Business and Management PhD Programme

SUMMARY OF THESES

Zsolt Matyusz

The effect of contingencies on the use of manufacturing practices and operations performance

Ph.D. dissertation

Supervisor:

Krisztina Demeter
Associate professor

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Faculty of Business Administration
Department of Logistics and Supply Chain Management

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1. Introduction and theoretical summary

My Ph.D. dissertation examines ***the effects of certain manufacturing contingencies on the extent of use of manufacturing practices by manufacturing companies, and also the consequences of these effects on operations performance.***
Research conducted on contingencies in the field of *operations management* (OM), and more specifically in the field of manufacturing practices was not so deep, so the topic is both very actual and relevant. In the field of OM Sousa – Voss (2008) highlighted the neglected situation of the examination of contingencies. They point out that more and more studies were published recently that question the universal results of manufacturing practice use – i.e. by using the same manufacturing prectice, applying companies get different results from case to case. These studies explain this phenomenon with the context-dependency of the practices. Contingency theory that examined contingencies from an organisational design point-of-view was used earlier in the field of OM. The original contingency theory works infiltrated OM through the work of Skinner, and they led to the manufacturing strategy contingency paradigm, according to which if the external and internal consistency of manufacturing strategy decisions exists, that phenomenon improves company performance (Skinner, 1969). At the same time though manufacturing practices were not examined from this aspect, so it was a logical choice to conduct my research on the manufacturing practices neglected from the contingency theory aspect.
The choice of topic identifies several research problems simultaneously. First, there is an obvious research gap in OM concerning contingencies (Sousa – Voss, 2008). Second, one can find a lot of contradicting statements, results in the existing knowledge about contingencies, which raises the question of the generalizationability of certain theory. Third, one can find a lot of untested hypotheses, models, propositions, concepts inside theories of contingencies generally, not just related to manufacturing.

The topic of my research fits into the *European research tradition*. The history of OM thinking was strongly influenced by the USA since the Second World War, which of course affected the European trends as well. At the same time there were some ideas born in Europe which spread the whole world. One of these was the contingency theory school in the middle 1960s, which was connected directly through OM by Woodward (1965). She uncovered different factors of contingencies of OM and technology in the manufacturing organisation

(Karlsson, 2009). The later development of contingency theory was significantly influence by the Aston studies (Pugh et al. 1963; Pugh et al. 1968; Pugh et al. 1969a; Pugh et al. 1969b).

In order to answer my research question I use the survey method primarily, so my reseacrh deals with the European approach in a more American way, because research based on large surveys is very popular among American scientists in certain industries, where the goal is to reach statistical significance and reliability while analysing narrow research questions very deeply with quantitative techniques on large databases. On the contrary, in Europe many scientists work in industry or quite close to it. Small sample, broad, longitudinal examinations are frequent. Output is more about description and hypothesis fabricating than hypothesis testing. My survey is supported by a series of interviews I conducted with industry experts, and they were used to discuss my results.

Logic of the research

Figure 1 shows the logic of my research together with my research question I wintend to answer. The reseacrh question is preceded by two literature review sections.

First section: Which are those contingencies that can be considered as the most important ones in the life of organisations based on previous experience?

Chapter 1 of my dissertation shortly overviews those major fields that emphasize contingencies to a greater extent. After that I present the identified contingencies from two aspects in detail: first from the point of view of organisation theory, then from strategic management.

Second section: How can be these identified contingencies interpreted and how do they appear in the field of OM?

Chapter 2 of my dissertation investigates this matter, in which I examine how can one translate the identified contingencies to the language of OM as manufacturing contingencies, while also presenting the existing OM literature on contingencies and the actual problems related to them.

Research question: Do manufacturing contingencies influence, and if yes, how, the use of manufacturing practices and the operations performance of the manufacturing companies? What kind of contingency – manufacturing practice configurations can be identified and how do these affect operations performance?

This question is investigated by statistical analytical methods. The research question is transformed into testable hypotheses, which are introduced in Chapter 3 of my dissertation along with the research model.

