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Mathematical Modelling of Boston Consultant Group Growth (BCGG) Matrix in handloom products of Weaving Industry of Maruthamunai: Case study approach

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Abstract Weaving companies such as RHL, JAFW, JARW and NAJW companies sell six brands of sarongs such as padayappa, white, full colour, light colour, multi colour and groom line. Objectives of this study are to know market share of selected weaving companies of Maruthamunai and to derive a mathematical model for weaving industry using market share. This is a case study of four weaving companies. Secondary data were collected from owners of these companies during 2012 &2013. Results indicated that RHL, JAFW, JARW and NAJWC companies have 40.45 %, 30.00%, 19.74 % and 9.50 % as their market share. Results revealed that for Log log model, R square and adjusted R square are 92.2% and 88.2% respectively. While benchmarking with Linear log model, MAPE, MAD and MSD of Log log model are lower. So, Log log model is selected. It is also concluded that it is possible to derive a mathematical model for weaving industry using market share.
Keywords: Boston Consultant Group Growth, Case Study.

Introduction of the study

The BCG matrix is a chart that had been created by Boston Consulting Group to help corporations with analyzing their business units or product lines. To use BCG Matrix, analysts plot a scatter graph to rank the business units or products on the basis of their relative market shares and growth rates. B*usiness dictionary (2013) defines business unit as a* logical element or segment of a company (such as accounting, production, and marketing) representing a specific business function, and a definite place on the organizational chart, under the domain of a manager. It is also called department, division, or a functional area. In this study, researcher views business unit from the point of view of marketing. Researcher selects four weaving companies such as RHL company, JAFW company, JARW company and NAJW company that are located in Maruthamunai, Ampara district, Eastern Province of Sri Lanka. Weaving product line sold by these four companies represent six brands of sarongs such as padayappa, white, full colour, light colour, multi colour and groom line. *Investopedia (2013) defines product line as a* group of related products manufactured by a single company. Wikipedia (2013) defines product lining involves offering the products for sale separately. A line can comprise related products of various sizes, colors, qualities, or prices. This study considers product line manufactured by companies on the basis of colours. Wikipedia (2013) defines strategic business unit (SBU) as a profit center which focuses on product offering and market segment. An SBU may be a business unit within a larger corporation, or it may be a business unto itself. Corporations may be composed of multiple SBUs, each of which is responsible for its own profitability. When using the BCG matrix, SBUs can be shown within any of the four quadrants such as star, question mark, cash cow and dog as a circle whose area represents their size. With different colors, competitors may also be shown. The precise location is determined by the two axes, market growth as the Y axis, market share as the X axis. Star products are currently have high growth and high market share however question mark is product with low share but high growth. Cash Cow has high share but low growth. Finally, dog is product that has low growth and low share.

Statement of the problem

Studies highlight that there are number of studies in BCGG matrix in different contexts. For example, Hambrick, MacMillan and Day (1982) studied about strategic attributes and performance in the BCG Matrix in industrial product businesses. They empirically explored the performance tendencies and strategic attributes of businesses in the four cells of the Boston Consulting Group product portfolio matrix. Businesses differed in their performance and strategic attributes, according to the two dimensions of the BCG matrix-product life cycle stage (growth rate) and market share. Some other studies highlight about investment decision- making on the basis of BCGG matrix. For instance, Armstrong and Brodie (1994) studied about effects of portfolio planning methods on decision making. This study was conducted among managers who were asked to choose between investment opportunities. Of subjects exposed to the BCG matrix, 64% selected the unprofitable investment. Of subjects who used the BCG matrix in their analysis, 87% selected the less profitable investment. Empirical evidences of previous studies confirm that BCGG matrix can be applied for knowing business performance and investment opportunities in different industries and in different countries. BCGG matrix is based on market share and market growth of companies. This study prefers to apply the BCGG matrix in weaving industry. Maruthamunai is one of the most important city that is famous for weaving industry. Weaving Industry of Maruthamunai is comprised of number of players. In recent years, few weaving companies are growing so fast. Their market share is high and their market growth is also higher. RHL company and JAFW company are the two leading key players in weaving industry. Therefore, researcher discussed with the owners of RHL company and JAFW company for confirming the research problem. It revealed that their market share and market growth. They both indicated that their market share is 40 % and 30 % respectively. Their market growth is 10 % and 6 %respectively. They also indicated that JARW company and NAJW company are also growing so fast in weaving industry. These facts and figures highlight that market share and market growth of these four companies are growing fast.

