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Decision Making and Strategy Development in SMEs: An Empirical Investigation into the Role of Adaptation

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This research investigates the nature of decision making in small and medium-sized manufacturing companies (SMEs). The role of adaptation is explored through a new proposed construct, Adaptive Decision Making (ADM). ADM is defined as "a conscious or unconscious tendency to place a high priority on adaptation to the environment throughout the decision making process". ADM is based on the premise thattop managers in SMEspossess an adaptive orientation toward decision making that impacts strategy development.Data was gathered from over 500 SMEmanufacturing concerns in the US to develop and test ADM. The relationship between adaptive decision making and manufacturing strategy is explored using SEM. Results suggest that adaptive decision making plays a significant role in the formation of strategy in manufacturing SMEs.

Keywords: adaptation, adaptive decision making, strategy, SME.

1. Introduction

The continuing research on Small to Medium-Sized Enterprises is no surprise considering the major role SMEs play in the US economy and other economies around the world. According to recent data from the US SBA (USSBA, 2011) SMEs represent forty-four percent of payroll dollars and have generated sixty-four percent of the new jobs in the US over the last fifteen years and hire approximately forty percent of high-tech workers; SMEs are responsible for over half of all private sector employment in the US. SMEs generate thirteen times more patents per employee when compared to large firms and are more than twice as likely to have their patents in the top one percent most cited. In spite of their significant role, smaller firms continue to experience problems staying on the radar screen of governments and researchers. This study concentrates on one of the most threatened groups of small firms in the US, the SME manufacturing concern. With the recent shift of major manufacturing companies to cheaper labor markets around the world the US SME manufacturers are under tremendous pressure to maintain financial viability.

This research focuses on this group and contributes to what we know about decision-making in a small but significant way. The concept of adaptive decision making, with slightly different definitions, has been around for decades, however very little research in this area has been focused on SMEs and even fewer studies of an empirical design have made it to press. While a few papers have discussed ADM and possible correlates, there has been a lack of theoretical development of the construct. Consequently, there has been no measurement scale available to researchers for measuring ADM and therefore no testing of the relationship between ADM and other critical constructs such as manufacturing strategy. Thisresearch addresses this shortfall in empirical research by developing a measurement scale for ADMand testing the relationship between ADM and strategy development in SME manufacturing companies.

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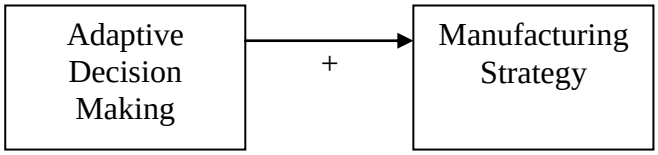
The specific contribution is the development and testing of a measurement scale for adaptive decision making, and testing the relationship between adaptive decision making and manufacturing strategy in SMEs.

This research framework investigates the relationship between the adaptive focus of the decision maker and the resulting realized strategy. Review of prior literature on decision theory and adaptation supports the proposed construct, *adaptive decision making* and the linkage between decision making and strategy. The research framework is depicted in Figure 1.1.

Figure 1.1: Research Framework



This framework tests the premise that manufacturing SMEs possess an adaptive orientation in top management decision making which influences strategy-making and the resulting emphasis on certain manufacturing strategic imperatives. In the following sections the research project unfolds beginning with a discussion of the relevant literature and theory development in section 2.0, the methodology and instrument development in section 3.0, data analysis results in section 4.0, a discussion of the results and conclusions in section 5.0, and implications for future research in section 6.0.

2. Literature Review and Item Development

Use of the term *adaptive decision making* is not new or unique to this work. Specific references to the term have appeared in articles related to the discussion of business decision making (Etzioni, 1990),decision theory and decision making (Phillips 1997), decision making in small businesses in the leisure industry (Byers and Slack, 2001) and in numerous medical science publications related to decision making under risk (for example Goldberg and Podell, 2000). *Adaptive decision making* as a construct has not emerged in the literature and use of the term is typically descriptive. The following paragraphs provide a basis for this idea from prior literature by reviewing relevant aspects of the literature on decision theory and adaptation.

The literature on decision making is exhaustive with studies on prescriptive and descriptive approaches as well as more recent contributions from medical science in brain lesion studies. Due to space constraints only a brief introduction is made here. The Rational Model prescriptions as summarized by Phillips (1997) include *true reasoning*(Parson 1909), *quality of decision making*Gelatt 1962), and *expected utility*(Savage, 1954; Pitz and Harren, 1980). The rational model makes several assumptions that have not stood up well when compared to human experience or observation. This does not mean that it has been abandoned, especially in decision prescriptive modeling. Rational decision making addresses *how a decision <u>should</u> be made* rather *than how decisions <u>are</u> made*. Some of the obvious inferiorities of rational decision making as spoken by Herbert Simon (1978) include "*failures of knowing all the alternatives, uncertainty about relevant exogenous events, and inability to calculate consequences*". These prescriptions of rational decision, in a strict sense require

omniscience behavior beyond human capacity. The beauty of rational decision making is that no matter how irrational the process is that we use to arrive at a decision we are usually quick to defend the *rationality* of the decision in the face of our limitation to make a better decision.

