EFFECTS OF ADVANCED MANUFACTURING TECHNOLOGY ADOPTION AND MARKET COMPETITION ON MANAGEMENT ACCOUNTING SYSTEM OF MANUFACTURING FIRMS IN MALAYSIA

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ABSTRACT

Contingency theory proposes that advanced manufacturing technology adoption and market competition necessitate the adoption of sophisticated MAS for more accurate and timely accounting information to enhance firms’ decision making and to sustain their long-term success. This study empirically examines the effect of advanced manufacturing technology adoption and market competition on the adoption of sophisticated management accounting system (MAS). Using a structured questionnaire, data from 137 manufacturing companies from Malaysia were obtained for analyses. The regression results show that the sophistication of MAS adopted is significantly and positively related with advanced manufacturing technology adoption and market competition. The findings suggest that the adoption of sophisticated MAS design is parallel with the technological innovations that are incorporated into their manufacturing technologies and the adoption of sophisticated MAS design is able to assist managers in cost and control activities and to provide more relevant information for strategic decision making purposes. Besides, the adoption of sophisticated MAS design is also able to assist firms to cope with the increasing customer demands and competition from their core competitors by providing more relevant information regarding the changes in the business environment. These results have contributed to the management accounting change literature by suggesting that attempts by the MAS designers to improve the timeliness and the scope of the information are of particular relevance to the managers as the firm adopts more advanced manufacturing technology and as the market competition increases.

Keywords: Management accounting system design, contingency theory.

1. Introduction

In this current age of intense competition, management accounting system (MAS) design has been an important research topic as the management of a company needs to have relevant information at different levels of management to make appropriate decisions and to stay competitive (Mahfar & Normah, 2004; Tuanmat & Smith, 2011). However, as various researches were done and found that
firms are beginning to adopt more sophisticated management accounting system (MAS) (Haldma & Laats, 2002; Hyvonen, 2005; Angelakis, Theriou & Floropoulos, 2010), it is also important to understand the factors that drive the adoption of such accounting system in the firm. A review of past literature have revealed that most researchers are convincing organizations to adopt sophisticated MAS (Hyvonen, 2005; Angelakis et. al., 2010). However, Tillema (2005) noted that success is not guaranteed as it is the appropriateness of using these sophisticated MAS that would bring added value to the business, thus giving rise to a contingency theory perspective. Thus, following this concept, this study applies contingency theory to explain the MAS design among manufacturing firms in Malaysia as there is no single MAS design that is applicable to all business structure. Rather, the most appropriate MAS design is contingent to the business context and environment and it should provide managers with relevant information for decision making purposes (Gerdin, 2005; Tillema, 2005; Adbel Kader and Luther, 2008).

This paper aims to identify the contingent factors that influence the adoption of sophisticated MAS among manufacturing firms in Malaysia. In particular, this paper aims to empirically investigate whether the adoption of sophisticated MAS is significantly influenced by the changes in the adoption of advanced manufacturing technology and the intensity of market competition. These variables are identified as the contingency theory literature indicates that these factors are able to affect a manufacturing firm’s MAS design (Adbel-Kader & Luther, 2008). Besides, as manufacturing technology continues to advance, there is also a need to identify whether advanced manufacturing technology affects the MAS design in Malaysia as Adbel-Kader and Luther (2008) noted a distinctive difference while Haldma and Laats (2002) found no clear difference in the MAS design with different production technologies. The findings from this research will shed some light on whether firms in Malaysia are able to cope with the manufacturing technological changes and the changes in MAS design as the need for more accurate cost data increases. Besides, there is a also a need to identify whether the best MAS design is able to assist firms to cope with the intensity of the market competition as Khandwalla (1972) noted that the MAS design could be impacted by the intensity of the market competition as different kinds of information are needed. Thus, this study will adopt the contingency-based approach with the following specific objectives:

- To examine whether manufacturing firms in Malaysia are able to cope with the manufacturing technological change with the changes in MAS design.
- To examine whether manufacturing firms in Malaysia are able to cope with the intensity of market competition with the changes in MAS design.

