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A VENSIM BASED ANALYSIS FOR SUPPLY CHAIN MODEL Mohammad SHAMSUDDOHA Curtin University, Australia mdsdoha

15**@gmail.com Alexandru NEDELEA Stefan cel Mare University of Suceava, Romania alexandrun@seap.usv.** ro **Abstract**

The emphasis on supply chain has increased in recent years among academic and industry circles. In this paper, a supply chain model will be developed based on a case study of the poultry industry under the Vensim environment. System dynamics, supply chain, design science and case method under positivist and quantitative paradigm will be studied to develop a simulation model. The

1**objectives of this paper are to review literature, develop a** Vensim based

simulation **supply chain model,** and examine **the**

model qualitatively and quantitatively. The model will be also briefly discussed in relation of among forward, reverse and mainstream supply chain of the case. Key words: simulation; poultry industry; supply chain model; Vensim. JEL Classification: L60; O10; Q01; Q56; Q57 I. INTRODUCTION Bangladesh Poultry sub-sector is contributing vibrant way to economy and society in light of self- employment opportunities,

3**cheap sources of protein supply, and livelihood for millions of people.**

Afterward, this industry failed to adapt modern business concepts with latest technology for poultry supply chain, procurement and processing. This industry needs a structured supply chain model that must be tagged of sustainability, efficient forward and reverse

3**supply chain** process, **environmental issues, profitability, and optimality concepts.**

This research focuses on how supply chain practices can carry out better profitability with maximum utilization of resources. A noteworthy

1**research gap exists in the implementation of proper supply chain** theory **to this particular industry** and its operations. **This research proposes a** poultry **model,** which includes **the**

concept of supply chains which can create by-products from poultry wastages, generate more employments and so on.

1**This approach has the potential of creating new windows of** creating small **and medium enterprises** (SMEs) **that will contribute towards**

society, economy and environment. II. LITERATURE Supply chain process starts from

9**initial raw materials to the ultimate consumption of the finished product linking across suppliers, user companies; and within and outside a company**

(Cox, Blackstone, & Spencer, 1995). It is also

21**a step towards the** wider acceptance **and development of sustainability**

that integrates

4**disposal, recycling, reconditioning, and remanufacturing of used products** (Gungor & Gupta, 1999; **Kocabasoglu, Prahinski, & Klassen, 2007;**

Srinivas, 2007). Such things includes the product design,

3**re-design, manufacturing by-products, by-products produced during product**

use, product life extension, product end-of-life, and recovery processes at end-of-life (Linton, Klassen, & Jayaraman, 2007).

Dynamic

4concept of reverse supply chain (RSC), which is related to

the concept of recycle, reuse and reduce (3R) as it may be applied to waste management. RSC

18refers to the series of activities necessary to retrieve a used product (or

12a product waste) from a customer and either dispose of it or recover value from it (Guide & Van, 2002; Prahinski & Kocabasoglu, 2006).

However, the dynamic supply chain perspective have received little attention.

2Hence, this paper has taken account of such research gap on the issues related to poultry

and its supply chain. III.

1METHODS This study covers a literature review on

reverse supply chain, and Bangladesh poultry industry. This study adopted

2positivist ontology, empirical epistemology, and quantitative methodology based on case studies of a real poultry case. The

design science methodology and case study method

1chosen for this study. Design science is concerned with "devising artefacts to attain goals (Hevner & Chatterjee, 2010; Simon, 1969). Design science is based on "build and evaluate" an artefact of a model (March & Smith, 1995;

Venable, 2010). On the other hand,

2a Case study is observing the descriptions of particular instance of an occurrence (Yin, 1994).

2Both primary and secondary information used in this study. Primary information collected from December 2011 to January 2012, mainly through in-depth interviews with the respondents.