Based on the limitations of human capacity Herbert Simon (1955, 1978) proposed "bounded rationality" as an alternative view. Bounded rationality is based on the realization that human capacity has natural limits for absorbing and analyzing information. The limits of human capacity have become more acute with the information explosion of our age in which we cannot be completely certain of anything. March (1978) built on the work of Simon by pointing out the limitations of underlying assumptions of accuracy required by rational decision making. March (1978) discusses several alternatives to expected utility theory (a proxy for rational decision making) by offering several additional definitions of rationality. These include limited rationality, adaptive rationality, game rationality, contextual rationality, selected rationality, posterior rationality, and process rationality. Of these, the ones that are relevant to the decision space of SMEs are *limited rationality* (human capacity requires limiting the decision space), *contextual rationality* (focusing on a selected context), *adaptive rationality* (relying on knowledge and experience), and *selected rationality* (relevance to survival of the organization). These alternative definitions reflect conditions in SME manufacturing companies that face severe resource constraints in personnel, a need to comply with requests of larger customers, dependence upon a single or small group of top managers / owners, and persistent threats to survival.

Recent contributions to decision making from the medical perspective are particularly interesting in that they are a physiological perspective that has been missing thus far in the literature on decision theory.Brain lesion studies have linked decision making tendencies (which the authors refer to as adaptive decision making) to the locations of brain lesions on different areas of the brain. Goldberg and Podell (2000) concluded that the prefrontal cortex is critical for *adaptive decision making* which they describe as "a decision making process [that] involves ranking and scaling of the organisms priorities in relationship to the parameters of the external situation". Weller, Levin, Shiv and Bechara (2007) found that lesions to the amygdala region, which is the region of the brain that processes emotional responses, were correlated with impaired decision making when considering risky gains. By contrast, their findings concluded that damage to the ventromedial prefrontal cortex, which is an area connected to integrating cognitive and emotional information, exhibited impaired decision making when considering risky gains or losses. This suggests that there is a physiologicalcomponent supportingthe role of emotion in decision making and that humans have a genetically wired bias toward preserving our ability to evaluate risky losses. The authors point out that "the ability to make advantageous choices in the face of risk….. is an essential aspect of human survival". The future connection between the physiological or biological aspects of decision making and that observed in practice will produce some interesting research.

There is an interesting correlation between this research stream and the concept of adaptation discussed by McCarthy and Tan (2000) in an article applying fitness landscape theory to manufacturing environments. By adopting a "complex systems" approach (Casti, 1998), they viewed manufacturing organizations as a system which evolves over time by adopting characteristics in order to survive. Biologists have long used fitness landscape theory to explain the mechanisms by which organisms adapt to conflicting constraints and the complex interactions of the environment. This view

pictures a biological landscape where organisms adapt and search for "fitness" peaks on a rugged, multi-peaked, mountainous, "fitness landscape". While this theory certainly was not meant for business applications I find that the description is rather consistent with the modern day business reality, especially for small manufacturing concerns. These fitness points are locations of increased performance and survivability while the lower points represent non-competitiveness and the threat of extinction. While global optimums are rarely identified, local optimums, or fitness points, are sought after because they will increase performance or the likelihood of survival. Once there, the search for a more optimum location continues, moving the organism about the landscape. This is representative of the research framework proposed here; strategy development through adaptive decision making in SMEs. The SME constantly scans or does mixed scanning (Etzioni, 1990) of the environment for a more preferable position and makes decisions based on a desire to adapt to avoid extinction or improve position on the landscape.According to Mcarthy and Tan (2000), fitness landscape theory could help manufacturing organizations obtain new insights about the interrelation between internal characteristics and the external environment. In other words, the adaptive processes are used to translate environmental factors into effective strategic action which increases survivability in today's complex business environment.

In his article "So Much Data, So Little Time" Etzioni (1990) discusses what he refers to as humble decision making which he later defines more specifically as *adaptive decision making*. According to Etzioni, the complexity of the business decision making environment in 1990 had already reached information over-load to the point that rational decision making was … well… irrational. His statement that *"whatever knowledge there is in the mountain of data we daily amass is often invisible"*. To the extent this was true in 1990, one can imagine how much bigger the mountain is today. Etzioni defines the adaptive decision making idea as follows:

"it entails a mixture of shallow and deep examination of data – generalized consideration of a broad range of facts and choices followed by detailed examination of a focused subset of facts and choices".

He also suggests that *adaptive decision making* incorporates our understanding that since we can only know part of the true domain of any decision we are making we resort to *"focused trial and error"* to adapt to having*"partial knowledge".*

In a similar vein, an article by Garcia-Retamero and Rieskamp (2009) found that adaptation was a response to missing information created by the "mountain of data" (Etzioni, 1990). This experimental study presented subjects with situations with incomplete information and provided options for handling the missing information (inference) which included ignoring it, treating it as either positive or negative, using the average of past information as a substitute, or using the most frequent observation of the available information. Each situation presented included information about environmental characteristics which modified the correct response. The results showed that subjects were sensitive to the environmental modification and selected the inference mechanism that was most adaptive.

