Abstract Number : 008-0016

Abstract Title "Agile Capabilities in Uncertain Business Environments: an empirical study of the Jordanian Manufacturing Sector"

POMS 19th Annual Conference

La Jolla, California, U.S.A.

May 9 to May 12, 2008

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Abstract

Purpose- To explore and investigate the relationship between the amount of change related to marketing and manufacturing functions and the overall needed level of agility in the Jordanian Industrial Sector.

Design/methodology/approach- A cross-sectional survey employing a questionnaire method of data collection was adopted. An entire population, which consisted of 88 Jordanian Manufacturing Companies classified in Amman Stock Exchange Market, was targeted by this study.

Findings- The results of data analysis suggested that the overall level of agility needed is associated with the amount of change related to marketing and manufacturing function.

Research limitations/implications- The research has not taken into consideration the effect of the moderating and intervening variables (*such as company size, business unit, organisational structure, industry type, etc.*) on the relationships between the amount of changes associated with marketing and manufacturing function and the overall needed level of agility that is required for coping with uncertainties.

Practical implications- Enumerating the changes related to marketing and manufacturing functions provides a basis for identifying the needed level of agility.

Originality/value- This paper offers assistance to managers in linking the level of agility needed to changes associated with marketing and manufacturing functions.

Keywords- Agile capabilities; Uncertainty; Amount of change.

Paper type- Research paper

Introduction

In today's business environment characterised by rapid changes, shorter product life cycles and customised products, manufacturing agility is emerging as a key competitive weapon. As a result of changing circumstances in business environments, agility is seen as a prime requirement for coping with uncertainty. Agility according to Sanchez and Nagi (2001) means different things to different enterprises under different contexts, they argue that agility is characterised by cooperativeness and synergism (possibly resulting in virtual corporations), by a strategic vision that enables thriving in face of continuous and unpredictable change, by the responsive creation and delivery of customer valued, high quality and mass customized goods/services, by nimble organisation structures of a knowledge and empowered workforce, and facilitated by an information infrastructure that links constituent partners in a unified electronic network (Sanchez and Nagi, 2001, p. 3561). It could be concluded from these characteristics that agility is strategically important to organisations to enable them to thrive in turbulent environments where more attention should be paid towards a quick response to the rapid changes that may result from business decisions. However, these changes should be managed effectively and efficiently at the lowest cost with the least disruption to the existing production operations.

Clarifying the concept of agility

Flexibility and agility concepts are used in the literature (e.g. Yusuf et al., 1999, Zhang and Shirifi, 2000, Helo, 2004) as competitive weapons required for coping

with uncertainty. Sometimes these concepts are used as synonyms, but it is very important to distinguish between the two concepts. Zhang et al. (2002) define flexibility as "*the organisation's ability to meet an increasing variety of customer expectations without excessive costs, time, organisational disruptions, or performance losses"* , while Yusuf et al. (1999) define agility as *"the successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment*".

According to Helo (2004), flexibility as a close concept to agility refers to the capability to adapt to a changing environment and is also related to the concept of elasticity. It is the ability to manufacture in different conditions, whilst agility is a business concept for a company. In a similar approach, Sanchez and Nagi (2001) point out that some researchers contrast flexible manufacturing systems (FMS) and agile manufacturing systems (AMS) according to the type of adaptation: FMS is reactive adaptation, while AMS is proactive adaptation. Similarly, Tan (1998) supports the idea that agility and flexibility are closely related. Flexibility refers adaptability and versatility while agility is related to the speed that a system adapts. Therefore, flexibility is a necessary condition for agility.

Despite the differences between flexibility and agility concepts, it could be concluded that both concepts are extensively required for coping with uncertainty in a reactive or proactive manner. The term agility as a concept in manufacturing was introduced for the first time in the report presented by Goldman et al. (1991) at Iaccoca Institute,

Lehigh University in the United States. The report's title is: "Twenty-First Century Manufacturing Enterprise Strategy" and it is used as a main reference for agility and agile manufacturing studies (e.g. Yusuf et al., 1999; Tan, 1998; Ramasesh et al., 2001; Kassim and Zain, 2004). In his comment on the Goldman report, Tan (1998) mentions that the report had three key points:

1. A new competitive environment is emerging, which is acting as a driving force for change in manufacturing;
2. Competitive advantage will accrue to those enterprises that develop the capability to rapidly respond to the demand for high quality, highly customised products; and
3. To achieve the agility that is required to respond to these driving forces and to develop the required capability, it is necessary to integrate flexible technologies with a highly skilled, knowledgeable, motivated, and empowered workforce.

Drivers of agility

Organisations are required to maintain their competitive advantage by determining the level of agility required for coping with changes in unpredictable environments. Thus, change is the main reason that leads organisations to seek for agility. This idea is consistent with the conclusion drawn by Yusuf et al. (1999) who state "The *main driving force behind agility is change"*. Therefore, it could be concluded that the primary purpose of agility is to cope with uncertainty. Uncertainty is the condition under which an individual doesn't have the necessary information to assign probabilities to the outcomes of alternative solutions (Hellriegel et al., 1999). A major

concern of organisations is how to deal with uncertainty and is a major challenge. In this context, Becker and Knudsen (2005) indicate that one of the central problems faced by management today is how to cope with the uncertainties arising from the internationalisation of competition, increasing pressures to innovate, new communication technologies, and other sources of turbulence.

According to Awwad (2004) there is a debate about how organisations respond to uncertainties. Some of the discussions have highlighted the role of organisational structure in dealing with uncertainties, which emphasise the role of organic structure in managing the available resources and capabilities in organisations to minimise the environmental threats and at the same time to maximise the expected benefits. In this context, Pagell and Krause (1999) indicate that many of the early works on organisation theory address how organisations should arrange their structures to respond to uncertainty in the external environment. They argue that successful firms in relatively certain and predictable environments would have a mechanistic structure with greater subdivision of tasks and simpler jobs. In contrast, successful firms in uncertain and unpredictable environments would have more organic structures, with less specialisation and more complexity.