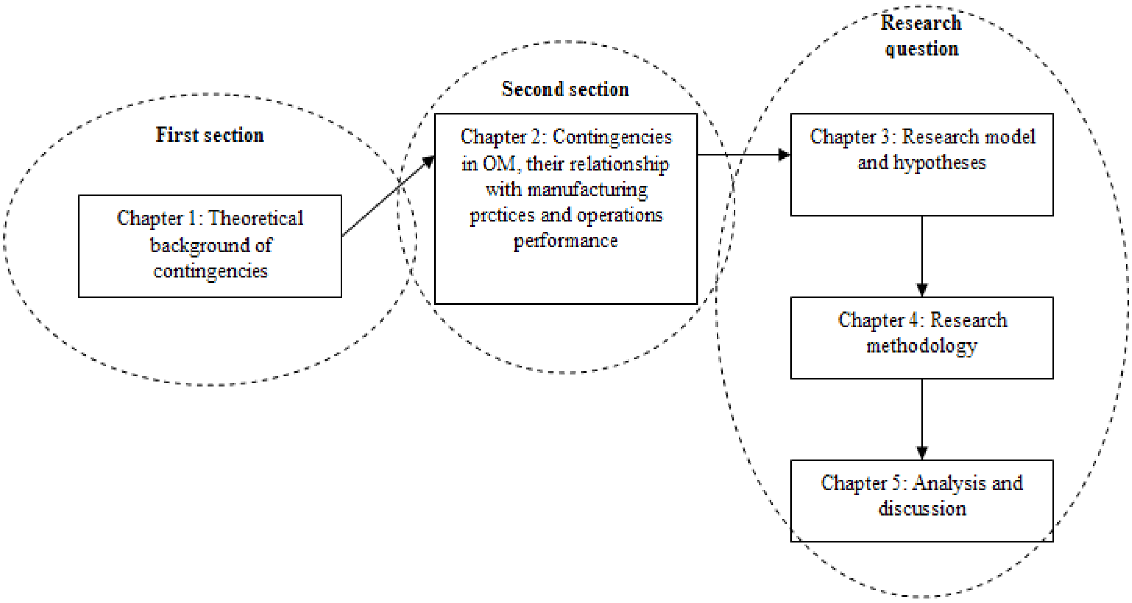

Figure 1 – Logic of the reseacrh

2. Research methodology

Figure 2 shows the elaborated research model, which consists of three major blocks. The first block is the configuration of manufacturing programs which affects the second block, namely operations performance. The third block includes the contingencies which have a dual role. First, they act as a driver of manufacturing practices. Second, I propose that contingencies have a moderating effect on the relationship between manufacturing practices and operations performance. As I mentioned earlier I identified four important contingencies whose effect will be tested in the model: environment, size, technology, manufacturing organization and strategic focus. Similarly to Mintzberg (1979) I accept the assumption that the causal direction goes from the contingencies towards manufacturing practices.