Research question and objectives

Empirical evidences and facts & figures revealed by owners of weaving companies confirm that research problem lies on market share and market growth that are key components of BCGG matrix. Researcher sets "do different weaving companies of Maruthamunai have different market share?" as research question and "is it possible to derive a mathematical model for weaving industry using market share?". These research questions are converted into research objectives as "To know market share of selected weaving companies of Maruthamunai" and "to derive a mathematical model for weaving industry using market share".

Significance of this study

BCGG Matrix helps the company to know about its market share and market growth. Once it knows its market share and market growth it can allocate resources accordingly. Some company products may earn higher cash flow whereas others may not. Products earning high- cash flow are identified and then from which, other products earning low- cash flow are allocated money for its survival if possible. It is used as an analytical tool in product management and portfolio analysis. It helps to identify the high- profit making products and low- profit making profits. This is why Armstrong and Brodie (1994) studied about effects of portfolio planning methods on decision making using with respect to investment opportunities. Information about the BCG matrix helps to make investment decisions. This study is undertaken in weaving industry. Key players in weaving industry can know their market share that would be helpful to identify market leader, challenger, follower and niche that they design different marketing strategies to fit their market share. Mathematical model found can help to mathematically prove company's growth. Number of studies highlights the importance of BCGG matrix. For example, Morrison and Wensley (1991) studied about a short history of the Boston Consulting Group Share/ Growth Matrix. The stated that application of the "Boston Box" became a powerful means of simplifying and "boxing up" complex issues of marketing strategy.

Review of literature

BCGG matrix at a glance

Henderson (1970) put forward a matrix to Boston Consultant Group Growth matrix. Cash cows are units with high market share in a slow-growing industry. These units typically generate cash in excess of the amount of cash needed to maintain the business. They are to be "milked" continuously with as little investment as possible, since such investment would be wasted in an industry with low growth. Dogs, or more charitably called pets, are units with low market share in a mature, slow-growing industry. These units typically "break even", generating barely enough cash to maintain the business's market share. They do not generate cash for the company. They depress a profitable company's return on assets ratio, used by many investors to judge how well a company is being managed. Dogs, it is thought, should be sold off. Question marks (also known as problem children) are growing rapidly and thus consume large amounts of cash, but because they have low market shares they do not generate much cash. The result is a large net cash consumption. A question mark has the potential to gain market share and become a star, and eventually a cash cow when the market growth slows. If the question mark does not succeed in becoming the market leader, then after perhaps years of cash consumption it will degenerate into a dog when the market growth declines. Question marks must be analyzed carefully in order to determine whether they are worth the investment required to grow market share. Stars are units with a high market share in a fast-growing industry. The hope is that stars become the next cash cows. Sustaining the business unit's market leadership may require extra cash, but this is worthwhile if that's what it takes for the unit to remain a leader. When growth slows, if they have been able to maintain their category leadership stars become cash cows, else they become dogs due to low relative market share. BCGG matrix is shown in the following tab. 1.

		Market share	
		High	**Low**
Growth rate	High	Stars	Question marks
	Low	Cash cows	Dogs

Table 1: BCGG matrix

(Source: Adopted from literature review and Henderson)

Related previous literatures

Ismail (2011) studied about association between brand preference of market leader and market niche in weaving industry of Maruthamunai. Ismail (2011) studied about a comparative study of sales force turn over (SFTO). Both were case study approach in weaving industry of Maruthamunai. Smith (2010) studied about Derrick's Ice–Cream Company: applying the BCG matrix in customer profitability analysis. This case highlights the differences in the profitability possible when different customers are in receipt of substantially the same product. It provides the opportunity to develop a customer portfolio, along the lines of the Boston Consulting Group (BCG) portfolio matrix, as part of a customer profitability analysis. Seeger (2006) studied about reversing the images of BCG's growth/share matrix. Boston Consulting Group, the cows, dogs, stars and question marks of the growth/share matrix have become part of the language of business strategy. Since BCGG matrix is oversimplified prescriptions for action which managers may attach to the images their images are powerful. Managers should kick the dogs, cloister the cows, and throw our money at the stars. To avoid those oversimplifications, managers must remember that the dogs may be friendly, the cows may need a bull now and then to remain productive, and the stars may have burned themselves out. Morrison and Wensley (1991) studied about a short history of the Boston Consulting Group Share/ Growth Matrix. They look critically at the