However, agility rather than organic structure is now seen as a way for manufacturing organisations to adapt to uncertain external environments. Therefore, organisations need to be agile to respond effectively to uncertainty in the external environment. In this context, Newman et al. (1992) conclude that contemporary firms strive to compete on the basis of flexibility and speed in order to cope with uncertainty. In the same vein, Pagell and Krause (2004) emphasise that one of the most widely accepted

theoretical relationships in the field of operations management is the link between uncertainty and flexibility. Thus, it is the agility that enable organisations reactively or proactively to cope with uncertainty. In this context (Helo, 2004, p. 567) states "*a manufacturing company being agile should not be only reactive for uncertainty but also proactive for unknown".* This view is consistent with the argument presented by Sharifi and Zhang (1999) in which they indicate that the term agility comprises two main factors. They are:

- Responding to change (anticipated or unexpected) in proper ways and due time.
- Exploiting changes and taking advantage of them as opportunities.

Similarly, Katayama and Bennett (1999, p. 44) support the above idea in which they indicate that agility has been expressed as having four underlying principles. These are:

- Delivering value to the customer;
- Being ready for change;
- Valuing human knowledge and skill; and
- Forming virtual partnerships.

As a result, agility should be considered as a competitive weapon, which leads to a quick response to changing circumstances. Quick response is defined by (Christopher et. al, 2004, p. 372) as "*a state of responsiveness and flexibility in which an organisation seeks to provide a highly diverse range of products and services to a*

customer in the exact quantity, variety and quality, and at the right time, place and price as dictated by real-time customer/ consumer demand". In the same vein, Christopher et al. (2006) have linked the term responsiveness to the term agility. They state "Agility is concerned primarily with responsiveness. It is the ability to match supply and demand in turbulent and unpredictable markets.

Christopher et al. (2006) have also addressed the term agility considering it as a business–wide capability that embraces organizational structures, logistics processes and, in particular, mind-sets. They argue that the origins of agility as a business concept lie in flexible manufacturing systems. They have also contrasted the lean concept to agility concept in which lean concepts work well where demand is relatively stable and hence predictable and where variety is low. Conversely in those contexts where demand is volatile and the customer requirement for variety is high, a different approach is called for. This approach is called agility.

However, the two paradigms agility and leanness can complement each other. In the work presented by Christopher and Towill (2001), the authors have addressed the combinations between the two paradigms to enable highly competitive supply chains capable of winning in a volatile and cost-conscious environment. They refer to Naylor et al. (1999) to explain the differences between the paradigms as:

"Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace".

"Leanness means developing a value stream to eliminate all waste including time, and to enable a level schedule".

However, it is very important here to report that there is no census on how to master uncertainty. In this sense Oetinger (2004, p. 57) emphasises the role of strategic thinking whilst dealing with uncertainty in which he states *"there is no tool that can switch off uncertainty in business. The aim of strategic thinking is thus not to achieve certainty but to prepare us for uncertain times"*. Most organisations according to Newman et al. (1992) have more options in dealing with uncertainties. Examples of these options are presented below:

- Trying to insulate the technical core from the impact of uncertainty;
- Using buffering mechanisms to handle the uncertainty of complex manufacturing environments
- Producing a variety of products and volumes, accommodate external uncertainty by using more general-purpose technologies and decentralised infrastructure;
- Increasing integration and simplification both of technologies and infrastructure can decrease internal uncertainty; and
- Better-integrated buyer/vendor relationships can reduce external uncertainty.

Recently, Christopher and Lee (2004) assure the role of shared information among the supply chain members in reducing uncertainty and thus reducing the need for safety stock. They argue that the system becomes more responsive and, ultimately, could become demand driven rather than forecast driven.

Considering the above argument, it could be concluded that manufacturing companies need to be agile for dealing with uncertainty. However, the rationale for agility in manufacturing systems is the fact that agility can gain great benefits for manufacturing companies. In his review for the literature on agility, Helo (2004) concludes the following three characteristics for agile manufacturing:

1. Delivering value to customers, especially, in time-based measures;
2. Being ready for changes in terms of market and technologies; and
3. Prospering from the turbulent environment emerging.

Similarly, Yusuf et al. (1999, p. 36) indicate that the main points in the definition of agility of various authors may be summarised as follows:

∞ High quality and highly customised products;

∞ Products and services with high information and value-adding content;

∞ Mobilisation of core competences;

∞ Synthesis of diverse technologies;

∞ Response to change and uncertainty; and

∞ Intra-enterprise and inter-enterprise integration.

Reviewing the literature on flexibility and agility shows that uncertainty is caused by a number of factors which place an emphasis on manufacturing companies to be agile. Newman and Sridharan (1993) point out that the level of uncertainty faced by a firm can be linked to factors such as: number of products manufactured, number of

engineering changes, variety of order sizes, inconsistency in promised lead times and delivery date changes. Some researchers (e.g. Cheng et al., 1997; Narian et al., 2000) argue that the sources of environmental uncertainty emerge from two perspectives. The *first* is from the perspective of marketing function. Marketing function is concerned with the capability to cope with dynamic market change. The *second* is from the manufacturing function. Manufacturing function deals with the flexibility inherent within the manufacturing resources and the production management system that provides or supports the desired level of market based flexibility. Similarly, Davis (1993) distinguishes between three sources of uncertainty: customer demand, manufacturing and supply. The effects of change drivers according to John et al. (2001) are summarised in four groups as presented in Table I:

take in Table I

Based on their review for the previous studies, Lin et al. (2006) summarise the agility drivers in five factors: (1) market volatility (2) intense competition (3) changes in customer requirements (4) accelerating technological change, and (5) changes in social factors. Similarly, Kara and Kayis (2004) referring to Chen and Everett (1991) argue that the environmental uncertainty is linked to two groups: environmental uncertainties with regard to marketing, and uncertainties with regard to the manufacturing process. They indicate that the both groups require manufacturing companies becoming flexible or agile. In Table II, various factors of uncertainties have been classified as either marketing or manufacturing related factors.

