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Profit Maximization of DELL Inc. through Build-to-Order Supply Chain for Laptop Manufacturing

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Abstract

The Build-to-order supply chain management (BOSC) strategy has recently attracted the attention of both researchers and practitioners, given its successful implementation in many companies including Dell computer, Compaq and BMW. The era is becoming modern day by day and the variation in demand of men is changing with one accord. At beginning stage, men would use personal computer (PC) but they could not use PC according their preference. After some time of that period, DELL Inc. first launched PC according to customer need and they gained a great market share. After that, a new technology had come that is laptop. As a result, laptop market share crossed the PC market share. Different company is developing standardized laptop but no one is actually paying attention to the customer preference. This work represents a model of BTO production of laptops and the profit estimation which represents how BOSC strategy on DELL laptop would increase the profit. In this research paper, we have developed an optimum supply chain network and build-to-order (BTO) management for laptop manufacturing of DELL Inc. and also showed that how can be more profitable by applying this strategy.

Keywords

Build-to-Order Supply Chain Management, Supply Chain Network Distribution, Implementation Strategy, Performance Measurement

1. Introduction

A typical supply chain network consists of various stages *i.e.* supplier, manufacturer, distributor, retailer, customer [1] [2]. Sultana *et al.* (2016), Munna *et al.* (2015) and Mondal *et al.* (2017) stated that each of the stages creates extra charge

to the final products [3] [4]. Mondal *et al.* also stated that the more stages present in supply chain, the more complex network creates [4]. As the complexity increases, more highly skilled personnel will be required, which eventually increases the cost of supply chain. If we can reduce some stages of the supply chain network, it can be easily said that it will reduce the supply chain cost. Sultana *et al.* stated that nowadays in the business world, companies are trying hard to gain competitive advantage over others by offering their customer satisfactory quality, price, responsiveness, flexibility, and dependability [3]. Towards this end, firms have developed a build-to-order supply chain (BOSC) to be flexible and responsive [5]. According to Sun *et al.* (2006), BOSC has become a popular operations paradigm after the success of its implementation in Dell Computers, BMW, and Compaq [6]. Dell operated on the direct sales model, taking orders over the phone and building PCs to the customer's specifications. Dell entered the retail PC channel for several years in the early 1990s, but a downturn in business in 1993 led it to return to its roots as a direct vendor (although the company does work with resellers in some markets). Dell grew rapidly and in the mid of 1990s, its sales reached an inflection point, soaring from $3.5 billion in 1994 to $25 billion in 1999. By 1999, Dell had become the number one PC seller in the United States, and was number two worldwide. More importantly, profits were soaring, thanks to the cost structure of the direct, build-to-order model. Dell's most recent 26% growth rate continues to outpace the industry as a whole, and it has not been able to match its earlier growth rates of 50% a year. And it was hit hard by the slowdown in PC sales in late 2000. The result has been a sharp fall in Dell's stock price and a reminder that Dell is vulnerable to the brutal price competition and cyclical demand of the PC industry [7].

2. Literature Review

Several review articles were found on Build-To-Order supply chain management, but none on BOSC provided an analytical framework for a critical review of the literature on Total Supply Chain Management (TSCM) which can be best suited for newly proposed BOSC strategy in laptop production of DELL Inc. For the research purpose the studies available on BOSC are reviewed and they are listed in **Table 1** (Summary of references under the detailed classification scheme of the literature on BOSC).

3. Build to Order Supply Chain Management

The manufacturing continuum can be classified as make-to-stock (MTS), assemble-to-stock (ATS), make-to-order (MTO), and engineering-to-order (ETO). BTO and MTO are similar. MTO indicates the manufacturing of component and parts along with assembly, but BTO includes mostly assembly operation, where the component and parts outsourced [5]. For that reason, BTO are more responsive than MTO. And that is why different companies are changing their strategy and moving towards the BTO and establishing BOSC for increasing responsiveness.

Table 1. Classification of the literature available on BOSC.