history of the development of the Market Share/Market Growth matrix by the Boston Consulting Group and its popularization in both the practitioner and academic domains mainly from public sources. Of particular interest is the question of whether this central technique in any marketing strategy analysis of the seventies or eighties also bred its own form of "marketing myopia" and "boxed in" strategic discussions to a limited set of options and prescriptions. A short survey of marketing lecturers in the UK was also conducted to establish the current state of undergraduate teaching of the "Boston Box" itself, which indicated that there are still considerable areas of concern in terms of the teaching of such techniques.

Ismail and Velnampy (2013) studied about corporate performance in public health service organizations. This study tries to determine factors affecting performance of PHSOs and to know the reliability and validity of items & factors and to create a mathematical equation model. It was found that Cronbach alpha for items shows high reliability for items. Content validity and convergent validity are higher. Discriminant validity are lower statistically. Log log model is the best fitted model than linear models.

Conceptualisation and operationalisation

The following conceptual framework is adopted and developed as study framework for using as conceptual framework. It is depicted in fig. 1.

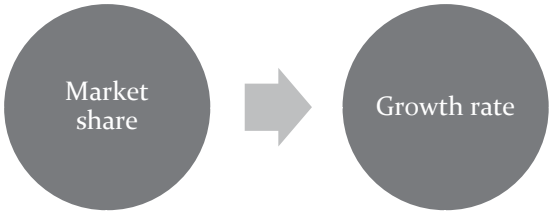

Figure 1: Conceptual framework

The following hypotheses are set to determine the relationship between market share and growth rate. The following set of hypotheses is developed. They are null and alternative hypotheses. Null and alternative hypotheses are coded as Ho and H1. Ho is stated as there is no relationship between market share and growth rate. H1 is stated as there is relationship between market share and growth rate.

The above constructs in conceptualization framework is operationalised. Operationalisation is tabulated in tab. 2.

Concept	Construct	Indicator	Measure
BCGG	Market growth	Market growth ratio	Units sold in current year and units sold in previous year
	Market share	Market share ratio	Unit sold in a particular year and grand total units sold

Table 2: operationalisation

Methodology

Population and sample

Four weaving companies are selected as case studies as sample. These four weaving company cases are leading players in weaving industry. They are RHL company, JAFW company, JARW company and NAJW company. These four case studies are selected because of the homogeneity of weaving industry and for the reasons of data availability and accuracy.

Data collection

Secondary data were collected from owners of these four cases. These companies sold six brands of sarongs such as padayappa, white, full colour, light colour, multi colour and groom line. Sales records of these six brands of sarongs such as padayappa, white, full colour, light colour, multi colour and groom line were scrutinized during 2012 & 2013. The tab. 3 shows the statistical summary of six brands of sarongs sold by companies.

Data analysis technique

Regression analysis was run by researcher using SPSS. Minitab was used for drawings and measures of accuracy of the fitted model such as MAPE, MAD and MSD

	RHL company					JAFWC company					JARW company					NAJWC company				
Brand of sarongs	Sarongs sold in 2012	Sarongs sold in 2013	Market growth %	Market share 2012	Market share 2013	Sarongs sold in 2012	Sarongs sold in 2013	Market growth %	Market share 2012	Market share 2013	Sarongs sold in 2012	Sarongs sold in 2013	Market growth %	Market share 2012	Market share 2013	Sarongs sold in 2012	Sarongs sold in 2013	Market growth %	Market share 2012	Market share 2013
Padayappa	9216	10138	10	6.67	6.9	6912	7396	7	5	5	4608	4792	4	3.4	3.3	2304	2327	1	1.7	1.6
White	9216	10045	9	6.67	6.85	6912	7396	7	5	5	4608	4792	4	3.4	3.3	2304	2327	1	1.7	1.6
Full colour	9216	9953	8	6.67	6.78	6912	7396	7	5	5	4608	4792	4	3.3	3.3	2304	2327	1	1.7	1.6
Light colour	9216	9861	7	6.67	6.68	6912	7396	7	5	5	4608	4792	4	3.3	3.2	2304	2327	1	1.7	1.6
Multi cour	9216	9769	6	6.67	6.657	6912	7396	7	5	5	4608	4838	5	3.3	3.29	2304	2327	1	1.7	1.6
Groom line	9216	9677	5	6.67	6.59	6912	7395	7	5	5	4608	4961	6	3.3	3.38	2304	2327	1	1.6	1.6
Total units	55296	59425	7.46	40	40.45	41472	44375	7	30	30	27648	28967	4.61	3.3	19.74	13824	13962	1	1.6	1.5
Grand total units	138240	146729				138240	146729				138240	146729				138240	146729		10	9.5
Marker share	40	**40.499**				30	**30.242**				20	**19.741**				10	**9.515**			