take in Table II

Considering the above sources of uncertainties, Gerwin (1993) strongly prompts organisations to cope with uncertainty whether it is linked to product markets, or manufacturing processes and their inputs. The literature on agility proposes many capabilities to deal with uncertainty. Zhang and Shirifi (2000) have developed a methodology for achieving agility in manufacturing organisations. The methodology divides the capabilities into four major categories namely: *responsiveness*; *competency*; *flexibility*; *and speed*. Recently, Lin et al. (2006) agree with Zhang and Shirifi (2000) in which they consider the same named capabilities are very important for dealing or coping with uncertainty and changes in business environment. These capabilities are described below:

1. Responsiveness, which is the ability to identify changes and respond to them quickly, reactively or proactively, and also to recover from them;
2. Competency, which is the ability to efficiently and effectively realize enterprise objectives. In other words competency is an extensive list of abilities that provide a company with productivity, efficiency, and effectiveness in achieving its aims and goals. Example on these abilities include: strategic vision, sufficient technological capability, cost-effectiveness;
3. Flexibility/adaptability, which is the ability to implement different processes and apply different facilities to achieve the same goals. It consists of items such as: product volume flexibility, people flexibility, etc; and

4. Quickness/speed, which is the ability to complete an activity as quickly as possible. Items include: quickness in new products time-to-market, quickness and timeliness in products and service delivery.

However, acquiring the above capabilities would help organisations cope with uncertainty. As changes related to marketing and manufacturing functions faced by organisations may vary, Zhang and Sharifi (2000) argue that the degree of agility required by individual organisations will be different. This degree, they indicate, is defined as the "*agility need level*". Therefore, the overall needed agility level differs among organisations and environments. Zhang and Shirifi (2000) point out since different organisations experience different sets of changes, and therefore, would require different combinations of practices and tools to cope with the changes.

Research Objectives

The motivation for this study comes from the recommendations made in the literature on agility. Ramasesh et al. (2001) referring to Gunasekaran (1999) conclude that the relationship between agility and a company's success has not been scientifically tested. In addition, the research has originality in the following aspects:

1. Originality in testing a model, which predicts the hypothesised relationships between the amount of change related to marketing and manufacturing functions and the overall needed level of agility that is required for coping with uncertainty.
2. Originality in conducting empirical work in the industrial sector in Jordan. This work has never been done before in Jordanian manufacturing companies.

3. Originality in testing some of the theoretical ideas concerning the relationship between agility and uncertainty. Much of the previous research has theoretically emphasised the role of agility in coping with changes in business environment. But this study, has empirically, investigated what was theoretically hypothesised regarding the importance of agile capabilities in coping with uncertainty.

The major objectives of the research are concerned with answering the following questions:

1. Is the overall level of agility needed associated with amount of changes related to marketing and manufacturing functions?
2. To what extent are Jordanian manufacturing companies agile enough for coping with uncertainty related to marketing and manufacturing functions?
3. What are the main agile capabilities that can be used for dealing with uncertainty?

Research model

Considering the argument presented in the previous sections, a research model is proposed and is depicted in Figure 1. The model suggests that the overall level of agility needed is determined by predicting the amount of change associated with marketing and manufacturing functions. The model comes from the fact that the sources of environmental uncertainty emerge from two perspectives: marketing function and manufacturing function (Cheng et al., 1997; Narian et al., 2000). These

two functions are viewed as the independent variables of this research while the overall needed level of agility is viewed as the dependent variable.

However, it has been argued that determining the required level of agility is done by matching agility driver assessment with agility capabilities. In this context, Lin et al. (2006) argue that different types of changes need to be predicted to assess the agility drivers. These changes include: changes in marketplace, change in competition, change in customer desire, change in technology, and change in social factors. As a result, the challenge that faces management today is how to cope with uncertainty caused by changes in marketing and manufacturing issues such as the changes in customers' expectations, product innovation, intense competition, new communication technologies, etc. (Becker and Knudsen, 2005). This notion is consistent with the major objective of this research, which is: *determining the extent to which the needed level of agility is determined by the amount of changes related to marketing and manufacturing functions.* Thus it is expected that agile capabilities play a major role in reducing uncertainty related to marketing and manufacturing functions. This notion means that agility has a job to do; its function is to enable a firm to respond effectively to changing circumstances in both internal and external environment**.**

take in Figure 1

Methodology

Data collection methods and measurement of the research constructs

A decision was made to adopt a positivistic methodology, because of the need for quantitative data to satisfy the objectives of the research and the need for a large sample to carry out the data analysis. In addition, the researchers needed to examine the anticipated relationships included in the research model depicted in Figure 1.

Data collection consisted of a questionnaire designed to test the model and a delivery and collection questionnaire method was used in distributing and collecting the questionnaires to ensure a high response rate and to take the advantages of personal contact since this method enhances respondent participation. However, to ensure that the criteria of questionnaire construction and pre-testing were met, time and effort was devoted towards design, layout, and wording of the questionnaire used in this research. As a result, the survey instrument was pre-tested with executives and academic experts who were asked to review the questionnaire for readability, ambiguity, completeness, and to evaluate whether individuals items appeared to be appropriate measures of their respective constructs. (Dillman, 1978; DeVellis, 1991). This process has led to several minor changes, which were made prior to generating the final version of questionnaire. The questionnaire format was highly structured where all of its questions were fixed-response alternative questions that required the respondents to select from responses which are located by using a five point Likert scale.

All of the measurement scales used in this research was based on existing research. Assuring the validity and reliability measures requires supported literature to validate

the measurement scales used for operationalising the research constructs. For measuring agile capabilities, capabilities were divided into four groups namely: responsiveness, competency, flexibility, and quickness. The measurement scales and indexes were adapted from the previous work of: Becker and Knudsen (2005); Zhang and Sharifi (2000) for measuring *responsiveness, competency and quickness*; Gupta and Somers, 1996; Zhang et al. 2002 for measuring *flexibility*. Because flexibility is a multidimensional concept it was divided into five dimensions namely: volume flexibility, mix flexibility, labour flexibility, expansion flexibility, and delivery flexibility. These dimensions according to Pagell and Krause (2004) are commonly found in the manufacturing strategy literature to address the competitive priority of flexibility.