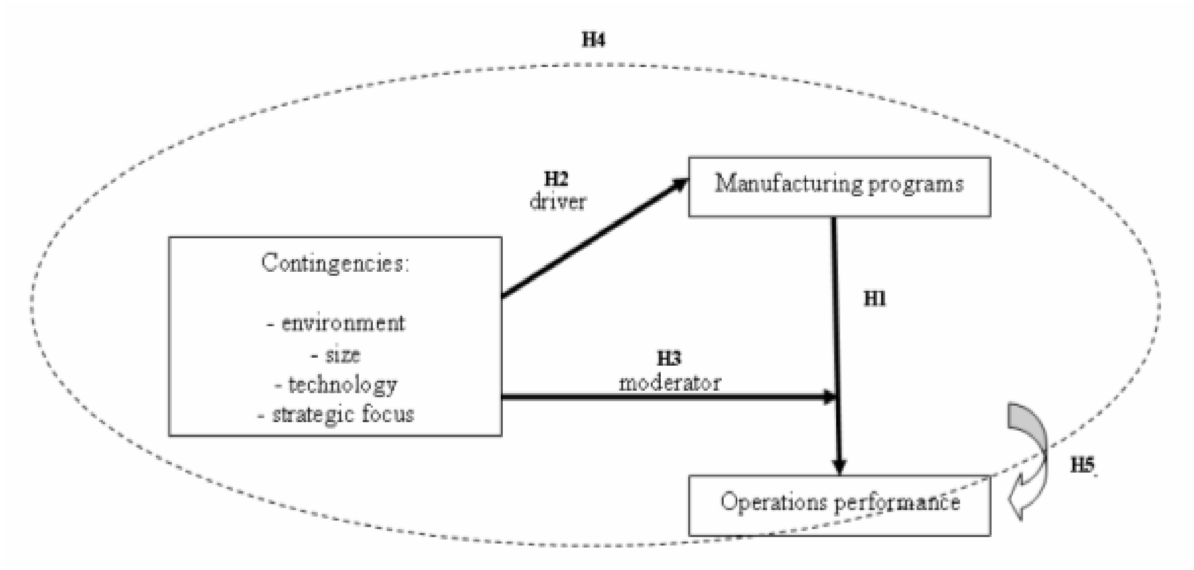

Figure 2 – The research model

The model is simpler than the theoretically possible in order to be able to handle the relationships and does not include other contingencies that could be involved (e.g. culture, country of origin, industry). I also do not analyze the relationship between operations performance and business performance.

During testing the model I apply two forms of fit, namely the interaction and the system approach (Drazin – Van de Ven 1985), which are two different level of the analysis. As for the interaction approach, I investigate the relationships between single manufacturing programs and contingencies and their effect on operations performance. During the system approach I analyze different configurations of contingencies and manufacturing programs, and the effect of these configurations on operations performance.

The interaction view is used to test the realtionships described with solid black lines on Figure 2. First I uncover the connections between manufacturing practices and operations performance if the effect of contingencies is not addressed. This is followed by the addition of contingencies to the empirical analysis. I examine the role of contingencies, to what extent are they drivers of the use of certain manufacturing practices, then I investigate the moderating effects of certain contingencies on the relationship between manufacturing practices and operations performance. In order to test these, I propose three major hypotheses:

H1: the manufacturing programs investigated in the research model have significant effect on operations performance.

H2: the contingencies investigated in the research model have significant effect on the implementation of manufacturing programs.

H3: the contingencies investigated in the research model moderate the relationship between manufacturing programs and operations performance.

Hypotheses H1-H3 are tested by SEM (structural equation modeling), more precisely with the PLS (partial least squares) approach, during which I can accept or reject hypotheses by analysing regression equations. The PLS approach has some very beneficial characteristics for the analysis (Henseler et al. 2009):

1) it does not require any a priori assumptions on the distribution of the data;
2) it is robust using various scales;
3) it can handle complex models;
4) it can be used with smaller sample size too; and
5) it is adequate for explorative research like the one I present in my dissertation.

The system view examines the joint effect of several contingencies and manufacturing practices on operations performance, and the resulting configurations may be analyzed further (Hypotheses H4 and H5). This configurational view is the natural extension of the contingency approach (Ahmad et al., 2003), and its importance is also marked by the argument of Boyer et al. (2000). This also means that this part of my research is an aggregate research under the terms of Sousa – Voss (2008), which type is in minority compared to the inferential research in existing literature, hence increasing the professional value added of my research. In OM literature configurational research methods appeared earlier, but the existing models are restricted to the field of operations strategy. I have not met studies during my literature review that used configurational methods on manufacturing practices and contingencies. My fourth hypothesis is the following:

H4: there are different stable contingency-manufacturing practices configurations that coexist simultaneously.

The configurational approach supports that in any given environment one can be successful in more than one way, i.e. explicitly accepts the concept of equifinality. (Meyer et al. 1993) The system approach makes it possible to explore the existence of equifinality in the context of certain configurations which is reflected in hypothesis H5:

H5: the state of equifinality can be shown, i.e. different and stable contingency-manufacturing practices configurations exist that lead to the same high level of operations performance.

In order to test hypotheses H4 and H5 we need to implement configurational methods (Venkatraman 1989; Venkatraman – Prescott 1990). The main problem at the time of the writing of the cited articles was the fact, that there were no really elaborated ways to test fit theories mathematically. There are several possible solutions for this problem as there are many ways to interpret the concept of fit (see Table 1).