Table 3: Statistical summary of six brands sarong sold by companies
(Source: Secondary data of owners)

Formulas used

Based on indicators, two ratios were calculated. They are market growth ratio and market share ratio. They are calculated as indicated in the following formulas 1 and 2.

Market growth = {[Units sold in current year – Units sold in previous year]/ Units sold in previous year}*100 (1)

Market share = {[Unit sold in a particular year/ Grand total units sold]} * 100 (2)

Results and discussion of findings

Extracted results of four weaving companies are presented in the tab. 4.

More than 10 % of market share are categorized as high market share. Less than 10 % of market share are categorized into low market share. More than 5 % of growth rate is categorized into high growth rate. Less than 5 % of growth rate is categorized into low growth rate. Products of RHL company and JAFW company have high market share and high growth rate.

Company products	Market share (%)	Growth rate (%)	Type of company	Type of product	Type of market
RHL company products	40.45 (high)	07.46 (high)	Star company	Star products	Market leader
JAFW company products	30.00 (high)	07.00 (high)	Star company	Cash cow products	Market challenger
JARW company products	19.74 (high)	04.61 (low)	Cash cow company	Cash cow products	Market follower
NAJWC company products	9.50 (low)	01.00 (low)	Dog company	Dog products	Market niche/ niche market

Table 4: Extracted results of four weaving companies

Products of these two companies are star products. Products of JARW company has high market share and low growth rate. Products of this are cash cow products. Products of NAJW company has low market share and low growth rate. Products of this company are dog products. Kotler (2000) defined that any company having market share of 40 %, 30%, 20% and 10% are termed as market leader, market challenger, market follower and market niche. On this argument, RHL company products, JAFW company products, JARW company products and NAJWC company products have 40.45 %, 30.00%, 19.74 % and 9.50 % as their market share. RHL company, JAFW company, JARW company and NAJWC company can be categorized as market leader, market challenger, market follower and market niche in weaving industry. BCGG is depicted to illustrate company positions. It is shown in the following BCGG matrix that is depicted in fig. 2.

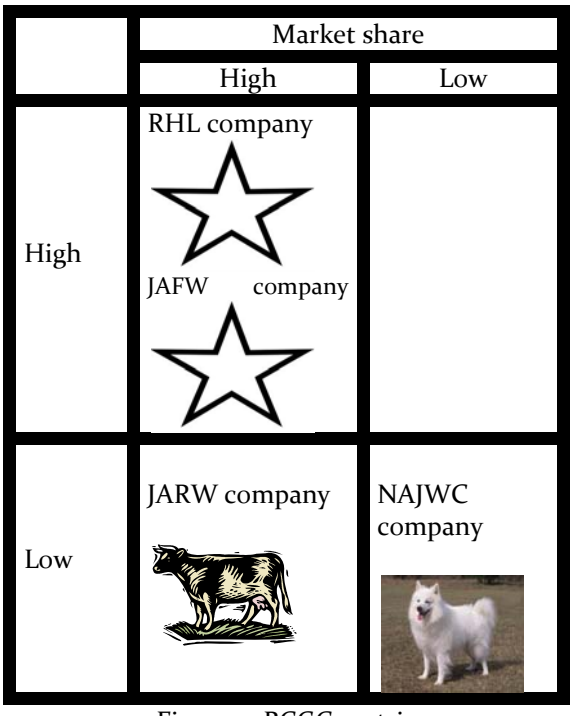

Figure 2: BCGG matrix

Results revealed that different weaving companies in Maruthamunai such as RHL company, JAFW company, JARW company and NAJW company have different market shares.