Marketing-related factors construct is a term which refers to the all factors associated with marketing function as a process and concept rather than a department. At the same time, the manufacturing-related factors construct is used to describe and quantify the factors that may affect the marketing function as a process and concept rather than an organisational unit. For measuring the variable of *marketing-related factors*, the measurement scales used in this research were adapted from Chen et al., 1992; De Toni and Tonchia, 1998; Zhang and Sharifi, 2000; and Kara and Kayis (2004), while measuring the variable of *manufacturing-related factors* was done using the measurement scales adapted from Chen et al., 1992; Gerwin, 1993; and Corrêa, 1994.

However, the amount of change is a term refers to the volume of change that may face an organisation. In other words, it is a measure for the dynamism of change. Amount

of change is operationalised in this study using a five point Likert scale where the respondents where asked to rate the amount of change (from very low to very high), which they perceive is taking place in each of the marketing-related factors and manufacturing-related factors. The overall needed level of agility is a function for the amount of change taking place, thus, the higher amount of change taking place, the higher level of agility is required for coping with uncertainty. A sample of questions determined for measuring the above constructs is given in Table III:

take in Table III

The data of interest in this study are responses from executives with titles of Director, Vice-President, Operations or Production Manager, and Marketing Manager. They were selected as targeted managers for addressing the research objectives due to the fact that the measurements of the research variables were done based on the literature of operations and marketing since the focus of this research is on predicting the relationship between the amount of change related to marketing and operations functions and the needed level of agility that is required for coping with uncertainty.

Jordanian manufacturing companies that are classified as public shareholding companies at Amman Stock Exchange Market were chosen as the targeted population for this research because the industrial sector is more relevant and clearly reflects the constructs of this research since its variables are related to manufacturing rather than services. Because the population of this research is small, the entire population, which consisted of 88 industrial companies that are classified at Amman Stock Exchange

Market as industrial shareholding companies according to its report for the year 2004, was targeted as the sample. The decision was made to adopt the individual distribution to administer the questionnaire. The questionnaire was accompanied by a covering letter explaining the research objectives. The participants were asked to complete the questionnaires, which were picked up later. The main reason for choosing the entire population is to ensure that the sample is representative and not biased.

The main survey consisted of 352 questionnaires. Each manufacturing company was delivered four questionnaires to be given to the Director, Vice-President, Operations or Production Manager, and Marketing Manager. The respondents comprised 171 questionnaires, of which 162 completed questionnaires were returned and a further 9 questionnaires were returned with a letter explaining that they have not had enough time to complete the questionnaire and their company policy did not allow them to respond to surveys. Out of 162 completed questionnaires only two were unusable. The completed questionnaires were collected from executive with title of Director (n = 26), Vice-President (n = 31), Operations or Production Manager (n = 55), and Marketing Manager (n = 48). These usable responses represented a response rate of 45%. The responding firms cover a wide range of manufacturing activities including electronics, engineering products, electric, chemical and pharmaceutical.

Data Analysis and Discussion

A reliability test was carried out using Cronbach's alpha, which measures the internal consistency of a construct. The recommended minimum acceptable limit of reliability "alpha" for this measure is 0.60 (Hair et al., 2003). The results can be seen in Table

IV representing α – values constructs. The table shows that all the constructs have passed the reliability test where all α – values have exceeded the recommended minimum value of Cronbach's alpha.

take in Table IV

Frequency and descriptive statistics were used to determine the relative importance for each of the agile capabilities in coping with uncertainty. The results are given in Table V.

take in Table V

As seen in Table V, the respondents agreed that their companies use the different agile capabilities in dealing with uncertainty caused by manufacturing and marketing changes. Responsiveness was ranked with an average of 3.85 as the most important type of agile capabilities in dealing with uncertain business environment. The next frequent type of agile capabilities was flexibility, which was ranked in the second class with an average of 3.70. Competency and quickness are ranked with an average of 3.64 and 3.46 respectively. It was noted that all the agile capabilities seen in Table V have an average of above 3. This result leads us to conclude that all of the agile capabilities listed above occupy a considerable importance in the manufacturing firms' view in Jordan. This result is justified as it is expected that agile capabilities are interrelated. An organisation needs to be responsive in order to be flexible; at the same time flexibility requires quick response for accommodating the changes result

from uncertain business environments. To address the interrelationships between the agile capabilities, a correlation matrix is given in Table VI. The table displays significant correlations between flexibility and each of the other agile capabilities (responsiveness, competency, and quickness). This result supports the notion that flexibility is restricted to the other agile capabilities. In other words to be agile you need to have the necessary agile capabilities as it is rationally difficult for organizations to be agile if they don't have the ability to be responsive, quick, and flexible.

take in Table VI

As flexibility is a multidimensional concept, five dimensions of flexibility were tested by this study to determine the extent that they are used for coping with uncertain business environments. In this context, Newman et al. (1992) conclude that contemporary firms strive to compete on the basis of flexibility and speed in order to cope with uncertainty. Table VII shows the descending means of these dimensions based on their importance for response to changes in a turbulent business environment from the respondents' view.

take in Table VII

Volume flexibility was ranked with an average of 3.9 as the most important type of flexibility in dealing with uncertain business environment. The next frequent type of agile capabilities was labour flexibility, which was ranked in the second class with an average of 3.83. The result can be justified due to the importance of volume flexibility in response to uncertainty since volume flexibility according to Kara et al. (2002) is a result of uncertainty concerning the amount of customer demand for the products offered. In the same vein, (Oke, 2003), point out that the major drivers of volume flexibility requirements in manufacturing plants were found to be demand uncertainty, short product life cycle, supply chain complexity and competitors' actions. The other dimensions are approximately having closed means. More specifically all the dimensions have an average more than (3), and standard deviation less than 1. The standard deviations are closed for all variables. This is an indication that the dispersion of the respondent's responses was small. This indication gives an insight that there is a strong tendency between the respondents to agree on the items that are operationalised for measuring the research variables.

