company has identified sharing infrastructure, research, and development, as well as financial resources which have an important impact on sustaining an agile manufacturing system.

As shown in figure (3):

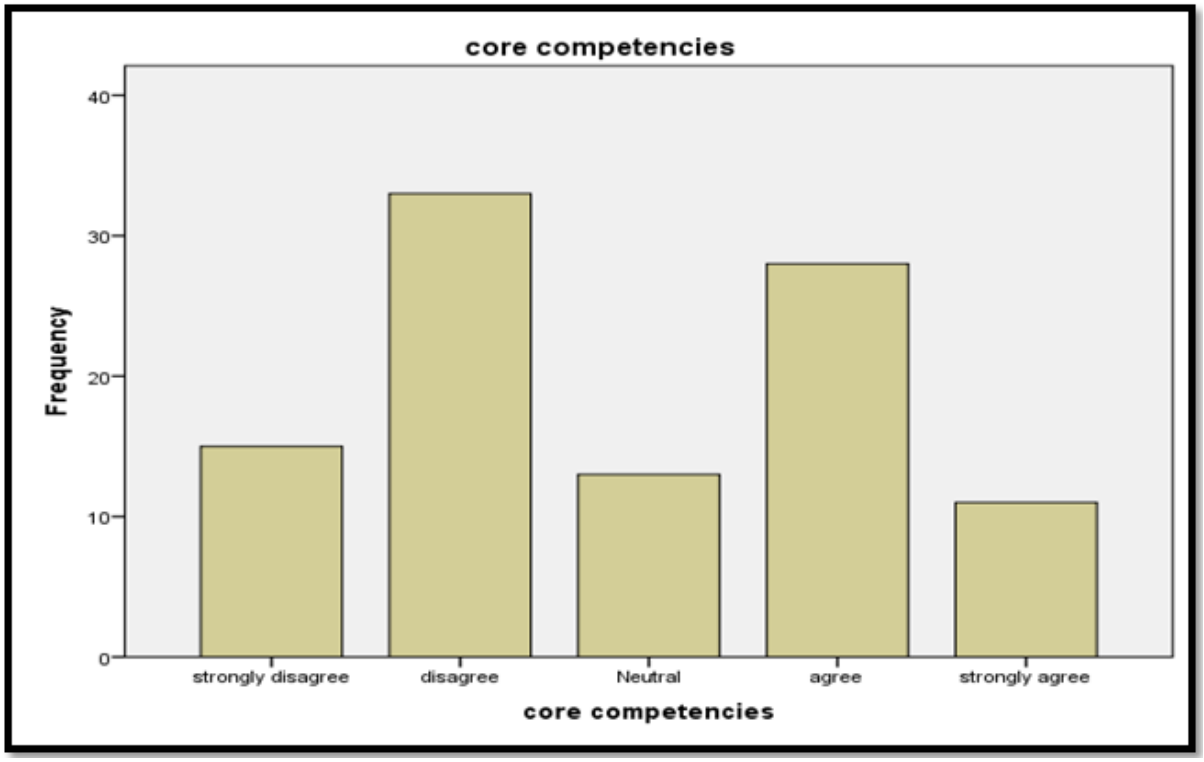


Linking complementary core competencies (VE2)

a- 15% strongly disagree that core competencies will enhance the performance of the agile manufacturing system.
b- 33% disagree about the impact of linking complementary core competencies with the agile manufacturing system.
c- 13% are neutral about the influence of VE2 on the agile system.
d- 28% agree about enhancing the agile system through core competencies.
e- 11% strongly agree that the company has identified core competencies in the company that will assist in sustaining an agile manufacturing system.