There are several linkages between decision making and adaptation in business research. The role of adaptation has been studied in several different business contexts including buyer-supplier behavior and relationships (Brennan and Turnbull, 1999; Canning and Hammer-Lloyd, 2002), supply chain (Quayle, 2003), decision support

systems (Fazlollahi, Parikh, and Verma, 1997) firm economizing behavior (Cyert and Kumar, 1996), investor strategy (Marinov and Marinova, 1998), employee psychological adaptations (James, 1999), product adaptation (Leonidou, 1996), supplier-customer relationships (Canning and Hammer-Lloyd, 2001), and cultural adaptation (Fang, 2001).

Sharfman and Dean (1997) suggest that the core of all organizational adaptation is the decision making process. They further suggest that adaptation is "a series of choices about how to respond to perceived threats and opportunities". In an earlier article (Dean and Sharfman, 1993) they suggest that the lack of flexibility in strategic decision making in small firms may have severe implications. This is consistent with the an earlier case study of 25 companies by Mintzberg and McHugh (1985) who found that top management flexibility in decision making was a key component of an organization's ability to adapt.

An equally interesting discussion of decision making in small businesses inthe leisure industry (Byers and Slack, 2001)concludes "*these individuals engage primarily in adaptive decision making*". The article, based on extensive interviews with 16 small businesses in the UK, notes the many internal and external factors that limit decision making in smaller enterprises consistent with many of those reported in prior literature. Several of these limiting factors require adaptation since they cannot be altered or affected by the decision maker. Responses indicated adaptation to environmental contingencies or circumstances including competitors, suppliers, changing economic conditions, government policy, weather, consumer demand, and current trends. Specific quotes indicating adaptive behavior included "we're like chameleons", "we pass through, we adapt and change",and in response to strategic planning "In large firms you have to do it…. It's far easier in a small concern to adapt".

More specific to our sample group of SME manufacturing companies is a casestudy by Brennan and Turnbull (1999). In studying 13 buyer-supplier relationships in the automotive and telecommunications industries, Brennan and Turnbull found confirmatory evidence to support their argument that the concepts of power and social exchange in relationships are important drivers of adaptive behavior. More specifically they found that in cases where a small supplier interacts with a large customer (such as an OEM in the auto industry), the power in-balance leads to a desire on the part of the smaller supplier to respond to requests of the larger customer. With respect to decision making processes that produce adaptations, Brennan and Turnbull (1999) made two significant observations in relation to this research effort. First of all they found that in some cases adaptations took place without any conscious decision having been made, while other times they were the result of formal data gathering, analysis, and decision. Secondly they found that often many small adaptations over a period of time can cause "substantial adaptation" resulting in a new strategy emerging from a pattern of decisions (Mintzberg 1994). These ad-hoc decisions are made at the senior level in small companies because there are fewer decision making levels and a given adaptation is comparatively more important in smaller organizations. Since small organizations lack the managerial depth to support formal processes they are more likely to employ ad-hoc or tacit adaptations that result in evolutionary strategy development through "emergent decisions". It may be that this adaptive tendency in SMEs is related to practically all business decisions, not just those investigated in prior research.

Based on the literature it seems plausible that a connection between adaptation and decision making exists in all business environments. In SMEs, which are characterized by thin resources, resulting in higher levels of missing information and decision ambiguity, it seems reasonable that simplifying the decision making process is required. There are several alternatives to simplifying decision making all of which require adaptation. Adaptation in manufacturing SMEs is likely to be focused on few aspects, such as the immediate business environment, as a way of simplifying choice alternatives to narrow the decision space and the time required to develop *rational* alternatives (based on our limitation). In other words *adaptive decision making*would reflect a particular focus on decision making that narrows the scope of choice and alternatives similar to the alternative definitions of rationality provided by March (1978) including *limited rationality* (human capacity requires limiting the decision space), *contextual rationality* (focusing on a selected context), *adaptive rationality* (relying on knowledge and experience), and *selected rationality* (relevance to survival of the organization). The literature supports this extension based on the works presented in this literature review. *Adaptive decision making* does not add to decision theory as much as it describes a bounded rationality approach based on ideas specified by prior work.

The use of the term in prior literature was largely descriptive providing no theoretical basis for dimensions or items. Several authors suggested characteristics associated with *adaptive decision making*that are similar with the exception of Phillips (1997) who used the term to summarize three perspectives of rational decision making. Table 1.1 summarizes the treatment of the term in literature across a number of research domains.

Table 1.1: Treatment of adaptive decision making in literature.