The remainder of the paper is organized as follows. In the next section, the concept of management accounting system (MAS) design and the independent variables are explored. Following this, the contingency model is developed with a set of testable hypothesis. In the subsequent sections, the research method is described and the findings and conclusions are outlined.

2. Management Accounting System (MAS)

The definition of management accounting system (MAS) has expanded over the years from one that focuses purely on providing useful, accurate and timely information for decision making to one that embraces a much broader scope of information, including both the internal and external information (Chenhall, 2003). As for the purpose of this research, the definition of management accounting systems (MAS) will be adopted from Rahman, Omar and Abidin (2003), where it states that management accounting system (MAS) are systems used to generate simple, timely, accurate and relevant information to meet the needs of the managers within a firm.

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The design of MAS consist of four dimensions namely scope, integration, aggregation and timeliness (Chenhall & Morris, 1986). In the first dimension known as the ‘scope of MAS’, it is known to be referred to three descriptions and they are ‘the dimension of focus, quantification and time horizons’ of the management accounting system (MAS) (Tillema, 2005, p. 102). The first description ‘focus’ refers to whether the MAS design should produce information that focuses on internal or external events of the organization. The second description ‘quantifications’ are concern with whether the information is quantified in financial or non-financial terms. The last description ‘time horizon’ refers to whether the information obtained concern historical data or future data (Chenhall & Morris, 1986). In the next dimension, integration, it ensures that information is shared among departments as decision making results and departmental performance can affect one another. Aggregation concerns the provision of information summary either in terms of area of interest, period of time or formal decision models (Chenhall & Morris, 1986). Lastly, timeliness concerns the frequency and speed of the reporting. These four dimensions are used to assist firms to adopt the appropriate management accounting system (MAS) design in order to obtain relevant information that is needed by managers to make decisions and to achieve organization's goals (Chenhall & Morris, 1986; Gerdin, 2005).

3. Advanced manufacturing technology and MAS

From a review of literature, it is noted that differing product processes and designs (Otley, 1980; Haldma & Laats, 2002; Abdel-Kader & Luther, 2008; McLean, McGovern & Davie, 2014) which is also known as the manufacturing technology, is able to affect the MAS design. Otley (1980) has long identified manufacturing technology as a contingent factor that could impact the management accounting system (MAS) design due to the differences in the production methods and product design, causing different cost measurement tools to be adopted and thus different MAS design. This view was subsequently supported by Haldma and Laats (2002) and McLean et. al., (2014), where they also found a positive relationship between the advancement of the manufacturing technology in a firm and the design of the management accounting system (MAS). Thus, as the manufacturing technology advances, this puts a constrain on the accounting system, prompting firms to adopt more sophisticated management accounting system (MAS) in order to accommodate the changes in the cost structures and to ensure the precision of each cost calculation (Haldma & Laats, 2002; Abdel Kader & Luther, 2008; McLean et. al., 2014). This has caused the firm to emphasize on the maintenance and interpretation of the information generated from their management accounting system (MAS) in order to ensure relevant information are provided on a timely basis to assist managers at all levels (Abdel-Kader & Luther, 2008). Likewise, technology is also found to be one of the factors that could impact the management accounting system (MAS) design among Malaysian firms (Azizi Ismail, 2007). Thus, this research will explore the relationship between the adoption of advanced manufacturing technology and the design of the management accounting system (MAS) among manufacturing firms in Malaysia.

4. Market competition and MAS

Khandwalla (1972) and Tuanmat and Smith (2011) has identified that market competition is one of the main factors that could affect the management accounting system (MAS) design in a firm. as market and financial deregulations increases both in the local and international market. This has resulted in active competitors, increasingly diverse customer demands and shorter product life cycle. As a result of the competitive market, O’Conner, Vera-Munoz and Chan (2011) and Abdel-Maksoud, Abdallah and Youssef (2012) has found that firms needs to pay special attention to its MAS design in order to obtain relevant information that are needed to make decisions and to subsequently adopt the best fit of management accounting system (MAS) design that will be able to produce such
information for the management of the firm. This will enable firms to support their goals of accessing and exploiting market opportunities and resources more efficiently and rapidly both globally and locally (O’Conner et. al., 2011). This is essential as the traditional management accounting system (MAS) was oriented towards measuring earnings and have been criticized as it is unable to reflect the realities of the global market (Abdel-Maksoud et. al., 2012).