This paper

3**used in-depth interviews and** observation tool **to gain insights** supply chain processes **to** understand and **develop a**

sustainable environment friendly simulation model on poultry. The case industry is one of the biggest and reputed farms in Bangladesh. They have multiple firm locations and researcher has chosen one particular flock which is producing around 150,000 day old chicks per week having nearly 100,000 initial eggs and 150 employees. The total respondents was the Managing Director from the case industry. The respondents nominated for open-ended questions relating to understands required process based on their widespread knowledge and experiences. The in-depth interview long last for more than an hour for each respondents and information's relating to production, process and waste management discussed. Secondary information

4**collected from different published documents such as referral** books, journals, **and conference** papers, **statistical yearbooks and** company record and **reports.**

Besides that, existing industry database used to get different distribution pattern for various simulation artefacts. All these calculations are nearly average value of mentioned period. The simulation package Vensim (version 5.11a) used to develop poultry supply chain model

1**and conduct trivial analyses of existing poultry processes in order to investigate the research objectives.**

IV. A SIMULATION BASED SUPPLY CHAIN POULTRY MODEL World's largest companies like Wal-Mart and Nokia have accepted dynamic supply chain concepts. For example, Wal-Mart processing centre are maintaining

4**reverse logistic aspects of repairs, replacement part return to customers, inspection, salvage, disposal and** reworking like **upgrades (Krumwiedea & Sheub, 2002).** This research examined **the**

supply chain within the existing poultry process based on simulation modelling. The

4**in- depth interviews with farm executives, the researcher**

clearly identified

4**a lack of** usage **of** existing **poultry wastes.** The **lack of**

poultry waste management practices turn into environment pollution as the wastes dumps onto vacant land and rivers. Apparently, forward supply chain is contributing a lot to the society in terms of employment generation and creating promising entrepreneurs. Initial eggs Distribution Loss Total Parent eggs in Poultry eggs HEI Total Hatche eagbgls CI Total chicks DI Distri bution house Parent egg dist Reject eggs Unhatched eggs Bogra in Vairab in Comilla in Ctg in Khulna in Bakery Farmers Wastage Broiler chicken Employments Fertilizers Fish Feed Bio Gas Open Market Processed Market Figure 1: Vensim based Simulation Supply Chain Model The participant farm already adopts latest technology in their production process which perhaps helps them to

1**remain free from diseases and allows** them **to achieve economic**

success (Shamsuddoha, 2011b; Shamsuddoha, Klass, & Quaddus, 2011). In this production process, it generates poultry wastes of

> 3**litter, feed waste, feathers, broken** and **rejected eggs and intestines. Poultry litter can be used for** making **fertilizer, bio gas, charcoal and fish feed; feathers can be used as raw materials for the bed industry; reject eggs can be used for the bakery industry; and broken eggs and intestines can be used for fish feed (Shamsuddoha,** 2011a; **Shamsuddoha**

& Nasir, 2013). Figure one exhibits a simple poultry process model, which modelled using Vensim – a simulation and system dynamics software package. The model consists of different phases of mainstream,

> 23**forward, and reverse supply chain** of poultry industry **in** Bangladesh. **The**

> 1**Mainstream component includes the general supply chain of the poultry industry that starts from parent (mother of chicks) and ends up with the finished product of meat. The forward supply chain component of this simulation model consists of** distributors, **farmers, and** intermediaries **of processed and mature birds. This is the** potential **area** of generating **employment and** achieving **other socio- economic benefits based on volume of bird transacted or reared. The reverse supply chain** phase **consists of managing poultry wastes**

> 4**of broken and un-hatched eggs, poultry litter, poultry feather etc.** that **is**

the main focal point of

> 2**this research. This research** demonstrates and understands **how poultry wastes** provide the **input**

(raw materials) to other by-product processing plant in the same industry. The

> 1**simulation model is** able **to** assess **the volume of wastes that can** use **as the input of by-products. Industrialist can simulate the different distributions in various work** centres **like parents, hatchery, broiler, and other processing** centres **to gain a better understanding of potential outcomes and to gain insight with respect to potential opportunities. The**

model will also able to use real life data through MS Excel input and allow

> 4**the researcher** to **run the model based on historic data from** the **case industry. The model**

can be easily customized as par individual farm requirement. Table 1: Simple average data entered into Vensim based simulation poultry model Bio Gas= 0.6*Wastage Processed Market= Broiler chicken*0.2