Classification criteria	Classified by
Supply chain and BTO environment	Hausman (2004) [8], Noorul Haq & Kannan (2006) [9], Gosling & Naim, (2009) [10], Christensen *et al.* (2005) [11], Gunasekaran & Ngai (2005) [5], Ho & Lin (2004) [12], Prasad *et al.* (2005) [13], Holweg & Pil (2001) [14]
Development and implementation of BOSC	Cravens *et al.* (2000) [15],Vrijhoef and Koskela (2000) [16], Forza and Salvador (2002) [17], Muffato and Payaro (2002) [18], Power and Sohal (2002) [19], Svensson and Barford (2002) [20], Thonemann and Bradley (2002) [21], Van Tulder and Mol (2002) [22], Chopra (2003) [23], Davila *et al.* (2003) [24], Erhun and Tayur (2003) [25]
Operations of BOSC	Banker and Khosla (1983) [26], Glasserman and Wang (1998) [27], Krause *et al.* (1998) [28], Chen *et al.* (2000) [29], Chen *et al.* (2003) [30], Griffiths and Margetts (2000) [31], Kolisch (2000) [32], Song and Yao (2002) [33], Geunes (2003) [34], Wagner *et al.* (2003) [35], Biswas and Narahari (2004) [36]
BOSC and information technology	Kraemer and Dedrick (2002) [37], Morris and Morris (2002) [38], Muffato and Payaro (2002) [18], Simatupang *et al.* (2002) [39], Van Tulder and Mol (2002) [22], Davila *et al.* (2003) [24], Skjott-Larsen *et al.* (2003) [40], Ghiassi and Spera (2003) [41], Jelassi and Leenen (2003) [42], Karkkainen (2003) [43], Karkkainen*et al.* (2003) [44], Kumar and Zahn (2003) [45]
BOSC and organizational Competitiveness	Sonntag (2000) [46], Papazoglou*et al.* (2000) [47], Dedrick*et al.* (2001) [48], Jarratt and Fayed (2001) [49], Walters and Buchanan (2001) [50], Carayannis and Sagi (2001) [51], Childerhouse *et al.* (2002) [52]. Prastacos*et al.* (2002) [53], Alessandri and Bettis (2003) [46], Holweg and Miemczyk (2003) [54], Holweg and Miemczyk (2003) [55]
Customization and postponement strategy	Partanen and Haapasalo (2004) [56], Sonntag (2000) [57], Svensson & Barfod (2002) [20], Fredriksson & Gadde (2005) [58]

According to Sun *et al.* (2006) Build-to-Order (BTO) supply chain management system have the capability to quickly build standard or mass-customized products upon receipt of spontaneous orders without forecasts, inventory, or purchasing delays [6]. In this environment products may be shipped directly to individual customers, to stores or dealers, or as a response to assemblers' "pull signals" (assemblers' signals that certain parts are needed right away for assembly).This chain reduces the dependence on forecasts, batches, inventory, or working capital. The basic strategies for implementing Build-to-Order are supply chain simplification, concurrent design of versatile products and flexible processes, the mass customization of variety, and the development of a spontaneous supply chain. Building system to order means there is no finished product inventory in channel to manage. However, the BTO system relies strongly on the tight integration of the upstream supplier of part, the midstream manufacturer and assembly of component, and the downstream distributor of finished goods in the supply chain.

Agarwal *et al.* (2006) stated that for successful implementation of the BTO phase, it is necessary to consider demand-management technique to manage fluctuation in volume, including marketing incentives, pricing strategy and in-

creased flexibility with supplier, all of which help balance supply with demand and allow the pipeline to change the right along with the consumer demand [59].

4. Research Methodology

For the purpose of this research, we have also studied Dell Inc. background, their business model (direct sales model), customer relationship, build-to-order production, refinement of their model, sale and services. Studies on previous research work on DELL Inc. and its success in computer manufacturing industries directs that applying BOSC strategy on laptop manufacturing will be so much profitable.