In Malaysia, Smith, Abdullah and Razak (2008) found that the intensity of the market competition could affect the MAS design of the firm the researchers found that the respondent adopt a particular system in relation to the competition factor that were faced by the organization (Smith et. al., 2008) such as cost competitiveness, quality improvement and wastage reduction. The demands for lower cost and improved quality products have placed firms in intense competition and this could be achieved by adopting the appropriate MAS design (Smith et. al., 2008, Adbel-Kader & Luther, 2008). Thus, there is a need to further examine whether manufacturing firms in Malaysia are able to cope with the intensity of the market competition by adopting more sophisticated MAS design. Thus, this research will explore the relationship between the intensity of the market competition and the MAS design among manufacturing firms in Malaysia.

5. Theoretical Framework

The contingency approach to management accounting states that there is no one universally best accounting system that could be applied to all organizations (Khandwalla, 1977; Otley, 1980). Rather, it suggests that the best accounting system depends on the context and the situation that an organization is in (Adbel Kader & Luther, 2008; O’Connor et. al., 2011; McLean et. al., 2014).

Through a review of literature, we found various studies adopted contingency theory to explain the relationship between the variables. Adbel-Kader and Luther (2008) and Halma and Laats (2002) used contingency theory to explain the relationship between the adoption of advanced manufacturing technology with the MAS design among manufacturing firms in UK and Estonia while Cadez and Guilding (2008) used contingency theory to investigate the relationship between market orientation and strategic management accounting. However, despite the conceptual and empirical research done, there is still in need of empirical evidence to explain the effect of these factors in the context of manufacturing firms in Malaysia. To address this issue, this study will examine the relationship between advanced manufacturing technology and market competition and the MAS design. Thus, the research model is depicted in Figure 1.

![Figure 1: Theoretical framework of this study](image-url)

Azizi Ismail (2007), Smith et. al. (2008) and McLean et. al. (2014) noted that managers often determine the design of the management accounting system (MAS) in order to obtain relevant cost and control information to support the production run by the organization’s manufacturing technology. This suggests that firms with higher level of manufacturing technology would need more sophisticated management accounting systems (MAS) in order to assist the managers to determine
the costs of production and to provide more useful information for the top management. However, Haldma and Laats (2002) noted no distinctive difference in the MAS design with different production technologies. Thus, in order to identify whether advanced manufacturing technology affects the MAS design in Malaysia, the third hypothesis is formed as:

\[ H1: \text{The adoption of advanced manufacturing technology is positively associated with the adoption of sophisticated management accounting system (MAS) among the manufacturing firms in Malaysia.} \]

On the other hand, Cadez and Guilding (2008) and O’Conner et. al. (2011) have noted that the intensity of the market competition does impact the sophistication of the adopted management accounting system (MAS) as firms would need more relevant and timely information in order to make more strategic decisions as market competition intensifies. Besides, it is found that local and international market competition has intensified over the past five years among manufacturing firms in Malaysia (Tuanmat and Smith, 2011). Thus, it is essential to further understand the effect of the intensity of market competition in the context of manufacturing firms in Malaysia and subsequently its impact on the MAS design in the firm. This is crucial due to as the market competition intensifies, the sophistication of the management accounting system (MAS) design also increases as the computation of costs and performance measurements are expected to be accurate and relevant. Thus, in order to identify whether the market competition affects the management accounting system (MAS) design in Malaysia, the fourth hypothesis is formed as:

\[ H2: \text{The intensity of market competition is positively associated with the adoption of sophisticated management accounting system (MAS) among the manufacturing firms in Malaysia.} \]

6. Methodology

6.1 Sample and data collection method

This research will employ the quantitative method, which is by using questionnaires. The questionnaire is developed through a mix and match method by adopting measurements from previous study in order to enhance the reliability and validity of the variables. Section A aims to identify the general information of the organization while in Section B, we will identify the types of information required by the management according to the four dimensions of the management accounting system (MAS) design stated by Chenhall & Morris (1986). For the purpose of this research, the design of management accounting system (MAS) will be measured using these four dimensions of the MAS design introduced by Chenhall and Morris (1986). The final section of the questionnaire aims to collect information for the independent variables.