Mintzberg and McHugh (1985)	- top management flexibility in decision making was a key component of an organization's ability to adapt
Etzioni 1990	- the use of mixed scanning, mixture of deep and shallow examination of data, generalized examination of a wide range of facts, focus on a subset of facts and choices.
Sharfman and Dean (1997)	- core of all organizational adaptation is the decision making process - "a series of choices about how to respond to perceived threats and opportunities".
Brennan and Turnbull (1999)	- concepts of power and social exchange in relationships are important drivers of adaptive behavior.
Byers and Slack – 2001	– response to environmental contingencies or circumstances including competitors, suppliers, changing economic conditions, government policy, weather, consumer demand, and current trends. - "We're like chameleons" - "we pass through, we adapt and change" - In response to strategic planning "In large firms you have to do it…. It's far easier in a small concern to adapt".
Goldberg and Podell (2000)	– involves ranking and scaling the organisms various priorities in relationship to the parameters of the external situation.
Garcia-Retamero and Rieskamp (2009)	– adaptation as a response to missing information

A few of the themes that are consistent throughout this review are; 1. adaptation is connected to decision making, 2.adaptive decision making is an informal process, 3. adaptive decision making is present in smaller enterprises, 4. adaptive decision making

can be a response to power differences between buyer and supplier, 5. adaptive decision making in organizations cover a wide array of situations in the business environment, and 6. adaptive decision making is used in situations that involve missing information.

While prior literature points to high levels of adaptation in SMEs and suggest that *adaptive decision making* exists, additional motivation for this work is based on in-depth experience in a manufacturing SME as an owner and discussions with others in the same field. The combination of complexity, uncertainty, and time compression require short cuts in decision making in these environments. In addition, one of the major driving forces for adaption are the SME characteristics already discussed which create significant resource issues and power indifferences.

Since *adaptive decision making* has not emerged as a construct in SME research, the measurement of it required scale development. The first step in this process was the generation of potential items for such a scale. Prior literature, interviews with manufacturing SME owners and executives produced a list of ten areas in which adaptations were common. The items generated from this process were subjected to testing by Q-sort methodology (Davis 1986, 1989). Items were sorted in each round by a different group of executives/owners and academics to classify the items by construct. The generated items were presented with item for a manufacturing scale and a performance scale to allow categorical sorting. The raw scores, inter-judge agreement scores, and Cohen's Kappa (Cohen, 1960) were tabulated for each round and are summarized in Table 1.2. The results of Q-sort show 100% inter-judge agreement scores and a kappa value of .785 indicating excellent agreement beyond chance.

Table 1.2: Q-sort results summary.

Measure	*Round 1*	*Round 2*	*Round 3*
Combined judge raw scores	72%	79%	88%
Inter-judge agreement	56%	69%	79%
Cohen's Kappa	.547	.679	.785
Combine judge raw score summary			
Manufacturing strategy	71%	73%	92%
Adaptive decision making	**83%**	**90%**	**91%**
Performance	65%	78%	83%
Inter-judge agreement score summary			
Manufacturing strategy	56%	56%	56%
Adaptive decision making	**60%**	**90%**	**100%**
Performance	50%	64%	86%

The resulting items wereadaptation to competitor pricing, industry market forces, customer needs and preferences, capabilities to current business environment, product pricing when compared to our suppliers pricing, cash flow restraints, capital availability, creditors, economic conditions, and social and political conditions. Because there are presumably few objective indicators of these items available, a subjective approach to presenting the survey question to respondents was used resulting in the set of items in Table 1.3.

It is important in scale development to test any new scale against a known construct with a probable relationship based upon prior literature. As presented in the following

section prior literature seems to support a positive relationship between decision making and strategy development.

Manufacturing strategy dates back to early work by Skinner (1969) that prescribed the importance of connecting manufacturing to overall business strategy by arguing that manufacturing can be a competitive weapon ifmanaged in support of the firm's resources. Skinner also perceived linkages

Table 1.3: Items and coding for adaptive decision making construct

CODE	ITEM **Indicate the degree of emphasis which your manufacturing plant places on the following activities/priorities…**
ADPT1	adapt to competitor pricing
ADPT2	adapt to market forces in industry
ADPT3	adapt our resources to customer needs and preferences
ADPT4	adapt our capabilities to the current business environment
ADPT5	adapt our product pricing to our suppliers pricing
ADPT6	adapt to restraints of our cash flow
ADPT7	adapt to restraints of capital availability
ADPT8	adapt to debt holder's (i.e. bank's) requirements
ADPT9	adapt to economic conditions
ADPT10	adapt to social and political conditions

betweenthe business environment, decision making, and manufacturing strategy. The conceptualization of strategy includes decision making as an embedded process. The business environment in SMEs is characterized by informality and resource scarcity that limits the ability to scan and process relevant information due to resource scarcity. This drives the need for adaptation (a proxy for missing information as indicated inGarcia-Retamero and Rieskamp, 2009). The work of Skinner has been confirmed by other research (Anderson, Cleveland, and Schroeder, 1989; Leong, Snyder, and Ward, 1990; Hayes and Upton 1998; Ward and Duray 2000).

In support of the connection between decision making and strategy development we look toMintzberg (1994) which characterized strategy in small firms as a consequence of an adaptive "visionary" approach resulting in an informal or "realized" strategy. Mintzberg viewed strategy-making in small firms as an informal process resulting in a "pattern of decisions" by top management. This directly supports the linkage between decision making and strategy development in SMEs. Additional support more specific to this work is found in Slack, Chambers, Harland, Harrision, and Johnson (1998) who define *manufacturing strategy*in small firms as:

"the total pattern of decisions and actions which set the role, objectives and activities of manufacturing operations so that they contribute to and support the organization's business strategy".