Hypothesis Testing

The hypotheses of this research are aimed at investigating and examining the relationships between the overall level of agility needed and the amount of change from marketing and manufacturing functions. In other words, the hypotheses are aimed at investigating the extent that the construct of overall level of agility needed is a function for uncertainty associated with marketing and manufacturing functions. However, hypothesis 1 is concerned with investigating the extent that Jordanian

manufacturing companies use the agile capabilities in dealing with uncertainty is consistent with objectives 2 and 3 of the research, while hypothesis 1 is an attempt for meeting the objective 1 (the central objective of the research) which is concerned with answering the following question "*is the overall level of agility needed associated with amount of changes from marketing and manufacturing functions?"*

More specifically, the rationale for developing the research hypotheses is the fact that the sources of environmental uncertainty emerge from two perspectives: marketing function and manufacturing function (Cheng et al., 1997; Narian et al., 2000). This conclusion leads us to test the hypothesised relationship between the needed level of agility and uncertainty associated with marketing function and manufacturing function is consistent with the central objective of the research mentioned above.

H1: Jordanian Manufacturing companies use agile capabilities for coping with uncertain business environment

A one-sample test was carried out to determine if the mean of the sample is similar to that of the population. The population mean is unknown, using the scale provided below which its average is equal to 3, we can formulate the above hypothesis in a mathematical expression form as shown below.

(1)	(2)	(3)	(4)	(5)
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

HO: μ = 3

HA: μ > 3

Constructing a 95% confidence interval of the difference, the results presented in Table VIII show that there is no significant difference between the sample mean and the population mean for each of the agility variables (agile capabilities). This result leads us to accept the hypothesis that the mean of the sample is similar to that of the population mean **(μ).**

take in Table VIII

H2: The overall needed level of agility is associated with the amount of change related to marketing and manufacturing functions

Multiple regression analysis was conducted to test this hypothesis. Multiple regression identifies how much of the variance in the dependent variable will be explained when a set of variables is able to predict a particular outcome. Hence, a multiple regression analysis is conducted. The results of multiple regression analysis are presented in Tables: IX and X. Based on the above hypothesis, two independent variables are identified: *amount of change related to marketing function and amount of change related to manufacturing function*, while the dependent variable or outcome variable is the *overall needed level of agility.*

take in Table IX and Table X

Multicollinearity between the two independent variables was checked using the collinearity statistics: Tolerance and Variance Inflation Factor (VIF). Tolerance is the amount of variance in an independent variable that is not explained by the other independent variables. The minimum cutoff value for tolerance is typically .10. That is, the tolerance value must be smaller than 0.10 to indicate a problem of multicollinearity. VIF measures how much the variance of the regression coefficient is inflated by multicollinearity. A VIF measure of 1 is an indication of some association between predictor variables, but generally not enough to cause problems. A maximum acceptable VIF value would be 5; anything higher would indicate a problem with muticollinearity (Hair et. al, 2003, p. 305). The results of multiple regression analysis are seen in Table X. Looking at the information for the regression model depicted in Table X, and considering the above rules, the results haven't shown any problem with multicollinearity since the tolerance values and the VIF values for the both independent variables are ranging within the acceptable limits of the collinearity statistics (Tolerance, VIF).

take in Table X

With regard to the relationships between the independent and dependent variables, as seen in Table IX, the results emerged from the multiple regression analysis revealed that the coefficient of determination R^2 which predicts the relationship between the independent variables and dependent variable is equal to 0.44. This indication shows

that 44% of the total variance in the dependent variable (overall needed level of agility construct) is accounted for by the independent variables (the amount of change related to marketing function, and the amount of change related to manufacturing function).

This R^2 Value is not believed that is a high value, and therefore it is both rational and reasonable as it is known that ($0 \leq R^2 \leq 1$), this means that the more R^2 is the more proportion of the total variation in the dependent variable is explained by the independent variables in the regression equation. Therefore, it could be concluded that the R^2 value for the equation as a whole is 0.44, implying that 0.56 of the variance in the dependent variable (overall needed level of agility construct) is not explained by the two independent variables (the amount of change related to marketing function, and the amount of change related to manufacturing function) in the regression equation. This indication motivates other researchers to search for other variables that may contribute to explanation of the total variation in the overall needed level of agility construct.

It is also important to point out that the R^2 value (0.44) is considered as significant as well as a reasonable ratio due to the following:

1. The hypothesis that predicts the relationship between the two independent variables (the amount of change related to marketing function, and the amount of change related to manufacturing function) and the dependent variable (overall needed level of agility) is supported and accepted by the results of multiple regression mentioned above.

2. The literature on operations strategy (e.g. Cheng et al., 1997; Narian et al., 2000) supports the notion that uncertainty is associated with two functions: marketing and manufacturing which they are highly integrated and mainly drivers for changes and uncertainty where the focus on acquiring the agile capabilities should be emphasised.
3. As seen in Table II, the variable of marketing related factors and the variable of manufacturing related factors are considered as interrelated and multidimensional ones, and therefore it is expected that they relatively contribute to explanation of the R^2 value which is equal to 0.44.
4. As seen in Table IX, The adjusted R^2 is equal to 0.429. According to Bryman and Cramer (2001), the magnitude of R^2 is bound to be inflated by the number of independent variables associated with the regression equation. The adjusted R^2 corrects for this by adjusting the level of R^2 to take into account of the number of independent variables. The adjusted R^2 for the equation as a whole is 0.429, which is just a little smaller than the non adjusted value

As shown in Table X the evidence of the multiple regression analysis shows that a positive *significant* relationship is found between each of the two independent variable (the amount of change related to marketing function, and the amount of change related to manufacturing function) and the dependent variable (the overall needed level of agility). The results of the multiple regression analysis revealed that the calculated t-values (t=8.277, 6.94) of the hypothesised relationship between the amount of change related to marketing function and the amount of change related to manufacturing function respectively and the overall needed level of agility is *significant*.