The sample and respondents used in this research were accounts or finance manager in manufacturing firms in Malaysia which are selected from the FMM directory. This is due to this industry is the most influential contributor to the Malaysian economy (Rahman et. al., 2003; Mahfar & Omar, 2004) and researches have noted that the manufacturing sector is considered an information-intensive sector as production technology and machines are advancing rapidly and is exposed to the constant development in the manufacturing technology such as newer manufacturing technology and production cost structure (Smith et. al., 2008). FMM directory is used as it is currently the largest private sector economic organization in Malaysia, representing over 2,500 manufacturing companies of various sizes. Firms from Selangor, Negeri Sembilan and Melaka state were chosen. In order to achieve generalizability of the results and sufficient sample size, the survey population of 200 manufacturing firms in this research were chosen using the probability sampling (simple random method). Five addresses were used for pilot survey and the rest were used as the main survey population. Of the 200 questionnaires sent out, 140 returned questionnaire were
obtained, out of which 137 questionnaires were usable. Descriptive analysis were used to analyse the background information of the population while multiple regression analysis were used to test H1 and H2.

6.2 Instrumentation

The measurement of variables to be used in this survey were adopted from the research instruments from earlier studies, such as Chenhall and Morris (1986), Gordon Narayanan (1984) and Smith et. al. (2008) to enhance the validity and reliability of the measures. The measurement of the variables are summarised in Table 1.

Table 1: Contingent variables constructs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source of construct</th>
<th>Construct description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management accounting system (MAS)</td>
<td>Chenhall and Morris (1986)</td>
<td>Consist of nine questions identified from Chenhall and Morris (1986), indicated on a five point scale, to test the scope, timeliness, aggregation and the integration of information needed by managers. These items will be used to measure the sophistication of the MAS design adopted by manufacturing firms in Malaysia.</td>
</tr>
<tr>
<td>Advanced manufacturing technology</td>
<td>Smith, Abdullah and Razak (2008)</td>
<td>Consists of eight technology to be indicated on a five point scale the degree of technology usage in the firm.</td>
</tr>
<tr>
<td>Intensity of market competition</td>
<td>Gordon and Narayanan (1984)</td>
<td>Consists of seven questions, indicated on a five point scale the degree of intensity faced by the firm in the local and international market. Gordon and Narayana (1984) has adopted most of the questions from Khandwalla (1972).</td>
</tr>
</tbody>
</table>

7. Finding & Discussion

7.1 Reliability analysis and confirmatory factor analysis

Reliability test and confirmatory factor analysis were conducted to ensure the reliability and validity of the measurement. Cronbach alpha statistics for advanced manufacturing technology was 0.798, market competition was 0.737, management accounting system (MAS) design was 0.853, indicating satisfactory internal reliability for each of these variables (Nunnally, 1978, as cited in Adbel Kader and Luther, 2008). Subsequently, confirmatory factor analysis was used to test the validity of the construct. This research uses maximum likelihood (ML) estimation. All of the 137 responses were evaluated and all measures had a full response. The results were further evaluated using Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA). The respecified model fitted the data well (NFI = 0.806, CFI = 0.912, RMSEA = 0.068). Thus, the new model will be used in the multiple regression analysis.

7.2 Descriptive statistics & analysis

A general review of the profile of the respondent revealed that majority of the respondents were from Malacca (40.9 percent) while 35.8 percent of respondents were from Selangor and 23.4 percent were from Negeri Sembilan. Besides, 54.7 percent (75 respondents) were accounts or finance managers, 20.4 percent (28 respondents) were accounts executive or finance officer, 13.1
percent (18 respondents) were directors, general managers and chief finance officer while the remaining 11.7 percent were others, including cost accountant, project managers, project finance analysts and etc. Further analysis also noted that the highest number of sample companies were from the food and beverage industry (17.5 percent), followed by electrical and electronics (16.8 percent), other industry (14.6 percent), machinery and equipment (12.4 percent), wood based firms (11.7 percent) and rubber products (10.2 percent).