In agreement with the substantiallinkages between decision making and strategy found in prior literature, manufacturing strategy in SMEs is viewed hereas the culmination, or antecedent of, a pattern of informal decisions. In support of this conclusion the following hypothesis is proposed.

H1: As the level of emphasis placed on adaptation in decision making increases, the level of emphasis on manufacturing strategic imperatives (manufacturing strategy) will increase.

Measures for the manufacturing strategy construct were adopted from prior work by Youndt, Snell, Dean, and Lepak (1996) consistent with those found throughout literature (Leong et al. 1990; Marucheck, Pannesi, and Anderson, 1990; Schroeder, Anderson, and Cleveland, 1986; Skinner, 1969; Upton, 1995; Wheelwright, 1981). The 31 item scale includes operationally defined competitive priorities in manufacturing, including cost, quality, flexibility, and delivery. This scale was used in Metts (2007) which reported four stable factors witheigen-values greater than 1.00 and Cronbach's alpha values greater than 0.70. The items for manufacturing strategy are shown in Exhibit A-2.

3. Methodology and Instrument Development

Items for the adaptive decision making scale identified through literature review and the Q-sort procedure were designed into a questionnaire for the large scale survey. The questionnaire was reviewed by industry and academics in a pre-test of the survey instrument which included reading of the questionnaire to provide feedback on the clarity of questions, instructions, length of the survey, and general understandability. The feedback from this step was used to modify the presentation of the questions and the instructions to improve the overall clarity and understandability of the survey.

The survey instrument was mailed to SME manufacturing concerns located in Michigan, Indiana, and Ohio. The tri-state region represents a significant part of the total SME manufacturing base in the US and serves well as a proxy for all US Manufacturing SMEs. The survey was sponsored by the Michigan Manufacturer's Association (MMA), Indiana Manufacturer's Association (IMA), and the Ohio Manufacturer's Association (OMA). The total number of potential respondents for each state was 1,481 in the state of Michigan, 934 in Indiana, and 1,550 for the state of Ohio for a total of 3,965 potential respondents. A summary of the returned surveys is shown in table 3.1.

Table 3.1: Survey response summary

State	Valid Responses	Response Rate	Percentage of Total
Michigan	171	11.64%	31.3%
Indiana	198	21.24%	36.2%
Ohio	178	11.51%	32.5%
TOTAL	547	13.74%	100.0%

A wide variety of manufacturer's responded to the survey including companies involved in the manufacturer of automotive or recreational vehicle parts, specialty products, tool and die, food, wood, furniture and numerous other manufacturing types. Over ninety-four percent (94.5%) of the respondents were CEOs or top managers (532 valid cases out of 547) and almost seventy percent (69.6%) represented family businesses (533 valid cases out of 547).

4. Data Analysis

Prior to applying any analytical procedures, a random sample of 27(5% sample) surveys were selected and audited for data entry errors. Every data field was audited for the selected sample of surveys and no discrepancies were found. In addition, the statistics for each survey item was analyzed including maximum and minimum values, the mean, standard deviation and skewness. All cases were analyzed to check the number of missing and valid cases for each item as well as to make sure that the recorded response was within the appropriate range (1 to 5). Since no missing data patterns were detected the data is considered to be missing completely at random (MCAR). Mean substitution was used to replace missing data in all subsequent analysis. Certain survey questions had significantly higher levels of missing data but no item had more than 13.2% missing and no patterns were detected. According to Mertler and Vannatta (2002), replacement of less than 15% by mean substitution has little effect on the outcome of analysis. To satisfy the assumptions of the multivariate procedures used for confirmatory analysis, the linearity and normality of the data was evaluated prior to mean substitution. Scatter plots were utilized to evaluate linearity and histograms and normal Q-Q plots were used to evaluate univariate normality. Based on these evaluations the data is considered linear and univariate normal. Therefore, for analysis purposes we believe the data approximates multivariate normality.

The 547 responses from the large-scale survey were split into two data sets using random selection for analysis purposes. The first set was utilized for exploratory factor analysis of the Adaptive Decision Making scale developed in this study. The second data set was utilized for confirmatory factor analysis of the Adaptive Decision Making and Manufacturing Strategy (Youndt, Snell, Dean, and Lepak, 1996) and for model testing.

4.1 Factor Analysis

The items resulting from application of the Q-sort methodology for Adaptive Decision Making scale were submitted to exploratory and confirmatory factor analysis. Item refinement criteria included simplicity of factor structure, purification, reliability, convergent validity and discriminant validity. Data reduction was accomplished using SPSS software with mean substitution for missing data, principal components extraction method, and varimax factor rotation (except where otherwise indicated). The cutoff for the number of factors to extract was Kaiser's eigenvalues greater than one (1.0) (Nunnally, 1978). Certain exceptions to this rule were made based on analysis of the Scree plot for factors close to the target value of one (1.0). Items that did not load at 0.60 or greater and items with cross-loadings greater than 0.40 were eliminated from further analysis.Any exceptions to these rules were made based on the suggestion by Dillon, Kumar, and Mulani (1987) that the importance of an item to the research objective be taken into consideration before dropping items based on its loading value alone. In an effort to make the factor interpretation process more manageable loadings below 0.40 were not reported. Tinsley and Tinsley(1986) guidelines were followed to evaluate factor stability based the recommended minimum ratio of 5 to 10 times more responses than items.