As shown in figure (4):

Figure 4. Impact of VE2 on AMs



Reducing the concept of cash time through information sharing (VE3)

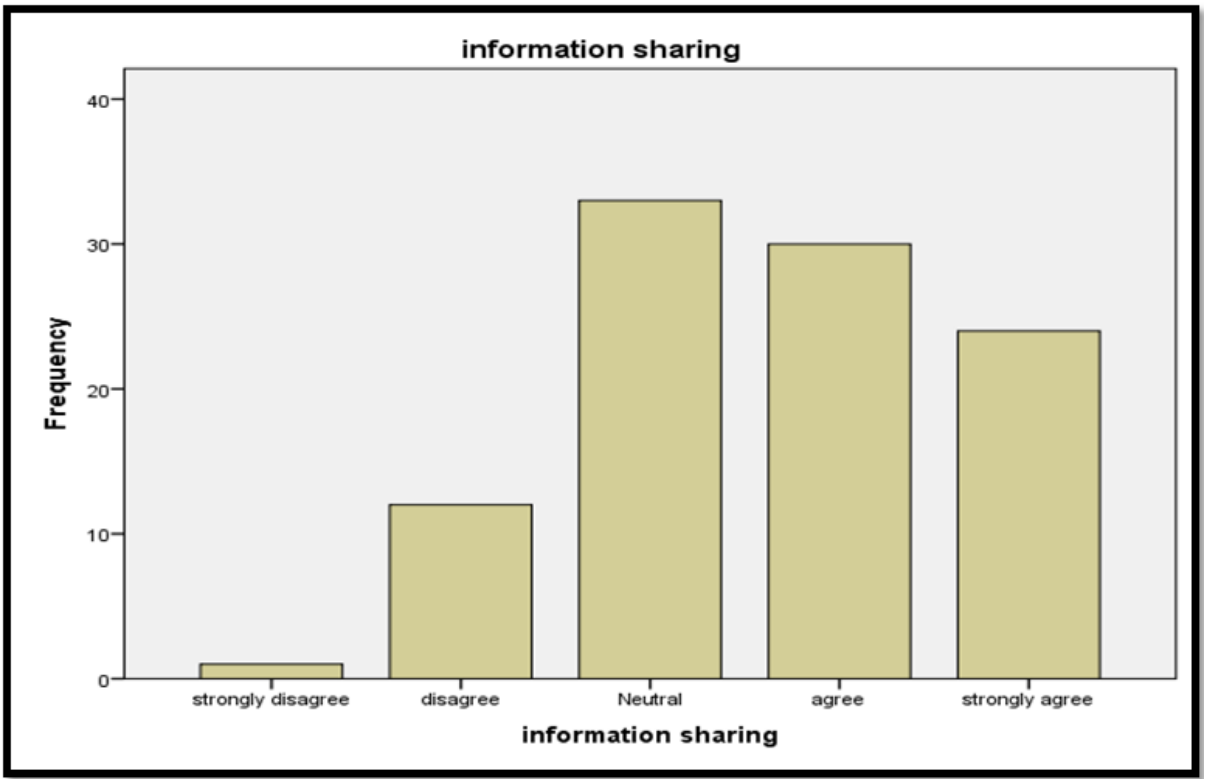
a- 1% of respondents strongly disagree that sharing information will advance the sustaining of an agile manufacturing system.
b- 12% disagree that their company was committed to continuous training and education of the workforce.
c- 33% are neutral about any impact between the two variables.

d- 30% agree a that the definition of this dimension (sharing information) has an impact on an agile manufacturing system.

e- 24% strongly agree that the company has recognised that sharing has a significant impact on sustaining an agile manufacturing system.

As shown in figure (5):

Figure 5. Impact of VE3 on AMs



Expanding production capabilities (VE4)

a- 2% of respondents strongly disagree that expanding production capabilities could enforce the process of an agile manufacturing system.

b- 10% disagree about this.