Table 2: Descriptive statistics of the dimensions of MAS and independent and dependent variables

<table>
<thead>
<tr>
<th>The dimensions of MAS</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of information</td>
<td>4.04</td>
<td>0.73</td>
</tr>
<tr>
<td>Integration of information</td>
<td>4.00</td>
<td>0.90</td>
</tr>
<tr>
<td>Aggregation of information</td>
<td>3.81</td>
<td>0.88</td>
</tr>
<tr>
<td>Timeliness of information</td>
<td>4.21</td>
<td>0.64</td>
</tr>
<tr>
<td>Overall MAS design</td>
<td>4.02</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Notes: Scale of 1-5: 1 is 'never', 2 is 'rarely', 3 is 'sometimes', 4 is 'often', 5 is 'always'.

According to Chenhall and Morris (1986), the need for sophisticated management accounting system (MAS) increases as the need for these four dimensions of MAS information by the management increases. According to the results from Table 2 above, the total mean score for the dimension of MAS is 4.02, noting that manufacturing firms in Malaysia require more timely and relevant information in order to make strategic decisions. As for the adoption of advanced manufacturing technology, the descriptive analysis revealed a mean score of 3.55, stating that manufacturing firms in Malaysia do adopt advanced manufacturing technology in their production, and a mean score of 4.05 for market competition suggested that manufacturing firms in Malaysia do face intense competition in the business environment.

Subsequently, Pearson correlation test was conducted and Table 3 below shows that all the relationships between the variables were positive and significant.

Table 3: Correlation table

<table>
<thead>
<tr>
<th></th>
<th>Advanced Manufacturing Technology</th>
<th>Market Competition</th>
<th>MAS Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Manufacturing Technology</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market Competition</td>
<td>0.455**</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>MAS design</td>
<td>0.409**</td>
<td>0.369**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

** Correlation is significant at 0.01 level.
* Correlation is significant at 0.05 level.

Besides, multicollinearity test was performed and Table 4 as below shows the result. The results revealed that a VIF value of less than 1.50 for all tests and a tolerance value of less than 0.90 for all tests showed that there were no multicollinearity issues among the independent variables.
Table 4: Results of regression of MAS design on Advanced Manufacturing Technology and Market Competition

<table>
<thead>
<tr>
<th>Models</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>(Constant)</td>
<td>1.961</td>
<td>0.315</td>
<td>6.224</td>
</tr>
<tr>
<td>Advance Manufacturing Technology</td>
<td>0.185</td>
<td>0.063</td>
<td>0.256</td>
</tr>
<tr>
<td>Market Competition</td>
<td>0.161</td>
<td>0.080</td>
<td>0.170</td>
</tr>
</tbody>
</table>

Note: * = p < 0.05

The multiple regression model for the relationship between the adoption of advanced manufacturing technology and market competition and the adoption of sophisticated MAS design produced R value = 0.548, R2 value = 0.301 and the adjusted R2 = 0.274. According to the ANOVA table, the results show that the independent variables can statistically predict the dependent variable [ F (5, 131) = 11.270, p < .05 ]. This shows that the regression model is a good fit of the data.

H1 examines the relationship between the adoption of advanced manufacturing technology and the adoption of sophisticated MAS design among manufacturing firms in Malaysia. Table 4 supported the results from the Pearson Correlation test. Thus, the relationship between the adoption of advanced manufacturing technology and the adoption of sophisticated MAS design is positive and significant (t = 2.948, p = 0.004). Therefore, H1 is supported.