Unhatched eggs= Total Hatcheable eggs- Reject eggs= Total Poultry eggs- Total chicks Total Hatcheable eggs CI (Chicks in)= 0.8*Total Hatcheable eggs Total Poultry eggs= INTEG (Parent eggs in, Initial eggs) Comilla in= 0.25*Distribution house Bogra in= 0.1*Distribution house Ctg in= Distribution house*0.4 Vairab in= 0.2*Distribution house DI (distribution in)= 0.995*Total chicks Wastage= 0.1*Farmers Distribution Loss= Total chicks-Distribution house Processed Market= Broiler chicken*0.2 Employments= (Farmers + Total chicks+ Total Farmers= Bogra in + Comilla in + Ctg in Poultry eggs)*0.001 + Khulna in + Vairab in Fish Feed= 0.1*Wastage HEI (Hatcheable eggs in)= 0.95*Total Poultry eggs Fertilizers= Wastage*0.15 Open Market= Broiler chicken*0.8 Final time = 25, Units: Week Khulna in= 0.05*Distribution house Initial eggs= 100000 **Ctg, Comilla,Vairab, Bogra and Khulna are the name of distribution house of Chicks Parent egg dist = WITH LOOKUP (RANDOM UNIFORM(0, 1, 50000), ([(0,144000)- (1,154000)], (0.0550459,145491), (0.06,145000), (0.250765,145404),(0.28,147000),(0.492355,147114), (0.504587,151456), (0.587156,151325),(0.605505,151500),(0.782875,151456),(0.792049,153167), (0.874618,153079), (0.995,153000))) V. V.MODEL IN REAL LIFE ENVIRONMENT The researchers collected historic data from the case farm, which provided parameters for the model and used as different level, auxiliary and constant variable in the Vensim software. For example, “total poultry eggs” is a level variable where eggs enter and go out for hatching. This level variable depends on other auxiliary and constant input. All the data used as average format by taking real data. The exception is only “parent eggs dist” auxiliary variable where lookup method used as a graphical presentation through real data. Eggs supply varied from 144,000 to 160,000. The system will pick the number randomly based on seed and also will added up with the initial eggs of 100,000. The model runs for 25 week having time step 1 though time step can be used as low as 0.03125 to see what is happening every small fraction of time. The process includes hatchery divisions to hatch those eggs,

> 1**twenty-one days needed to hatch** the **eggs that** produced **broiler chicks** which are called **day old chicks**

(DOC). The DOC then goes to distributors for distribution to the different regions.

> 1**After 25-35 days,** the **DOC becomes mature chickens** and is **ready to** sell in **open market, restaurants, and processing** centres. The rejected **eggs,** feathers, **culled birds, and litter are generating after a certain interval. All these** aspects **maintained** in **individual supply** chains **to produce different by-products.**

There are also different technology and methods used

> 1**to recycle, reuse, and reduce the poultry wastes.**

Table 1 above shows the data or information placed in different variable. Most of the data used as average; average data calculated from real life data for particular period. And table 2 reveals KPI’s of different variable of simulation model including various constants, levels and auxiliary. There are many ways to compare, contrast, and display the results of the simulation, for example, using graphs, pie charts, bar chart, compare runs, sensitivity analysis and so on. In this study, the model ran for 25 time step and table 2 represents the results of first, fifth, tenth, fifteenth, twentieth, twenty-fifth time step result. This kind of results allows the decision maker to adopt effective and quick decision to save time, money, and energy. Table 2 : Model results for different time step Time (Week) 1 5 10 15 20 24 25 Variables Runs: Bakery 24000 168306 346384 527246 704415 845795 882146 Bio Gas Bogra in 4537.2 7562 31818.2 53030.3 65484 109140 99675.8 166126 133170 221949 159898 266496 166770 277950 Broiler chicken 75620 530303 1

> 8.**09E+06 1.** 66E **+06 2.** 22E **+06 2.66E+06 2.** 78E **+06**

CI (Chicks in) 76000 532968

51.10E+06 1. 67E +06 2. 23E +06 2. 68E +06 2. 79E +06

Comilla in 18905 132576 272850 415316 554874 666240 694874 Ctg in 30248 212121 436560 664505 887798 1.07E+06 1.11E+06 DI (Distribution in) Distribution house 75620 75620 530303 530303