The primary aim of the literature search was to help researchers and practitioners develop an effective BOSC and by implementing it improve the supply chain profitability of DELL Inc. To check the feasibility of this proposal we have gone through several stages. All the stages were done with respect to the country Bangladesh and between the potential buyers of laptop computers. Our research objectives are: 1) To provide customer laptop according their preference, 2) To eliminate unnecessary stage from supply chain, 3) To maximize company market share and gaining more profit.

To satisfy the objectives, our research paper is classified into the following sections: 1) Market Analysis, 2) Designing build-to-order supply chain network, 3) Build-to-order management strategy, 4) Profit calculation, 5) Location selection to build assembly plant and warehouse, 6) Result and discussion, 7) Conclusion, and 8) reference.

5. Market Analysis

We have performed a market research on the annual market share of personal computer which includes desktop computers, laptop and notebook as well. DELL started their business at 1984. At first stage they grabbed a tiny market share. At the staring ten years that was not an easy time for DELL Inc. To increase their market share they go through a new strategy named Build-To-Order supply chain management and their market share was increasing drastically within decades. According to Zuckerman (1997) Dell has streamlined both procurement and inventory by redesigning its computer so that different models utilize as many of the same components as possible [60]. This reduced the number of inventory parts and the complexity of managing their procurement. Between 1992 and 1997, Dell reduced its 200 plus suppliers by 75 percent. The overall annual market share amongst the leading computer vendors starting the year 1996 to the year 2016 has been adjusted in **Tables 2-6** and the data has been collected from the source gartner technology [61].

From the above analysis represented into **Tables 2-6** which includes total market share of the major computer manufacturers around the world covering the timeline of 1985-2017. It is clearly visual that total PC market share of Dell Inc. has gone through ups and downs several times in this timeline. But their

Table 2. Global PC market share by units, percent (2011-2015).

Rank	2011	2012	2013	2014	2015
1	HP 16.6	HP 16.1	Lenovo 16.9	Lenovo 18.8	Lenovo 19.8
2	Lenovo 12.5	Lenovo 14.9	HP 16.2	HP 17.5	HP 18.2
3	Dell 11.7	Dell 10.7	Dell 11.6	Dell 12.8	Dell 13.6
4	Acer	Acer 10.2	Acer 8.0	Acer 7.9	Asus 7.3
5	Asus 5.7	Asus 6.9	Asus 6.6	Asus 7.2	Apple 7.2
Others	42.8	41.2	40.7	35.7	33.9

Table 3. Global PC market share by units, percent (2006-2010).

Rank	2006	2007	2008	2009	2010
1	Dell 15.9	HP 18.1	HP 18.2	HP 19.1	HP 17.9
2	HP 15.9	Dell 14.2	Dell 14.1	Acer 12.9	Acer 13.9
3	Acer 7.6	Acer 9.7	Acer 10.6	Dell 12.1	Dell 12.0
4	Lenovo 7.0	Lenovo 7.4	Lenovo 7.5	Lenovo 8.0	Lenovo 10.9
5	Toshiba 3.8	Toshiba 4.0	Toshiba 4.6	Toshiba 5.0	Asus 5.4
Others	49.8	46.5	44.9	42.8	40.0

Table 4. Global PC market share by units, percent (2001-2005).

Rank	2001	2002	2003	2004	2005
1	HP 18.4	HP 14.2	Dell 14.9	Dell 16.4	Dell 16.8
2	Dell 13.2	Dell 13.2	HP 14.6	HP 14.6	HP 14.6
3	IBM 6.4	IBM 5.2	IBM 5.3	Lenovo 6.8	Lenovo 6.9
4	NEC 3.8	Fujitsu 3.8	Fujitsu 3.7	Fujitsu 3.8	Acer 4.6
5	Toshiba 2.8	Toshiba 2.8	Acer 2.9	Acer 3.4	Toshiba 3.3
Others	55.4	60.9	58.6	55.1	53.8

Table 5. Worldwide Market Share in percentage (%) (based on Unit shipment).

Manufacturer	1985	1990	1995	1996	1997	1998
Compaq	3	4	10	10.1	13.1	13.8
IBM	25	13	8	13.1	8.6	8.2
Dell	less than 1	less than 1	3	8.6	5.5	7.9
Hewlett-Packard	2	1	4	4	5.3	5.8

Table 6. Top 6 vendors by number of units shipped, 2016-2017.