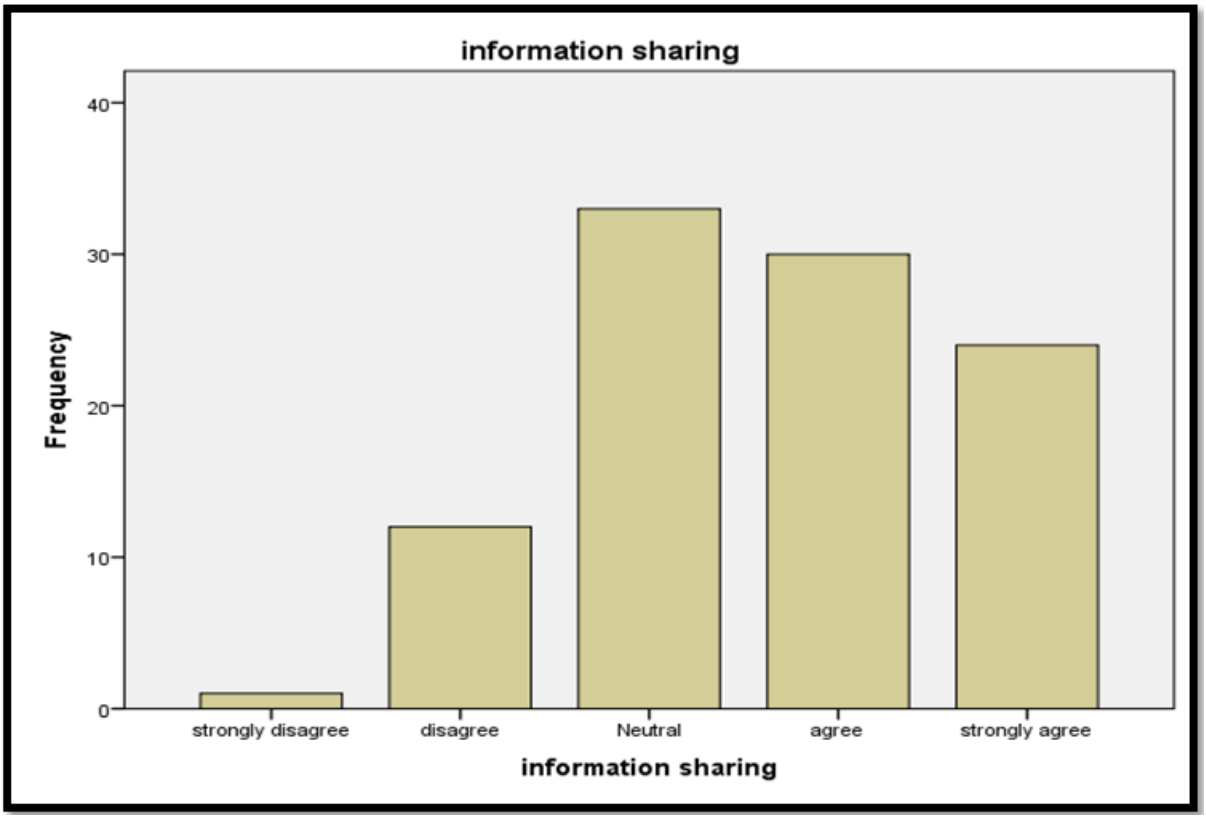
c- 19% are neutral which means the respondents neither agree nor disagree that expanding production capabilities has an impact on an agile manufacturing system.

d- 29% agree about the above.

e- 40% strongly agree that the company has to concentrate its capabilities on expanding production to boost the continuity of an agile manufacturing system.

As shown in figure (6):

Figure 6. Impact of VE4 on AMs



Gaining access to markets and sharing markets (VE5)

a- 12% of respondents strongly disagree that gaining access to markets and sharing markets enhance the sustaining of an agile manufacturing system.

b- 17% disagreed about the above.