One dimension to assess fit is the extent of specificity. This means that how precisely can we formulate the fit function of the investigated variables. It shows a strong correlation with the number of the investigated variables: with fewer variables we are able to determine the fit function more precisely than the other way around. This relationship is reflected in the right-hand column of Table 1.

The other dimension reveals whether the fit and its testing is linked to some exact criterion (e.g. some kind of efficiency indicator) or not.

With these two dimensions Venkatraman (1989) differentiated six perspectives of fit.

Low	Profile deviation (5)	Gestalts (4)	*Many*
Degree of specificity	Mediation (2)	Covariation (6)	**Number of variables in the fit equation**
High	Moderation (1)	Matching (3)	*Few*
	Criterion-specific	**Criterion-free**	

Table 1 – Different perspectives of fit (Venkatraman, 1989)

In order to test the perspectives of fit marked with numbers (1)-(6) one can apply different methods.

We can use three different methods to test hypotheses H4 and H5 *(*gestalts, profile deviation and covariation). In the following we introduce these three method briefly (based on Venkatraman 1989).

Gestalts: in this case we investigate the degree of internal coherence among a set of theoretical attributes. It is vital to analyze these attributes jointly because a strictly pairwise analysis may result in inconsistencies among pairs of contingencies. To put it another way, by using the gestalts method we intend to create archetypes. The most important analytical issues are the descriptive validity and the predictive validity of the gestalts.

Profile deviation: in this case fit is the degree of adherence to an externally specified profile, and in this sense it is similar to the pattern analysis of Drazin – Van de Ven (1985). The method differs from the gestalts method because the profile is linked to a certain external variable. This makes it possible to the researcher to create ideal types, and the method is very useful to investigate environment-strategy relationships because deviation from the profile can be connected to a reduction in performance. The most important analytical issues are the following: developing the ideal profile, adding differential weights for the multiple dimensions and using a baseline model to assess the power of the test.

Covariation: in this case fit is a pattern of covariation or internal consistency among a set of underlying theoretically related variables. This approach is similar to the interpretation of strategy as a pattern and, besides covariation, the gestalts method is also very good to investigate this kind of strategy interpretation. The main difference between the methods is that during the gestalts method we perform cluster analysis, while during the covariation method we perform factor analysis. The most important analytical issues are distinguishing between the exploratory and confirmatory approach and testing the impact that performance has on fit modeled as covariation.

I chose the gestalt approach and cluster analysis as a statistical tool, which is well known in OM, especially in case of manufacturing strategy configurations (see e.g. Miller – Roth, 1994; Bozarth – McDermott, 1998; Cagliano, 1998; Jonsson, 2000; Kathuria, 2000; Sousa – Voss, 2001; Christiansen et al., 2003; Sousa, 2003; Sum et al., 2004; Cagliano et al., 2005; Oltra et al., 2005; Zhao et al., 2006; Martin-Pena – Diaz-Garrido, 2008).

3. Results

In my dissertation I examined the effect of certain manufacturing contingencies on the use of manufacturing practices by manufacturing companies and its impact on operations performance. In total I identified four contingencies: environment, size, technology and strategic focus (which is a specialty of the field of OM and marks the strategic orientation of manufacturing of a company). I also reviewed the literature on the relationship between manufacturing practices and operations performance. Based on this knowledge I built my research model and five hypotheses, of which the results were the following:

H1: the manufacturing programs investigated in the research model have significant effect on operations performance.
H2: the contingencies investigated in the research model have significant effect on the implementation of manufacturing programs.

Hypotheses H1-H2 are mostly supported. At 1% level no fewer than 27 relationships were significant. The following contingencies have significant effect on manufacturing practices at this level (in brackets one finds the number of significant relationships): Complexity (4), Size (1), Product complexity (3), Technology level (5), Customer order (1), Quality focus (1), Flexibility focus (1) and Sustainability focus (3). There were no significant relationships between Competition, Process type, Cost focus and the manufacturing practices. If we take a look at the manufacturing practices, the following have significant relationships with at least one performance dimension at 1% level (in brackets one finds the number of significant relationships): HR practices (1), Process focus practices (4), Quality practices (2) and Product development practices (1).