This result is similar to findings from empirical work conducted by Vazquez-Bustelo and Avella (2005) in which they argue that the business environment, as a source of change and generator of uncertainty, has been considered the main motivator or agility driver. Thus, new forces and changes in the market's competitive landscape (changing customer expectations and escalating requirements to satisfy individual needs, globalization, intensification of competition from a national scale to a global arena, social pressure, fragmentation of mass markets into niche markets, technology and management innovations, shorter product life cycles, increasing product variety, strong need for rapid and dynamic product innovation cycle, etc.) are identified as precursors of agile manufacturing in that they are forcing firms to adopt practices linked to the new manufacturing paradigm (Vázquez-Bustelo and Avella , 2005, p. 2). Considering the agility drivers mentioned by Vázquez-Bustelo and Avella (2005), it could be concluded that most of them are related to the both main functions: marketing and manufacturing which support the significant relationship between the overall needed level of agility and the amount of changes related to marketing and manufacturing functions. Similarly, Lin et al. (2006) argue that different types of changes (i.e. changes in marketplace change in technology) need to be predicted to assess the agility drivers.

However, it is important to report here the findings of this study contradict the results emerged from other empirical works. In the work conducted by Pagell and Krause (2004), their attempts to empirically validate a relationship between the level of environmental uncertainty and the level of flexibility have failed to show a significant relationship. This contradiction is justified since different scales and measurements were used and as a result different organizations experience different sets of changes.

Agility within the Jordanian context

This study is concerned with investigating the ability of Jordanian manufacturing companies to use agile capabilities in uncertain business environments. To this end, our study is not a comparative one where there was no need to compare manufacturing industry in a developing county like Jordan with manufacturing industry in developed countries like Japan, Europe, or North America. Such comparisons need similar environments to draw sensible conclusions. But, it was noted that manufacturing industry in Jordan needs to be agile as it is at the dawn of a new era. The integration of the country in the World Trade Organisation, the ratification of the US Jordan Free Trade Agreement and of the Euromed program, is the starting point of Jordan's industry introduction to the global economy. Competition will be tough and the industrial sector has to implement structural changes to face it. The Jordanian industry has comparative advantages against the foreign one cost-wise, but the free access to the domestic market for imported goods represents a threat for the local industry. (http://www.1stjordan.net/content/editouk/industry.html).

Jordan's import policy theoretically was designed to promote domestic manufacturing industries by ensuring their access to cheaper imported capital goods, raw materials, and other intermediate inputs rather than by granting them monopoly markets. The government believed that development of a domestic manufacturing base had to be led by exports because Jordan's small population could not generate enough consumer demand for manufacturing plants to achieve economies of scale or scope. In some cases, consumer demand was too low to justify building even the smallest possible

facility. Domestic consumer demand alone was insufficient to support some manufacturing industries despite the relatively high wages paid to Jordanian workers; the high wages resulted in increased product costs and diminished export sales of manufactured goods (http://countrystudies.us/jordan/49.htm).

Moreover, Jordan has inadequate natural resources such as oil which allow the political, legal, and cultural changes in the local and global regions take place in manufacturing industry in Jordan, for example, the oil prices in Jordan have increased due to the outcomes of the US-led invasion of Iraq in 2003. In this context, Christopher et al. (2006) argue that "The uncertainty in oil markets before and after the US-led invasion of Iraq in 2003, raised questions about the longer-term viability of globe-spanning supply chains and the underlying assumptions of prevailing purchasing practices".

Manufacturing companies in Jordan have recently paid more attention to competitive priorities such as quality, flexibility and agility to improve the achievement of modernisation, development, organisational effectiveness, competitiveness and to respond effectively to globalisation. Developing countries, including Jordan, have invested heavily in resources, time and effort to adopt managerial development practices and theories developed in western developed countries. An important question is: Does what is working in Japan, Europe or North American industry work in Jordan? It is believed that the socio-cultural factors, the economical and political environment influence business environment in developing countries including Jordan. In this regard, Atiyyah (1993) argues that a high degree of political instability has led Arab businessmen and managers to favour low-risk, short-term investment. In

making their decisions, they rely mainly on their intuition and business sense rather than on relevant and reliable information. An Arab organisation is a closed information system with low-level disclosure to organisation stakeholders, constant change and high level of uncertainty of work. In this context, Hofstede (1980) mentions four cultural dimensions distinguish between developed and developing countries. The dimensions are: power distance, uncertainty avoidance, individualism, and Masculinity denotes. Uncertainty avoidance is defined *"the extent to which a society feels threatened by uncertain and ambiguous situations by providing career stability, establishing more formal rules, not tolerating deviant ideas and behaviours, and believing in absolute truths and attainment of expertise"*. Therefore, it is expected that agility should be considered in planning the operations strategy either in developing or developed countries as uncertainty is the basic dominant situation in business environments over the world. Thus, Jordan as a developing country is witnessing a high degree of changeability due to political instability in the region caused by the Gulf wars and Jordanian manufacturing companies need to be agile to thrive in turbulent business environments both locally and globally.

Contributions to Knowledge

This study has contributed to knowledge on both the academic and practical levels. Academically, the study extends empirical research investigating the role of manufacturing flexibility and agility in coping with uncertainty (e.g. Yusuf et al., 1999, Zhang and Shirifi, 2000, Helo, 2004, Lin et al., 2006). Practically, the study has several managerial implications. More specifically, the major contribution of the findings lies in increasing the ability of operations and marketing managers to improve their skills and capabilities for responding effectively to uncertainty related

to marketing and manufacturing functions. The findings of this research suggest linking the overall needed level of agility to the amount of changes related to marketing and manufacturing functions. In other words managers are required to analyse the change associated with marketing and manufacturing functions in terms of predictability and changeability to decide what is the needed level of agility that is required for coping with uncertainty. In addition, managers are encouraged to use different agile capabilities in order to cope with changes associated with marketing and manufacturing functions. However, definitions of capabilities such as flexibility, competency, quickness, and responsiveness are linked to certain types of change. In other words, enumerating the changes related to marketing and manufacturing functions provides a basis for identifying the needed level of agility.

Limitations and further directions for future research

This research has several limitations, which should be noted. It is worth mentioning that the measures used are based on managers' perceptions, which might be subjective. The research also has not taken into consideration the effect of the moderating and intervening variables (*such as company size, business unit, organisational structure, industry type, etc.*) on the relationships between the amount of changes associated with marketing and manufacturing function and the overall needed level of agility that is required for coping with uncertainties. In addition, the sample was limited to the Jordanian manufacturing companies classified in Amman Stock Exchange Market as public industrial shareholding companies. Thus, it is not representative of global industry and therefore the findings are not generalisable, since different organisations experience different sets of changes, and therefore, would require different combinations of practices and tools to cope with the changes (Zhang

and Sharifi, 2000). The study has considered the amount of changes associated with marketing and manufacturing functions to predict their role in identifying the needed level of agility while the changes associated with other functions such as (human resource, finance, etc.) were not considered.