Rank	Brand	Market Share, 2016	Manufacturer	Country	Market Share, 2017
1	Lenovo	20.4	Acer	Taiwan	8.0
2	HP	19.4	Apple Inc.	United States	10.0
3	Dell	14.7	Asus	Taiwan	10.0
4	Asus	7.6	Dell Inc.	United States	16.4
5	Apple	6.9	HP	United States	23.4
6	Acer	6.8	Lenovo	China	20.1
			Others		12.1

huge success and the breakthrough to the sales margin is only happened as the BOSC strategy had been applied. During the time period of 1997 to 2006 almost a decade long time Dell held the leading position of the global computer market. After that they lost their achieved top position and reached to the third within a very little glance of time as they have changed their strategy of manufacturing. This happened as they had decided to leave the BOSC strategy to MTO strategy for standardized goods which seems to us a major reason for losing their peak position in the global manufacturing world.

The overall effectiveness of Dell's direct model is indicated by the company's growth in sales and market share. According to Sun *et al.* (2006) between the year 1990 to 1998, Dell sales have increased from a mere $389 million in fiscal year 1990 to $18.2 billion in fiscal year 1999 which has been represented into Figure 1 [6]. (Ending January 1999, we refer to this as 1998 data in comparative figure to provide comparability with other company's annual data.) Other years are adjusted accordingly [62].

Statistics has been shown in Table 7 from the help of tech-insider [63] where that unit sales of PC to global market although was growing at an enormously rate till the year 2011 but a significant declining rate have been observed after that year and the trend of shrinkage of total sales continuing till now. Based on the statistical analysis we have gone through the decision that applying BOSC strategy with a new vision in laptop manufacturing. As technology is improving day to day so people now want compact devices like laptop, notebook, and mini/microcomputers over personal computers.

6. Designing Build-to-Order Supply Chain Network

Supply chain network have become an important topic in this era. Industries, organizations around the world are focusing on supply chain network. The different stages of supply chain play an important role in supply chain cost. For

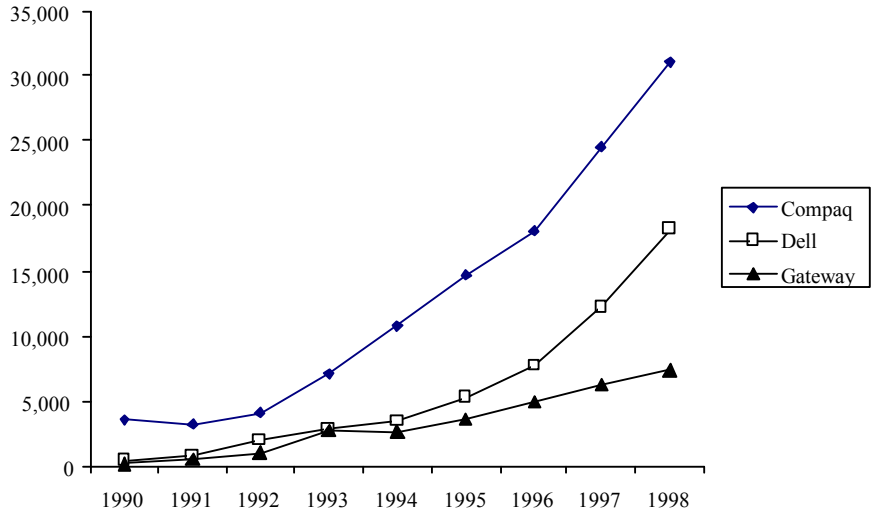

Figure 1. Revenue (in $ million) from 1990 to 1998 [62].

Table 7. Unit sales to global PC market from 1996 to 2005.