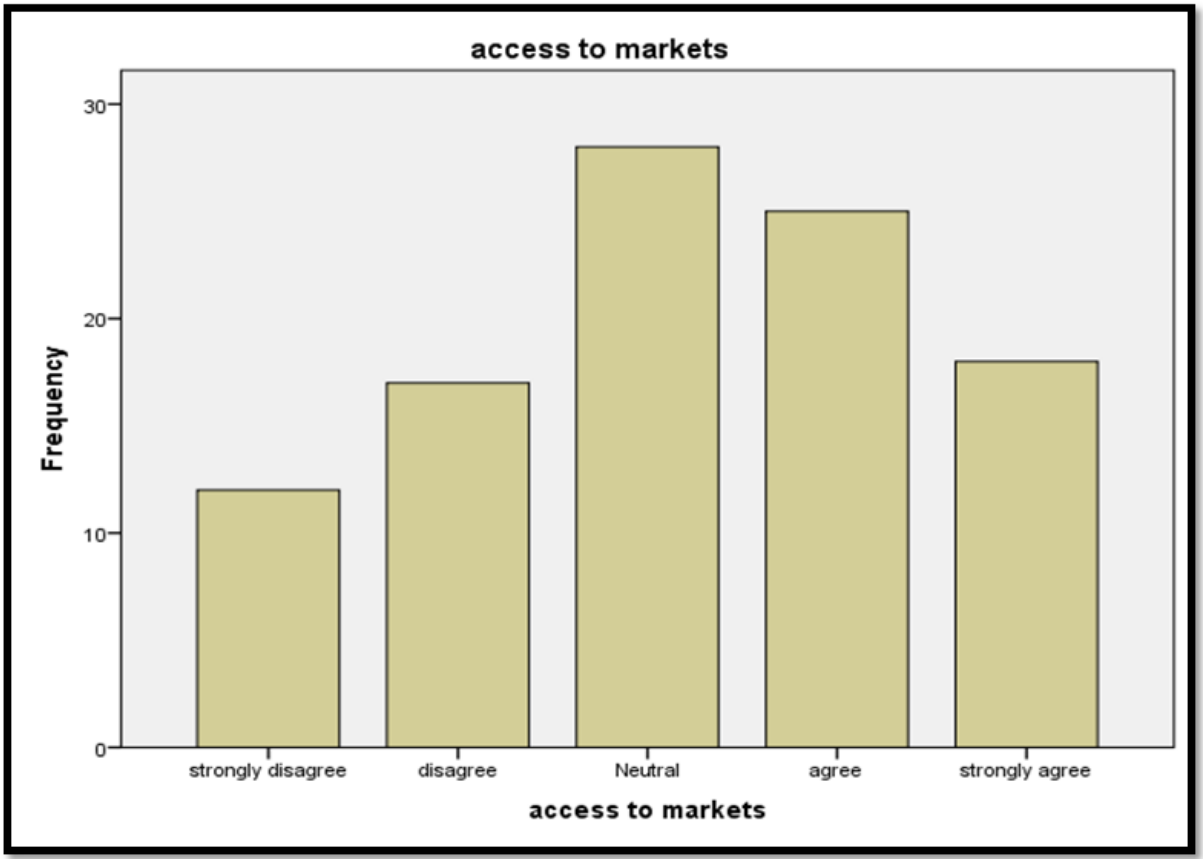
c- 28% are neutral which means that respondents neither agree nor disagree that sharing markets has an impact on an agile manufacturing system.

d- 25% agree about the terms of this dimension .

e- 18% strongly agree that the company has identified that gaining access to markets and sharing it has an important impact on sustaining an agile manufacturing system.

As shown in figure (7):