Despite the above limitations, this study is the first attempt in Jordan to examine empirically the relations between the mount of changes linked to marketing and manufacturing functions and overall level of agility required for coping with uncertainty. Future research opportunities should consider more empirical studies about the impact of agile capabilities on the financial and non-financial performance of a firm; the role of the intervening variables (i.e. company size, organisational level, industry type) on the relationship between agile capabilities and other variables such as performance, competitive advantage**,** the role of agile capabilities in planning the different functional strategies including manufacturing, operations, marketing, financial, and purchasing strategies, particularly, when dealing with uncertain business environments.

Conclusions

Utilising the findings of this research can help managers make sense of environmental change and checking their organisations' ability to cope with these changes. More specifically, the rationale for employing various types of agile capabilities in predicting the overall level of agility required for coping with uncertainty is threefold:

1. Organisations usually experience different levels of uncertainty that may relate to different functions such as the functions of finance, purchasing, operations, marketing, etc. which should be met by using different types of capabilities such as flexibility, responsiveness, quickness, and competency.
2. It is usually difficult for organisations to always employ one type of agile capabilities for managing different types of uncertainty.
3. Fast and dramatic changes in customer expectations, competition, and technology are creating an increasingly uncertain business environment which support the notion that the more the level of uncertainty is experienced, the more the agile capabilities are needed for coping with uncertainty. More specifically, enumerating the amount of changes provides a basis for identifying the needed level of agility that enables organizations to accommodate the uncertainty caused by marketing and manufacturing changes.

To put the findings of this study into a Jordanian manufacturing context, it could be concluded that: Jordanian manufacturing companies need to acquire the basic agile capabilities (responsiveness, competency, flexibility, and quickness) in order to have the ability to:

1. Cope with changes in business environment, particularly, the changes associated with marketing and manufacturing functions.
2. Thrive in a turbulent environment.
3. Measure their current abilities to respond effectively to changing circumstances and determine the overall needed level of agility that is required for coping with

uncertainty caused by changes associated with marketing and manufacturing functions.

However, the results of this study are consistent with the literature, in this context; Martin et al. (2004) consider the quick response as a key factor in dealing with uncertainty or variance. They conducted an empirical work employing the quick response in dealing with uncertainty in the fashion industry. They argue that speed and flexibility are the key, but it is important to realise that the level of uncertainty associated with the product dictates the optimal level of speed and flexibility required

Moreover, the findings of this study are similar to the results emerged from the empirical work by Zhang and Sharifi (2000), in which they developed a conceptual model to assist manufacturing organisations to achieve agility. The model consists of three main components: The first is concerned with "agility drivers", which are the changes in the business environment that necessitate from an organisation to search for new ways of running its business in order to maintain its competitive advantages. The second is concerned with "agility capabilities", which are the essential capabilities that the organisation needs in order to positively respond to and take advantage of the changes. The third is concerned with "agility providers", which are the means by which the "agility capabilities" could be obtained. They stated that "*Based on this model, a manufacturing enterprise experiences a variety of changes/pressures in its business environment, which drives the enterprise to identify "agility capabilities" that need to be acquired or enhanced in order to take advantage of the changes. This in turn forces the enterprise to search for ways and tools to obtain/enhance the required capabilities*" (Zhang and Sharifi, 2000, p. 498).

Therefore, based on the findings of this study and considering its model depicted in Figure 1, it could be concluded that Jordanian manufacturing companies need to:

1. Determine the agile capabilities that need to be acquired in order to cope with changes in their business environment.

2. Identify a list of business practices, methods, tools, and techniques that enable them to be more agile in coping with experienced, predictable and unpredictable changes in their business environment.

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Competitive environment	Business processes	Integration	Workforce
∞ More informed customers ∞ More evenly distributed technological capabilities among competitors ∞ More closely linked suppliers ∞ Easier entry by new competitors ∞ World wide market for suppliers and workers	∞ More knowledge about customer buying patterns ∞ Improved forecasting ability ∞ Improved production scheduling and tracking ∞ More rapid product-process design	∞ Coordination of geographically dispersed operations ∞ Coordination of culturally diverse workforce ∞ Coordination of logistics and information with dispersed networks of customers and suppliers	∞ More use of temporary workers ∞ Competition for skilled and knowledge workers ∞ Management across national cultures ∞ Difficulty in modelling organisational cultures

Table I: The effects of change drivers. Source John et al. (2001) p. 147

Marketing- related factors	Supported literature
Increased product diversity	Chen et al. (1992)
Short product life cycle	
An increase in buyer concentration (resulting in variations in demand)	
The variability of the demand (random or seasonal)	De Toni and Tonchia (1998)
Shorter life-cycles of the products and technologies	
Wide range of products	
Manufacturing- related factors	
Increased customisation	
Shorter delivery times	
Focused manufacturing	Chen et al. (1992)
Manufacturing technology innovation	
Unexpected competitors	
Uncertainty with respect to machine downtime	Gerwin, 1993; Corrêa (1994)
Uncertainty with respect to material input to the process	
Changes with respect to delivery times of raw materials	
Variations in workforce	

Table II: Factors causing flexibility needs. Adapted from Kara and Kayis (2004)

Construct	Questions
Responsiveness	∞ Our company makes quick decisions on reaction to price changes ∞ Our company has the tendency to perceive changes in customer needs ∞ Our company Periodically reviews the product development
Competency	∞ company has the ability in maintaining its position among its direct competitors in global markets in the current position ∞ Our company has the ability in predicting its market share considering the intensity of competition ∞ Our company has a strategic basis for competition (competition on: price, product differentiation/time/quality)
Flexibility	∞ Our company has the ability to operate efficiently at different levels of output ∞ Workers in our company can perform different types of operations effectively ∞ Our company has the ability to effectively respond to changes in planned delivery times
Quickness	∞ Our company can quickly change the quantities for our products ∞ Our company can changeover quickly from one product to another ∞ Our company can quickly launch new products into the market
Marketing-related factors	∞ The variability of the random demand ∞ Shorter product life cycles of the products ∞ Increased customisation
Manufacturing-related factors	∞ Manufacturing technology innovation ∞ High rate of change in introduction of new product technology related to the company's business area ∞ Complexity of technology used in products

Table III: A sample of questions determined for measuring the research constructs.