The strong positive relationship is consistent with the past researches as Azizi Ismail (2007), Smith et. al. (2008) and McLean et. al. (2014) noted that it is essential that firms adopt the appropriate management accounting system (MAS) design in order to obtain relevant cost and control information to support the production run by the organization's manufacturing technology. Besides, the motivation to adopt more sophisticated MAS design could also be due to most of the manufacturing firms are striving to achieve various ISO certificates and the OEM (original equipment manufacturer) status as a result of the volatile economic environment and increasing customized demands (Chen and Li Li, 2013). Thus, in order to achieve such status, firms are attracted to adopt more advanced manufacturing technologies in order to cope with the business changes (Chen and Li Li, 2013). Thus, a more sophisticated MAS design is needed to ensure that the top management receives relevant information for decision making purposes as the traditional MAS design is unable to effectively help managers to identify relevant costs and manage their resources. Thus, it is also concluded that manufacturing firms in Malaysia are able to cope with the manufacturing technological changes with the changes in MAS design.

H2 examines the relationship between the intensity of the market competition and the adoption of sophisticated MAS design among manufacturing firms in Malaysia. Table 4 results also supports the results from the Pearson Correlation test that the two variables were positively correlated and the relationship between market competition and the adoption of sophisticated MAS design is positive and significant (t = 2.005, p = 0.047). Therefore, H2 is also supported.

The results on the relationship between market competition and MAS design has subsequently provided empirical evidence to further support the findings by Cadex and Guilding (2008) and O'Connor et. al. (2011) in the context of the manufacturing sector in Malaysia, as the firms are adopting more sophisticated MAS designs as the intensity of the market competition increases.
Besides, Abdel-Maksoud et. al. (2012) noted that firms have found that the intensity of the market competition has increased as globalization, privatization and industry modernization initiatives increases in the country. They subsequently found high levels of adoption of the sophisticated MAS design among the respondents, concluding that high levels of market intensity leads to high levels of adoption of the sophisticated MAS design in order for firms to obtain relevant information for decision making purposes (Cadez and Guilding, 2008; Abdel-Maksoud et. al., 2012).

8. Conclusion and Future Recommendation

This research has found that manufacturing firms in Malaysia are adopting sophisticated management accounting system (MAS) design as the need for larger scope of information, the need for aggregated information, the need for integrated information and the need for timely information increases. This has interesting implications for the change management as firms begin to adopt more sophisticated management accounting system (MAS) design that could provide such information for strategic decision making purposes. This is due to more sophisticated MAS design is able to cope with the business and technology changes and produce relevant information that are needed by the managers. This reflects the acceptance to change as the firms find that the current MAS design is unable to produce essential information for decision making purposes.

Besides, this research has also provide empirical results on the positive relationships between the adoption of advanced manufacturing technology, the intensity of market competition and the adoption of sophisticated management accounting system (MAS) design as suggested in past literatures. It is found that the adoption of sophisticated MAS is able to help manufacturing firms in Malaysia to cope with the changes in the manufacturing technology and the intensity of the market competition. This is due to the adoption of sophisticated MAS is able to provide relevant information needed for cost and control purposes (Smith et. al., 2008; McLean et. al., 2014) and this is essential as the manufacturing technology advances as it enable the firms to make accurate pricing and budgeting decisions that could impact the firm's success.

This research is subjected to a number of limitations. Firstly, the sample size is drawn from the FMM directory (Federation of Malaysian Manufacturers) and limited to 200 samples only. Thus, it may not be able to fully represent the whole population of manufacturing firms in Malaysia as it only accounts for firms that registered under FMM. As a result, any generalization of the study's results to non members of the FMM, non-manufacturing firms and service organizations would need to be done with extra caution. Besides, the data collected from the organization are not longitudinally but only at one point in time. Thus, this research will not be able to include any time-lag changes in the management accounting system (MAS) design.

However, this study would suggest that future research could be done to include firms from the service sector. This is in line with Malaysia's aim of making the service sector the driver of Malaysia's economic growth. Thus, it is essential to include service firms in the future studies in order to further understand the management accounting system (MAS) design in the service sector. Lastly, future research could also include other variables from organizational theory such as the organizational culture, the country's economy and political situation and etc. Through this, there will be a wider research on the impact of different variables on the adoption of sophisticated MAS design in the context of manufacturing firms in Malaysia.
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