Scales explored through data reduction factor analysis were purified based on Churchill (1979) recommendation that the corrected-item to total correlation (CITC) be examined to make certain that all items are contributing to each dimension of a construct. This

was accomplished by comparing the change in Cronbach's alpha (Cronbach, 1951) that resulted from dropping each individual item with the alpha coefficient for the group of items (Flynn, Schroeder, and Sakakibara, 1995). Items that did not contribute to alpha were evaluated before dropping based on the significance between the dropped score and the overall score and the items importance to the research effort. Caution was used in eliminating items. However, if an items CITC value was less than 0.40 it was eliminated except if the items value to the research effort was considered highly valuable in which case the cutoff was 0.35. Reliability was evaluated using Cronbach's alpha and the average amount of variance extracted. The cutoff for variance extracted for any construct follows Baggozi and Yi (1992) recommendation of 0.50. The higher the average amount of variance extracted the more representative the items are of the construct.

Validity is the extent to which the scale is measuring the construct that it is intended to measure. The Q-sort pilot procedure provided reasonable assurance that the construct being measured was represented by the list of items (questions) used in the survey instrument. Discriminant validity was assessed by evaluation of the cross loadings produced by the factor analysis procedure. Convergent validity was assessed by evaluation of the items loading on each factor and the factor structure itself.

4.2 Results of the Exploratory Factor Analysis

The initial solution revealed three factors with a KMO value (Kaiser-Meyer-Olkin measure of sampling adequacy) value of 0.782 and three extracted factors with eigenvalues of 3.716, 1.722, and 1.084 respectively explaining 65.224% of total variance. Item Adpt10 did not load significantly on any factor and some cross-loading with items Adpt2 and Adpt9 was noted. Adpt10 was dropped for the second run and Adpt2 and adpt9 were kept for further analysis. The second run produced three factors with eigenvalues of 3.423 (F1), 1.721 (F2), and 1.084 (F3) respectively explaining 69.2% of the variance. Analysis of the second run output resulted in dropping item 9 from the analysis since it was not pertinent to understanding or naming the factors and because of the significant cross-loading between factor 1 and 2. Table 4.2.1 shows the final analysis result after dropping adpt9.

The resulting factors were named based on the analysis of the items that loaded on each factor. The final scale consists of three variables named financial adaptation (items adpt6-8), customer needs and preferences adaptation (items adpt3 and adpt4), and market / pricing adaptation (items adpt1, adpt2, and adpt5). The scale accounts for 71.71% of the variance and the over all reliability as assessed by Cronbach's alpha values are .8870, .6251, and .6412 respectively. The ratio of respondents to items for the adaptive decision making construct was 273/10, or 27.3, exceeding the recommended ratio range of 5 to 10. Items used in the adaptive decision making construct are shown in Appendix "A-1".

Table 4.2.1: Factor loadings for adaptive decision making construct after dropping item Adpt10 and Adpt9.

Items	Financial adaptation (Factor 1)	Customer adaptation (Factor 2)	Market / Pricing adaptation (Factor 3)
Adpt1			.868
Adpt2			.583
Adpt3		.829	
Adpt4		.804	
Adpt5			.702
Adpt6	.883		
Adpt7	.908		
Adpt8	.849		

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

4.3 Confirmatory Factor Analysis of Adaptive Decision Making

Structural equation modeling (SEM) software (AMOS 5.0.1, Arbuckle, 1999) was used for confirmatory factor analysis to test the unidimensionality of each construct. SEM has several notable advantages over traditional multivariate procedures (Fornell, 1982). First of all, SEM takes a confirmatory approach by requiring that the relationships among variables be specified *a priori*. Secondly, SEM provides explicit estimation of errors unlike traditional multivariate approaches (such as data reduction factor analysis used in the previous section) which are incapable of either assessing or correcting for correlated error terms. SEM also simultaneously estimates the strength of the various hypothesized relationships between observed variables (indicators) and latent variables resulting in rigorous hypotheses testing (Joreskog and Sorbom, 1989).

In SEM, model fit is estimated using either absolute, relative, or adjusted fit indexes (Marsh, Balla, and McDonald, 1988). Absolute indexes do not impose any baseline (comparison to alternate models) for a particular data set. These indexes measure whether or not the residual (unexplained) variance is appreciable. Absolute indexes include Chi-square (χ^2), Chi-square per degree of freedom (χ^2/df), root mean square residual (RMR), and goodness of fit index (GFI). The Chi-square and Chi-square per degree of freedom look at the absolute size of residuals. While Chi-square is perhaps the most popular index to evaluate goodness of fit, it is sensitive to sample size and departures from multivariate normality. Researchers suggest that Chi-square must be interpreted with caution (Joreskog and Sorbom, 1989). RMR is the square root of the mean squared difference between the elements of the predicted and observed matrices and has a value between 0 and 1. Lower values indicate better fit with 0.10 or lower indicating good fit (Chau, 1997). GFI assesses the relative amount of the variances and co-variances accounted for by the model.