Construct	**α- Value**
Flexibility	0.7937
Competency	0.8968
Quickness	0.8549
Responsiveness	0.7856
Amount of change related to marketing function	0.9050
Amount of change related to manufacturing function	0.9330
Overall needed level of agility	0.9511

Table IV: Values of Cronbach's alpha of the research constructs

Agile capability	Mean	Standard deviation
Responsiveness	3.85	0.63
Flexibility	3.70	0.50
Competency	3.64	0.85
Quickness	3.46	0.72

Table V: Descending means of the agile capabilities in coping with uncertainty

Variable	Responsiveness	Competency	Quickness	Flexibility
Flexibility	0.369**	0.354**	0.201*	1.000

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed

Table VI: Correlation matrix between agile capabilities

Type of flexibility	Mean	Standard deviation
Volume flexibility	3.9	.70
Labour flexibility	3.83	.55
Expansion flexibility	3.7	.72
Delivery flexibility	3.66	.66
Mix flexibility	3.49	.70

Table VII: Descending means of the dimensions of flexibility in coping with uncertainty

Test value = 3						
Variable	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Responsiveness	17.067	159	.000	.8549	.7559	.9538
Competency	9.602	159	.000	.6448	.5122	.7774
Quickness	8.008	159	.000	.4578	.3449	.5707
Flexibility	18.245	159	.000	.7222	.6440	.8003

Table VIII: the results of one-sample test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.660	.436	.429	.3013

Table IX: Model summary

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.943	.288		3.269	.001		
	Amount of change taking place related to marketing function	.465	.057	.494	8.227	.000	.998	1.002
	Amount of change taking place related to manufacturing function	.299	.043	.416	6.940	.000	.998	1.002

Table X: The results of multiple regression analysis

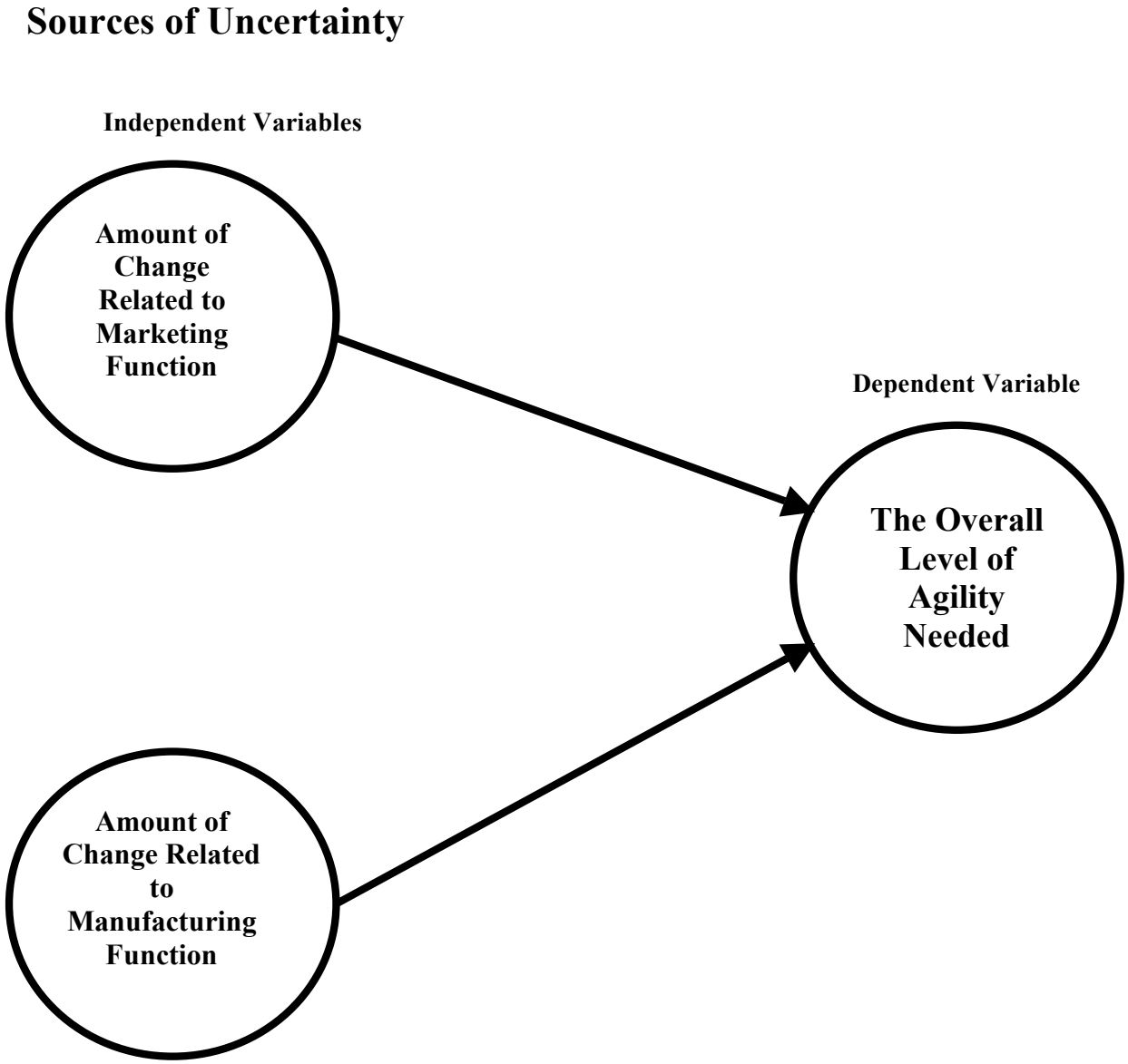

Figure 1: The Research Model