Regression Analysis and model selection

Four regression models have been run for selection of model. Results are shown in tab. 5.

Hypotheses tested

t test and f test are used to determine the relationship between market share and growth rate.

- Ho: There is no relationship between market share and growth rate
- H1: There is relationship between market share and growth rate

Linear Linear Model										
The regression equation is Growth rate (%) = - 0.18 + 0.208 Market share (%)	Regression Analysis: Growth rate (%) versus Market share (%)				Analysis of Variance					
Predictor	Coef	SE Coef	T	P	Source	DF	SS	MS	F	P
Constant	- 0180	1,388	- 0.13	0.909	Regression	1	23.453	43.453	17.06	0.054
Market share (%)	0.208	0.05025	4.13	0.054	Residual Error	2	2.750	1.375		
		S = 1.17257	R-Sq = 89.5%	R-Sq(adj) = 84.3%	Total	3	26.202			
Linear Log Model										
The regression equation is Log Growth rate (%) = - 0.165 + 0.0613 Market share (%)	Regression Analysis: Log Growth rate (%) versus Market share (%)				Analysis of Variance					
Predictor	Coef	SE Coef	T	P	Source	DF	SS	MS	F	P
Constant	- 0.1652	0.6454	-0.26	0.822	Regression	1	2.0484	2.0484	6.89	0.120
Market share (%)	0.06134	0.02336	0.02336	0.120	Residual Error	2	0.5942	0.2971		
		S = 0.545091	R-Sq = 77.5%	R-Sq(adj) = 66.3%	Total	3	2.6426			
Log Linear model										
The regression equation is Growth rate (%) = - 9.33 + 4.65 Log market share (%)	Regression Analysis: Growth rate (%) versus Log Market share (%)				Analysis of Variance					
Predictor	Coef	SE Coef	T	P	Source	DF	SS	MS	F	P
Constant	-9.325	1.454	- 6.41	0.023	Regression	1	25.690	25.690	100.34	0.010
Log Market share (%)	4.6453	0.4637	10.02	0.010	Residual Error	2	0.512	0.256		
		S = 0.505992	R-Sq = 98.0%	R-Sq(adj) = 97.1%	Total	3	26.202			
Log Log Model										
The regression equation is Log Growth rate (%) = - 3.05 + 1.43 Log Market share (%)	Regression Analysis: Log Growth rate (%) versus Log Market share (%)				Analysis of Variance					
Predictor	Coef	SE Coef	T	P	Source	DF	SS	MS	F	P
Constant	-3.0451	0.9251	-3.29	0.081	Regression	1	2.4354	2.4354	23.50	0.040
Log Market share (%)	1.4302	0.2950	4.85	0.040	Residual Error	2	0.2073	0.1036		
		S = 0.321933	R-Sq = 92.2%	R-Sq(adj) = 88.2%	Total	3	2.6426			

Table 5: Results of regression analysis

P values of t test and f test are 0.010 & 0.010 respectively. These values are less than 0.05. Researcher rejects Ho and accepts H1. This refers to that market share and growth rate are related to each other. If companies want to increase their growth rate they have to increase their market share.

Derivation of a mathematical model for weaving industry using market position

Four regression models have been run for selection of model. Of these four models, Linear log and Log log regression models could be selected. For Linear log model, R square and adjusted R square are 98.0% and 97.1% respectively. It reveals that market share influences on growth to a higher degree. The regression equation is:

Growth rate (%) = - 9.33 + 4.65 Log market share (%)

(3). For Log log model, R square and adjusted R square are 92.2% and 88.2% respectively. It also reveals that market share influences on growth to a higher degree. The regression equation is:

Log Growth rate (%) = - 3.05 + 1.43 Log Market share (%)
(4).