At 5% level much fewer, only 9 relationships were significant. Í The following contingencies have significant effect on manufacturing practices at this level (in brackets one finds the number of significant relationships): Complexity (1), Process type (2), Customer order (1), Flexibility focus (2) and Sustainability focus (1). If we take a look at the manufacturing practices, the following have significant relationships with at least one performance dimension at 1% level (in brackets one finds the number of significant relationships): Quality practices (1) and Product development practices (1).

Table 2 shows these results, also displaying 1) which contingency affects how many manufacturing practices significantly, 2) manufacturing practices are affected by how many contingencies, and how many performance dimensions are affected by manufacturing practices, and 3) each performance dimension is affected by how many manufacturing practices significantly. This gives a quantitative overview of the more important factors.

Contingency	**How many practices are affected?**	**Manufacturing practice**	**Affected by how many contingencies?**	**How many performance dimensions are affected?**	**Performance dimension**	**Affected by how many practices?**
Complexity	5	HR	4	1	Cost	2
Competition	-	Process focus	4	4	Quality	4
Size	1	Technology	8	-	Flexibility	2
Product complexity	3	Quality	5	3	Sustainability	2
Technology level	5	Product development	5	2		
Process type	2					
Customer order	2					
Cost focus	-					
Quality focus	1					
Flexibility focus	3					
Sustainability focus	4					

Table 2 – Summary of the results

H3: the contingencies investigated in the research model moderate the relationship between manufacturing programs and operations performance.

During the investigation of Hypothesis H3 only very few significant relationships were discovered, hence this hypothesis is supported only to a very limited extent. Only Sustainability focus showed some moderating effect on the relationship between process focus practices and the performance dimensions, but this effect was not weak at all. The power of the effects were between 0.023-0.064, which is above the 0.02 threshold, from which the strength of moderation can be considered weak. How can we interpret this result?

Based on the moderating effect the level of the sustainability focus of the firm has a positive moderating effect on the relationship between process focus practices and performance dimensions, i.e. if two companies use process focus practices to the same extent, then the company with the greater focus on sustainability will realize higher performance growth than the company with a lesser focus on sustainability.

H4: there are different stable contingency-manufacturing practices configurations that coexist simultaneously.

The resulting clusters supported Hypothesis H4. What werethe main cluster characteristics?

- In case of cost focus there were no significant difference among the clusters, the order winner role of price is considered as more important than the average by all the clusters.
- On the other hand members of Cluster 3 top the rankings in the case of every variable. Their environment is the most complex, they face the strongest competition. They are the largest in size, and besides cost they treat all other competitive priorities as the most important in order to win orders from major customers. The product is also very complex, the technology level is high, and the process is more standardized with more homogenous customer orders. They also use manufacturing practices to the greatest extent. Based on these they can be called the „Large leaders”.
- Their mirror image is Cluster 4, whose members use manufacturing practices to the least extent. The product is quite complex, but technology level is lower than average. Basically they focus on cost and quality, the other two factors are not that important. Environment complexity is low, they face the weakest competition. They are the smallest in size. Process type and customer orders are more uique and one-off. They can be named as the „Small laggards”.
- The remaining two clusters are similar to each other in many aspects. There are no significant differences between them in size, perceived competition (which is above average), technology level (average), and the use of technological and quality practices (below average). The other manufacturing practices are more emphasized by Cluster 1, as well as the focus on quality, flexibility and sustainability. This may be the consequence of a more complex environment they face. There is nonetheless a major difference between the two clusters: members of Cluster 1 manufacture one-off products in order to satisfy unique customer orders, while members of Cluster 2 have the most standardised process and

customer orders. Because of this difference members of Cluster 1 are named „One-off manufacturers”, while members of Cluster 2 „Mass producers”.

- There is a clear distinction between the clusters along process type and customer order. Two-two clusters are mass producers and unique manufacturers. But beyond this the clusters with the similar process type and customer order are not alike. One-off manufacturers and Mass producers are very similar in many aspects, while the Large leaders and the Small laggards are mirror opposites.

- We can also see that environment complexity moves with strategic foci: companies in more complex environments focus more on quality, flexibility and sustainability in order to win orders from major customers.