Year	Unit (M)	Growth (pct.)	Year	Unit (M)	Growth (pct.)
1997	80.6	13.7	2007	271.2	13.3
1998	92.9	15.3	2008	302.2	11.4
1999	113.5	22.2	2009	305.9	1.2
2000	134.7	18.7	2010	351	14.7
2001	128.1	−4.9	2011	352.8	0.5
2002	132.4	3.4	2012	352.7	0.0
2003	168.9	27.6	2013	316	−10.4
2004	189.0	11.9	2014	315.9	−0.2
2005	218.5	15.6	2015	287.7	−8.9
2006	239.4	9.6	2016	269.7	−6.3

that reasons different organization, Industry etc. are trying to apply effective supply chain network to gain more profit. Existing supply chain network of Dell Inc. is shown in **Figure 2**.

According to sultana *et al.* (2016), Munna *et al.* (2015) and Mondal *et al.* (2017) the more complexity is in supply chain, the more the cost is [3] [4]. We have proposed a new supply chain network for Build-to-order starter in laptop manufacturing in **Figure 3** which eliminates the distributor and retailer stages.

7. Build-To-Order Management Strategy

To achieve success from a new strategy depends on the effective and proper management in the strategic environment. The information flow plays an important part in the effective management. The more effective information flow on the supply chain, the more effective management becomes. An information flow network diagram is given in **Figure 4** which would make more effective the build-to-order supply chain management for laptop production (this model is based on assumption and proposed concept).

Here is a brief description to the proposal and how a customer order will be fulfilled. As given in the network diagram in **Figure 4**, "Customer will go the showroom, Inform about their laptop specification and then the officer in the showroom will confirm if it is feasible to build their specification. If yes, then officer will receive the order and send it to the assembly plant. If no, then reject the order and inform the customer. If they have any unnecessary circumstances occurs (*i.e.* sudden decisions can't be made), then the officer in the showroom will send the customer specification to assembly plant or plant in charge directly and after getting valid information he will share it to the customer whether it is feasible or if any further modification need to be made as he instructed from the plant in charge".

8. Profit Calculation

Commission in different percentage associates with different stages like custom office, distributor and retailer in supply chain from the source of Bangladesh

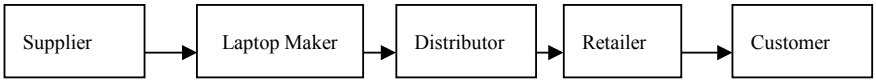

Figure 2. Existing supply chain network.

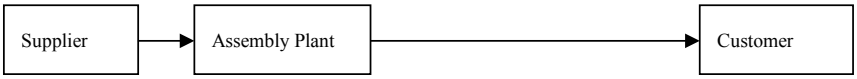

Figure 3. Proposed Build-to-order supply chain network for laptop manufacturing.

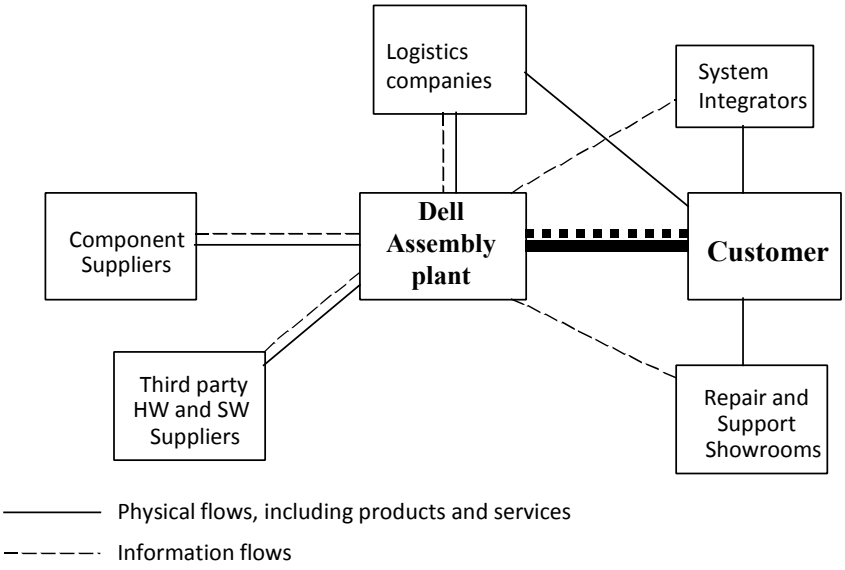

Figure 4. Information flow in the proposed build-to-order supply chain network.