Measures of accuracy

Minitab computes three measures of accuracy of the fitted model: MAPE, MAD and MSD. The three accuracy measures can be used to compare the fits obtained by using different methods. Mean absolute percentage error (MAPE) expresses accuracy as a percentage of the error. Because this number is a percentage, it may be easier to understand than the other statistics. For example, if the MAPE is 5, on average the forecast is off by 5%. Mean absolute deviation (MAD) expresses accuracy in the same units as the data which helps conceptualize the amount of error. Outliers have less of an affect on MAD and MSD. Mean squared deviation (MSD) is a commonly-used measure of accuracy of fitted time series values. Outliers have more influence on MSD than MAD. For all three measures, smaller values generally indicate a better fitting model. Of the four regression models, log log regression model have been selected due to lower MAPE, MAD and MSD. The tab. 6 shows measures of accuracy.

Table 6: Measure of accuracy

Models	MAPE	MAD	MSD
Linear linear	28.4440	0.7875	0.6265
Log linear	20.2356	0.3661	0.1412
Linear log	28.4440	0.7875	0.6265
Log log	20.2356	0.3661	0.1412

(Source: survey data)

Regression analysis selected Linear log and Log log regression models. For Linear log model, R square and adjusted R square are 98.0% and 97.1% respectively. For Log log model, R square and adjusted R square are 92.2% and 88.2% respectively. While benchmarking of these two regression models, MAPE, MAD and MSD of Log log model are lower than those of Linear log model. So, Log log model s selected. Measures of accuracy for log log model are shown in fig. 3.

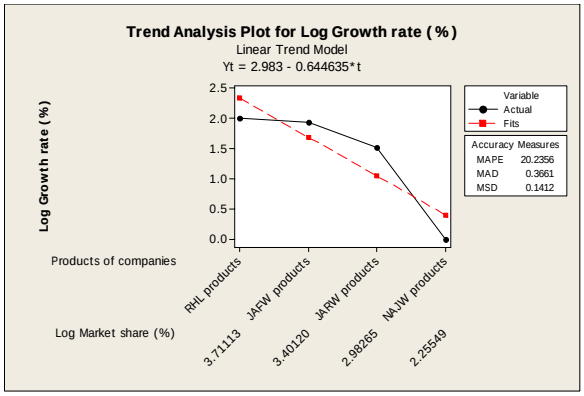

Figure 3: Measures of accuracy

Results revealed that it is possible to derive a mathematical model for weaving industry using market share.

Conclusions

It is concluded that different weaving companies in Maruthamunai such as RHL company, JAFW company, JARW company and NAJW company have different market shares. Products of RHL company JAFW company have high market share and high growth rate. Products of these two companies are star products. Products of JARW company has high market share and low growth rate. Products of this are cash cow products. Products of NAJW company has low market share and low growth rate. Products of this company are dog products. RHL company products, JAFW company products, JARW company products and NAJWC company products have 40.45 %, 30.00%, 19.74 % and 9.50 % as their market share. RHL company, JAFW company, JARW company and NAJWC company can be categorized as market leader, market challenger, market follower and market niche in weaving industry. Hypotheses tests proved that p values of t test and f test are 0.010 & 0.010 respectively. These values are less than 0.05. This refers to that market share and growth rate are related to each other. It is also concluded that it is possible to derive a mathematical model for weaving industry using market share. Regression analysis selected Linear log and Log log regression models. For Linear log model, R square and adjusted R square are 98.0% and 97.1% respectively. For Log log model, R square and adjusted R square are 92.2% and

88.2% respectively. While benchmarking of these two regression models, MAPE, MAD and MSD of Log log model are lower than those of Linear log model. So, Log log model s selected.

Managerial implications

RHL company products, JAFW company products, JARW company products and NAJWC company products have 40.45 %, 30.00%, 19.74 % and 9.50 % as their market share. Owners of RHL company, JAFW company, JARW company and NAJWC company can design their marketing strategy to survive in weaving industry. This refers to that market share and growth rate are related to each other. If owners of RHL company, JAFW company, JARW company and NAJWC company want to increase market growth they can manipulate their market share.

Acknowledgement

I acknowledge that I have cited and referred all articles to the best of my knowledge. This study is an original study done by me. I thank to Prof. T. Velnampy, Dean, Faculty of Management Studies and Commerce, University of Jaffna, Sri Lanka and all academic staff, Faculty of Management and Commerce, South Eastern University of Sri Lanka for encouraging and promoting me to continuously write research papers. Finally, I am thankful to all my family members for their patience and uninterrupted support in carrying out research works. This study is a self- funded study.

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