Relative fit indexes compare the test model to other possible models (independence or null) with the same data. Examples of relative fit indexes reported include NFI, TLI, IFI and BFI or RNI. Adjusted fit indexes combine model fit and parsimony into a single index. Examples of adjusted fit indexes include PGFI, PNFI, and TLI. For additional information and detailed formulation of the indexes see Maruyama (1998).

At the present time, there is no agreement in the literature on a single optimal test or even a set of optimal tests to evaluate models (see Maruyama, 1998). However, many researchers interpret scores for indexes such as AGI, AGFI, and TLI in the range of 0.80 – 0.89 as representing reasonable fit and 0.90 and higher as good fit (Joreskog and Sorbom, 1989). In this section we will provide several fit indexes including χ^2, χ^2/df, RMR, AGI, AGFI, and TLI for each measurement model.

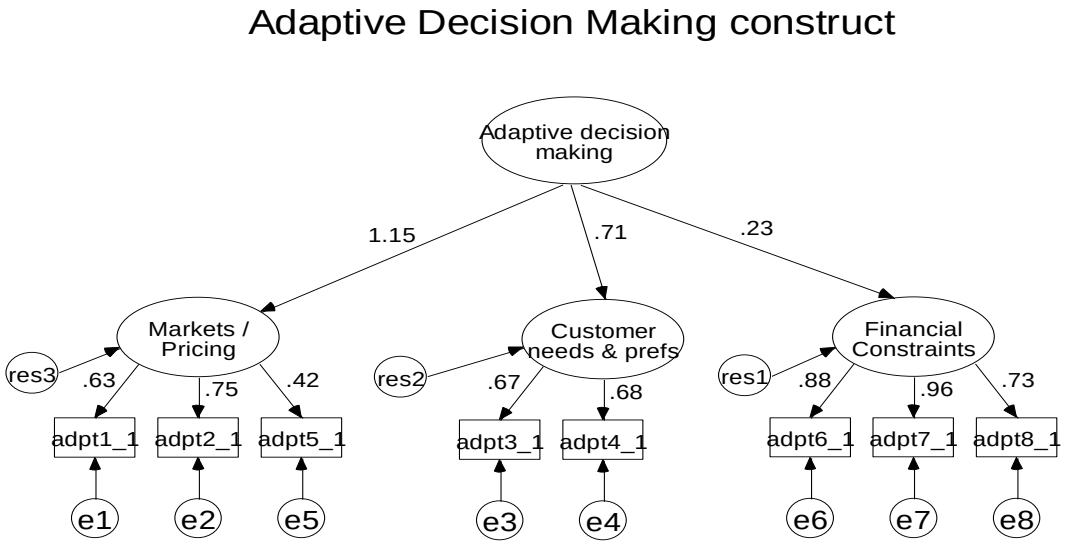
4.3.1 Adaptive Decision Making CFA

Confirmatory analysis of the adaptive decision making scale resulted in a χ^2 value of 58.212 with 17 degrees of freedom giving a χ^2/df ratio of 3.424. The second order standardized regression loadings were 0.23 for the financial constraints dimension, 0.71 for the customer needs and preferences dimension, and 1.15 for the marketing / pricing adaptation dimension. The first order standardized regression weights for the financial constraints dimension were 0.88 (adpt6), 0.96 (adpt7), and 0.73 (adpt8). The first order regression weights for the customer needs and preferences dimension were 0.67 (adpt3) and 0.68 (adpt4). And the markets / pricing adaptation dimension had first order standardized regression weights of 0.63 (adpt1), 0.75 (adpt2), and 0.42 (adpt5). All first order standardized regression loadings were significant at the 0.01 level. The model is presented in figure 4.3.1. Overall model fit indexes are shown in table 4.3.2. The high GFI and TLI (>0.90) and the low RMR value of 0.060 (<.10) indicate good model fit to the data.

Table 4.3.1: Model fit indexes for the Adaptive Decision Making measurement model

Model	GFI	AGFI	RMR	TLI
Default model	0.950	0.894	0.060	0.918
Independence model	0.549	0.420	0.278	0.000

Figure 4.3.1: SEM measurement model of Adaptive Decision Making construct (standardized regression weights)

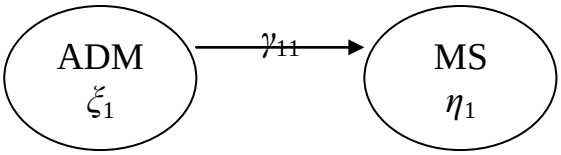


The Adaptive Decision Making scale consisting of 8 items loading on three dimensions is confirmed for use in the structural model.

4.4 Structural Model Testing

Hypotheses testing of the research framework presented in Figure 1.1 was conducted using structural equation modeling (SEM). The mathematical presentation of the structural model is presented in figure 4.4.1.