customs trade information [64]. At the existing supply chain network, it can be said that custom office, retailer and distributor are taking a large amount of profit. In our proposed supply chain network, Dell Inc. will also be able to gain that large amount the profit that is gained by custom office, retailer and distributor. A calculation of how much extra profit Dell Inc. will gain after applying our proposed build-to-order supply chain management for laptop manufacturing is given bellow:

According to **Table 8**,

Average custom office commission (Finished Product) = (14% + 25%)/2 = 19.5%

Average custom office commission (Parts product) = (8% + 14%)/2 = 11%

Distributor commission = (10% + 12%)/2 = 11%

Retailer commission = (12% + 14%)/2 = 13%

Let,

The number of parts that is to be assembled for a customized laptop: n

The average cost of the parts = x_1, x_2, x_3, ... x_n

$x = x_1+x_2+x_3+ \ldots x_n$

Average cost per Laptop (in case of existing environment) = x

Company's profit in the existing supply chain environment = y%

Table 8. Commission at each supply chain stages (in prospect of Bangladesh).

Stages	Commission	
	Finished Goods	Part Goods
Custom Office	14% - 25%	8% - 14%
Distributor	10% - 12%	
Retailer	12% - 14%	

Then company's profit in case of proposed supply chain environment = F(y%)

Now, in the existing supply chain environment:

Dell Inc. sells a laptop at price = $x \times y\% + x$

After crossing the custom office the price becomes = (x × y% + x) + (x × y% + x) 19.5%

That is the price which distributor have to pay to bring a laptop

$$= \{(x \times y\% + x) + (x \times y\% + x)19.5\%\} + \{(x \times y\% + x) + (x \times y\% + x)19.5\%\}11\%$$

That is the price which has to pay retailer to bring a laptop from distributor and finally retailer sells the laptop to customer at the following price

$= [\{(x \times y\% + x) + (x \times y\% + x)\ 19.5\%\} + \{(x \times y\% + x) + (x \times y\% + x)\ 19.5\%\}$ 11%] + [{($x \times y\% + x$) + ($x \times y\% + x$) 19.5%} + {($x \times y\% + x$) + ($x \times y\% + x$) 19.5%} 11%] 13%

$= 1.5x \times y\% + 149.89\%x$

We get a laptop at the price = ($1.5x \times y\% + 149.89\%x$)

In the proposed supply chain environment:

If Dell Inc. sells their laptop at the above price in our proposed supply chain environment, then their new percentage profit will be F(y%)

The value of the function is determined below:

Average cost per laptop in the proposed supply chain environment

$= (x_1 \times 11\% + x_2 \times 11\% + x_3 \times 11\% + \ldots x_n \times 11\%) + (x_1 + x_2 + x_3 + \ldots x_n)$

$= 11\% \times (x_1 + x_2 + x_3 + \ldots x_n) + (x_1 + x_2 + x_3 + \ldots x_n)$

$= 111\% \times (x_1 + x_2 + x_3 + \ldots x_n)$

$= x \times 111\%$

Profit gained in build to order Environment:

$= (1.5x \times y\% + 149.89\%x) - (111\%x)$

$= 1.5x \times y\% + 38.89\%x$

Percentage profit gained in build-to-order environment

$= (1.5xy\% + 38.89\%x)/x$

$= 1.5y\% + 38.89\%$

So, F(y%) = $1.5y\% + 38.89\%$

Extra profit will gain = F(y%) − y%

$= (1.5y\% + 38.89\%) - y\%$

$= 0.5y\% + 38.89\%$

9. Location Selection to Build Assembly Centre and Warehouse

As most important objectives in this research is to provide laptops to the cus-

tomers by their preferred configuration not by offering a standard mass production quality laptop. So a very important question is been rising now. That is where the assembly plant should be located and how the warehousing be done, which drives to the pace of building ware house and assembly house. To fulfill this objective, depending upon several criteria and location selection method we have offered a location for warehousing the supplies and also construction of plant. As both procedures requires a very large space and also environmental friendly area for an international computer manufacturing corporation the place is primarily choose is at Kashimpur, Gazipur Sadar, Gazipur. Very close to the industrial area where transport facilities will be quiet good. DELL Inc. has to establish an assembly house and showroom in Bangladesh. Depending upon various important criteria, we have identified required quantity, place of showroom and assembly house respectively.