Figure 7. impact of VE5 on AMs

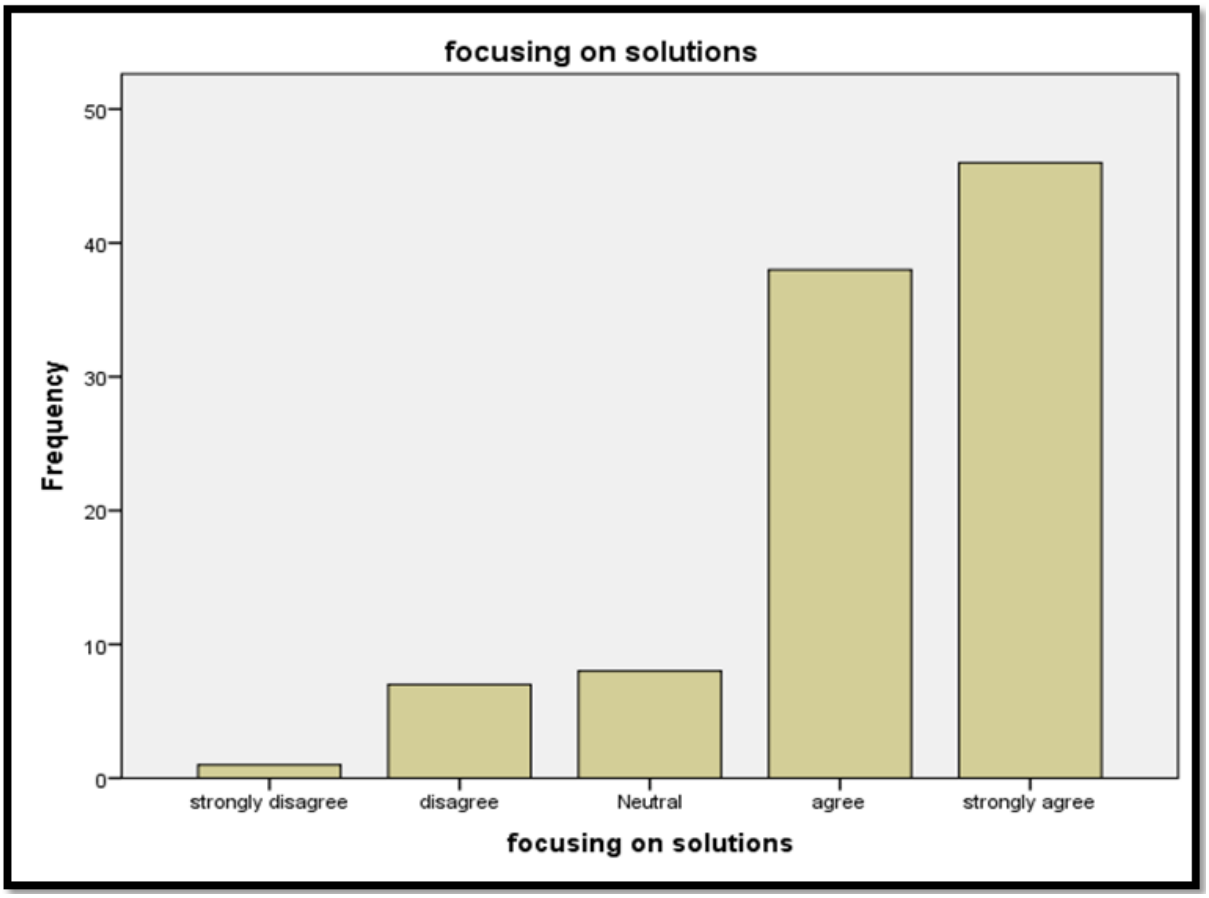


Focusing on solutions rather than selling products (VE6)

a- 1% of respondents strongly disagree that focusing on solutions will enhance the sustainability of the agile manufacturing system.
b- 7% disagree about this dimension of virtual enterprise.
c- 8% are neutral about the impact between two variables.
d- 38% agree that the terms of dimension (focusing on solutions rather than selling products) has an impact on an agile manufacturing system.
e- 46% strongly agree that the company has determined that focusing on solutions rather than selling products has an important impact on sustaining an agile manufacturing system.

As shown in figure (8):

Figure 8. Impact of VE6 on AMs



Conclusion

This paper has explored the link and impact between virtual enterprise and agile manufacturing systems in Etihad Food Industries Co. Ltd. Most of the studies in AM were conceptual in nature and lacked empirical evidence to support their proposed models and conclusions. This research not only provides a conceptual framework to systematically explore the relationship between VE and AM but also provides empirical evidence and detailed statistical analysis regarding the relationships between various constructs . More specifically the following relationships were tested using the path analysis approach:

The results of the relationship between VE and AM conclude that most dimensions are statistically significant. The study hypotheses are empirically supported.