- Compared with previous research we can find clusters that are similar to the clusters in the dissertation:

  - clusters similar to teh Large leaders were found by e.g. Kathuria (2000), Christiansen et al. (2003), Zhao et al. (2006), Martin-Pena – Diaz-Garrido (2008), where cluster members usually treat all or most dimensions important and have high values along these dimensions.

  - clusters similar to the Small laggards were found by e.g. Kathuria (2000), Sum et al. (2004), Zhao et al. (2006), where low values are abundant.

H5: the state of equifinality can be shown, i.e. different and stable contingency-manufacturing practices configurations exist that lead to the same high level of operations performance.

Concerning traditional performance dimensions One-off manufacturers and Mass producers supported Hypothesis H5. Small differences along the other performance variables also give further underpinning to the hypothesis.

One-off manufacturers and Mass producers show an almost similar performance improvement along all performance dimensions in the last three years. The small differences are not significant between the two clusters. Large leaders and Small laggards clearly pop out, the former upwards, while the latter downwards.

i) if we look at the cost structure, One-off manufacturers are significantly better than Small laggards in terms of manufacturing fixed costs (17.45% vs 21.80%). Large leaders payed significantly less direct wages than the others (17.9% vs 22.5-24.5%). Interestingly Small laggards spend significantly less on direct material costs than Large leaders and Mass producers (44.58% vs 53.36% and 52.01%).

ii) in the case of other process variables only throughput efficiency was different significantly: Large leaders (65.72%) were more efficient than One-off manufacturers (51.89%) and Small laggards (52.15%).

iii) finished goods inventory levels were not different significantly among the clusters (13.06-16.28 days). Raw material inventory levels were significantly lower at Large leaders (22.71 days) than at Small laggards (35.02 days). Work-in-process inventory levels were lower at One-.off manufacturers (10.69 days) compared to Mass producers (23.6 days).

iv) in the case of quality costs only internal quality costs showed significant differences, between Large leaders (19.97%) and One-off manufacturers (27.02%). The other quality cost elements were generally the same across the clusters: ispection costs between 33.34-37.36%, prevention costs between 22.03-26.57%, and external quality costs between 16.89%-19.71% with no obvious sequence in the ranking of the clusters.

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5. Connected own publications

PUBLICATIONS IN ENGLISH (BY YEAR)

Book chapter

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1. Matyusz, Zs. – Demeter, K. – Szigetvári, Cs. (2012): The impact of external market factors on the operational practices and performance of companies. Society and Economy, Vol. 34, No. 1, pp. 73-93. (megjelenés alatt)

2. Demeter, K. – Matyusz, Zs. (2011): The impact of lean practices on inventory turnover. International Journal of Production Economics, Vol. 133, pp. 154-163.

Full papers, conference presentations

1. Matyusz, Zs. – Demeter, K. (2012): The effect of contingencies on manufacturing practices and operations performance.
Seventeenth International Working Seminar on Production Economics, 20-24 February 2012, Innsbruck, Austria (megjelenés alatt a konferenciakötetben)

2. Matyusz, Zs. – Demeter, K. (2011): The effect of contingencies on manufacturing strategy and operations performance
Proceedings on the 18th International Annual EurOMA Conference
University of Cambridge, Cambridge, United Kingdom, 3-6 July 2011

3. Matyusz, Zs. –Demeter, K. – Boer, H. (2010): The effects of international operations on the relationship between manufacturing improvement programs and operational performance
Sixteenth International Working Seminar on Production Economics, Pre-Prints Volume 4, pp. 127-138. (eds. Robert W. Grubbström and Hans H. Hinterhuber)
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6. Demeter, K. – Matyusz, Zs. (2008): The impact of size on manufacturing practices and performance
Proceedings on the 15th International Annual EurOMA Conference
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Fifteenth International Working Seminar on Production Economics, Pre-Prints Volume 1, pp. 311-322.
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8. Matyusz, Zs. – Demeter, K. (2008): The Impact of Lean Practices on Inventory Turnover. 15th International Symposium on Inventories. Budapest, Hungary, 22-26 August 2008

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