Figure 4.4.1: Mathematical presentation of the hypothesized structural model

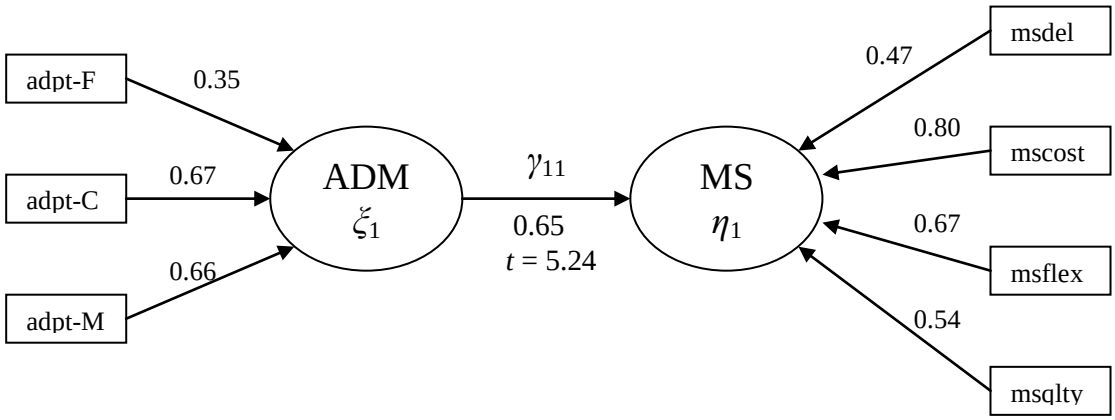


Where: ADM: Adaptive Decision Making construct
MS: Manufacturing Strategy construct

There are only two variables in the research framework; the exogenous variable Adaptive Decision Making – ξ_1, and the endogenous variable Manufacturing Strategy - η_1.Given the structural model form $\eta = \beta\eta + \Gamma\xi + \zeta$ hypotheses 1 is represented by structural equation $\eta_1 = \gamma_{11}\xi_1 + \zeta_1$.

Results of hypotheses testing of the research framework are presented in figure 4.4.2. As shown in the figure, the relationship between Adaptive Decision Making and Manufacturing Strategy was strongly supported by our data indicating a highly significant direct effect.

Figure 4.4.2: Structural model presentation



The model had a χ^2value of 70.106 with 13 degrees of freedom giving a $\chi 2/df$ of 5.39 indicating that the unexplained variance is not appreciable. The *p* values for all regression estimates were less than 0.000. The GFI for the final model was 0.931 and the RMR was 0.036 indicating good model fit to the data.

5. Discussion and Conclusions

This research has investigated the role of *adaptive decision making* and its potential significance in strategy making in small and medium-sized manufacturing companies. The following paragraphs highlight some of the contributions of this research effort.

The first contribution is a new construct, *adaptive decision making*. *Adaptive decision making*(ADM) is defined here as "*a conscious or unconscious tendency to place a high priority on adaptation to the environment throughout the decision making process*". The premise that smaller organizations are compelled to adapt in the face of resource scarcity, marginal capital structures, power indifference, and financially vulnerability was supported. A scale for measuring ADMin manufacturing SMEs consisting of three dimensions and eight items was developed, tested, and confirmed.

The second contribution is identification of the relationship between ADM and manufacturing strategy in SMEs. This confirms prior literature on decision making and strategy but also extends it by demonstrating that there exists an adaptive orientation among decision makers in manufacturing SMEs that influences the strategy making process.

A final contribution is the potential of ADM as a diagnostic tool. If ADM is an importantdriverof the strategy making process in SMEs, the extent to which a manufacturing SME exhibits the use of ADM may ultimately impact the effectiveness of strategy development.

6. Future Research

Since this research merely introduced ADM as a potentially valuable construct in SME research, it is important to explore the relationship between ADM and other constructs of interest. Exploring the relationship between ADM and environmental scanning and

overall business performance are just two of the many relationships which may yield meaningful insight. Lastly, the use of ADM in other contexts such as the service industry may be accomplished without significant modification to the measurement scale. Careful examination of the items that are in the scale seem, at least on the surface, to apply to most smaller enterprises. Of course, any such use will require theoretical justification and testing.

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APPENDIX A

Table A-1: Items and coding for adaptive decision making construct

CODE	ITEM Indicate the degree of emphasis which your manufacturing plant places on the following activities/priorities…
ADPT1	Adapt to competitor pricing
ADPT2	Adapt to market forces in industry
ADPT3	Adapt our resources to customer needs and preferences
ADPT4	Adapt our capabilities to the current business environment
ADPT5	Adapt our product pricing to our suppliers pricing
ADPT6	Adapt to restraints of our cash flow
ADPT7	Adapt to restraints of capital availability
ADPT8	Adapt to debt holder's (i.e. bank's) requirements

Table A-2: Manufacturing strategy items

Code	ITEM Indicate the degree of emphasis which your manufacturing plant places on the following activities..
Msflex1	Lead-time reduction
Msflex2	Set-up time reduction
Msflex3	Ability to change priorities of jobs on the shop floor
Msflex4	Ability to change machine assignments on the shop floor
Msqlty1	Statistical process control
Msqlty2	Real-time process control
Msqlty3	Updating process equipment
Msqlty4	Developing new processes for new production programs
Msqlty5	Developing new processes for old production programs
Msdel1	Provide fast deliveries
Msdel2	Meet delivery promises
Mscost1	Reduce inventory
Mscost2	Increase capacity utilization
Mscost3	Increase equipment utilization
Mscost4	Reduce production costs