1- Production capabilities are the most correlated variables with AGs (65%).
2- Information sharing has a 61% correlation ratio with AGs.
3- Sharing infrastructure has less correlation ratio (30%).

4- The coefficient of R= 80%. This means the change in an agile manufacturing system is caused by the virtual enterprise.
5- All dimensions of VE are significant under the 0.05 level.

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Appendix A

Table 2: correlation between VE dimensions and AMS

Correlations								
Dimensions		infrastructure	core competencies	information sharing	production capabilities	access to markets	focusing on solutions	Average AMS
infrastructure	Pearson Correlation	1	.358**	.275**	.205*	.231*	0.132	.304**
	Sig. (2-tailed)		0	0.006	0.041	0.021	0.19	0.002
	N		100	100	100	100	100	100
core competencies	Pearson Correlation		1	.617**	.509**	.608**	0.099	.349**
	Sig. (2-tailed)			0	0	0	0.329	0
	N			100	100	100	100	100
information sharing	Pearson Correlation			1	.702**	.595**	.380**	.617**
	Sig. (2-tailed)				0	0	0	0
	N				100	100	100	100
production capabilities	Pearson Correlation				1	.530**	.518**	.657**
	Sig. (2-tailed)					0	0	0
	N					100	100	100
access to markets	Pearson Correlation					1	.229*	.597**
	Sig. (2-tailed)						0.022	0
	N						100	100
focusing on solutions	Pearson Correlation						1	.567**
	Sig. (2-tailed)							0
	N							100
Average AMS	Pearson Correlation							1
	Sig. (2-tailed)							
	N							
** Correlation is significant at the 0.01 level (2-tailed).								

Appendix B

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.801[a]	.642	.618	.53417

a. Predictors: (Constant), focusing on solutions, core competencies, infrastructure, access to markets, production capabilities, information sharing

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47.501	6	7.917	27.745	.000[b]
	Residual	26.537	93	.285		
	Total	74.038	99			

a. Dependent Variable: AMV

b. Predictors: (Constant), focusing on solutions , core competencies, infrastructure, access to markets , production capabilities, information sharing

Co-efficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.567	.290		1.953	.054
	infrastructure	.137	.061	.150	2.246	.027
	core competencies	-.144-	.061	-.213-	-2.339-	.021
	information sharing	.174	.085	.204	2.047	.044
	production capabilities	.201	.078	.252	2.574	.012
	access to markets	.256	.058	.374	4.421	.000
	focusing on solutions	.254	.070	.275	3.636	.000

a. Dependent Variable: AMV

Appendix C

The impact of virtual enterprise on sustaining agile manufacturing system

I. Demographic Data

a- your position title (please select one): ____

- **Production manager**
- **Operations manager.**
- **Others**

b- experience by year:

□ **1-2**
□ **3-5**
□ **6-10**
□ **more than 10**

c- Email Address (optional): _____

II. Questions

Directions: Please indicate your level of agreement or disagreement with each of these statements regarding the phrases of virtual enterprise that you think could enhance the agile manufacturing system.

Virtual Enterprise Dimensions

Dimensions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
sharing infrastructure, R&D, financial resources (VE1) have an impact on AMS.					
linking complementary core competencies (VE2) have an impact on AMS					
reducing the concept to cash time through information sharing(VE3) have an impact on AMS					
expanding production capabilities (VE4) have an impact on AMS					
gaining access to markets and sharing markets(VE5) have an impact on AMS					
focusing on solutions rather than selling products(VE6) have an impact on AMS					

sharing infrastructure, R&D, financial resources (VE1) have an impact on AMS					

Agile Manufacturing system
Agility assessment

Dimensions	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
critically relation of suppliers(AM1)					
competitors circumstances (AM2)					
technology changing situations (AM3)					
Market place nature(AM4)					
customer requirements levels and rate(AM5)					
social/ culture changes (AM6)					
products/ process complexity(AM7)					
critically relation of suppliers(AM1)					

III. Thank you for sharing your experience with us.