The research work is done basically from the works available on Dell supply chain network and their business model. Using the data's that are availed from previous research work a business proposal has just been introduced through this paper. At the very beginning stage of starting the business Dell Inc. must establish an assembly plant where they will complete the necessary works related to manufacturing of customized laptop. For primary selection a plant location is been introduced in this paper located at Kashimpur, Gazipur Sadar, Gazipur. The location will cover a huge space which can be easily occupied for the construction of warehouse and the assembly plant. Dell Inc. must also establish their brand showroom including service centers of their own to reach maximum customer satisfaction.

10. Results and Discussion

Data's has been gathered from several sources. Research paper that containing the information of how Dell Inc. success through using the build-to-order supply chain management strategy and pioneering this method how they incorporated a great market share has inspired to rethink about the strategy and to re-implement the strategy in laptop manufacturing. Research paper published on international journals *i.e.* Journal of Operations Management, Journal of Operations Research and Information Systems, Computer & Industrial Engineering and the International Journal of Operations and Production Management, International Journal of Production Economics which are published by Elsevier, Emerald, Tailor, Francis and Research Gate in the areas of supply chain specially on the build-to-order model was so inspiring that by using this strategy again Dell Inc. may lead the market once again.

It has also been represented that the market for personal computers are declining. New technologies like laptop, smartphones and virtual realities have now become more demandable than conventional PCs. As laptop market is substantially rising it would be a wiser decision to make a new strategy and embrace the market with success again. Why Dell? As Dell Inc. has previously applied this

strategy and captured a huge market among the PC maker industries all over world so it is easy to say that they have a very efficient and effective management team. And as also a leading tech company one of the biggest manufacturer of computers and laptops this would not be very hard to invest for the implementation of the new strategy in laptop manufacturing. For the proposal and as feasibility analysis a profit calculation and an assembly plant have been introduced in this paper which is done as prospects to Bangladesh. The taxes and excise duties for trading of electronic sub-parts, parts, partial goods, raw item and finished goods are taken directly from Customs Office Bangladesh also shown in Table 8. How much retailer and distributer profit is annexed from RIANS, SMART Technologies and GLOBAL Brand Pvt. Limited respectively? As these three companies are the largest authorized distributor DELL laptops sold in Bangladesh. Laptop sales forecasting policy is hired from GLOBAL which helps to build the profit calculation task. To propose the location of assembly plant an example is taken (Walton High Tech Facility) which is one of the biggest high tech. industry in Bangladesh.

The profit calculation also suggests a great profit margin increment in sales of laptops. If for manufacturing and solely distribution of laptops Dell Inc. makes a profit of y% by applying the BOSC strategy the company will be easily able to gain an extra $0.5 \times y\% + 38.89\%$. Though this margin does not offer the actual profit amount. There are several sectors which would require a massive investment to implement such a new strategy and also for marketing of this strategy. But it can be still said boldly that this would certainly provide a huge market share for Dell Inc. in laptop manufacturing and selling all over the world.

11. Conclusion

SCM is important topic in this era. All industry and organization want to go through effective SCM process. To sustain in the competitive business world, it is necessary to innovate tactics in SCM. Mainly the project is done on an innovative tactic in supply chain management. In this project, we have tried to give the complete information to start a new business with BOSC tactics in Bangladesh. Different analysis and estimation have been done in this project, such as market analysis, profit estimation. From the above analysis, it can be said that if DELL Inc. starts their business with Build-to-Order supply chain tactic, they will be able to increase more market share and gain more profit.

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