101.09E+06 1. 09E +06 1. 66E +06 1. 66E +06 2. 22E +06 2. 22E +06 2. 66E +06 2. 66E +06 2. 78E +06 2. 78E +06

Distribution Loss 380 2664.81 5484.38 8348 11153.3 13391.8 13967.3 Employments 327.24 2294.85 4722.95 7188.99 9604.7 11532.4 12028.1 Farmers 75620 530303 1

8.09E+06 1. 66E +06 2. 22E +06 2.66E+06 2. 78E +06

Fertilizers Fish Feed 1134.3 756.2 7954.55 5303.03 16371 10914 24918.9 16612.6 33292.4 22194.9 39974.4 26649.6 41692.4 27795 HEI (Hatch eggs in) Initial eggs Khulna in Open Market Parent egg dist 95000 100000 3781 60496 151490 666210 26515.2 424243 145247 1.37E+06 54570 873120 151450 2.09E+06 83063.1 1.33E+06 145491 2.79E+06 110975 1.78E+06 145125 3.35E+06 133248 2.13E+06 151462 3.49E+06 138975 2.22E+06 151488 Parent eggs in Processed Market Reject eggs Total chicks Total Hatcheable eggs Total Poultry eggs Unhatched eggs Vairab in Wastage 151490 145247 15124 106061 5000 35063.7 76000 532968 95000 666210 100000 701274 19000 133242 15124 106061 7562 53030.3 151450 218280 72163.4

51.10E+06 1.37E+06 1. 44E +06

274221 218280 109140 145491 332253 109843

201.67E+06 2.09E+06 2. 20E +06

417403 332253 166126 145125 443899 146753

52.23E+06 2. 79E +06 2.94E+06

557662 443899 221949 151462 532992 176207

222.68E+06 3. 35E +06 3.52E+06

669588 532992 266496 151488 555899 183781

52.79E+06 3. 49E +06 3.68E+06

698366 555899 277950 Numerous experiments and analyses can be done in the model environment by providing various inputs to find out optimum output. Synthesim mode of Vensim package can experiment more on changing constant variables to see what best results can be achieved. Eggs used as throughput of this model and mature chicken and wastage shown as output. Within the process, the model can able to assess volume of employment, wastage, by- products. Table 2 collected some results from simulation run that are displaying various output. Naturaldisaster Diseaseoutbreak Bakery Product + Sales manager chicks Carraying Loss <Chicks Hatched> + Bank loan + Order GP Chicks ++ + - - - <Chicks orders> + - Hatcheable - Chicks Total Chciks + + Distribution Salesmen <Revenue> funds <Distribution OwnCapital

house> + Govt intervention + - - <Demand Gap> Reject eggs + + Unhatched eggs + + + + + + Area sales office + Land security + + + Capital flow + - GP chciks + eggs Hatched + Suppplied house - + - + + + Chicks orders - Reduce chicks Ingredients: maize soya etc Feed mlil + <Required Feed> Competitors acti+on GP Farming + Total Parent eggs + + eggs input in hatchery - <Calamities><Impact on production> - + Broiler Farms Lands - + BrocaliepracFiatyrm+ + Individual capital - - <Demand Gap><Calamities> GP farm size - + order + + - Reduce + Eggs for Bakery Med ciine + <Impact on Feed inventory - Total feed intake - Parent eggs - production> + + + production + Expected prod Capital + entreprenuerial <Demand Gap> skill tax cost + net profit <Fish Feed> Mortality + + Other sources of Calamit eiss production + Under grade <GP chciks> + Target production per GP + + Revenue + <Fertiilzers> + Sold Chicken + + <Bio gas> Demand Gap + Rawmaterailcost Feedprocesscost Inefficient faming unit pr cie Operatoinalprofti + - Broiler + - Supp yl + chicken Cost per unit Unit feed cost <Disease demand + p+r-oductioncost <unit gas price> outbreak> <GP Farming> + Unit chcken electrciity + cost + - + <GP Farming> Litter per bird + + desired capac tiy Feed cost week + Efctviesuplyinthe ActualProduction + + + + + Utilitiescost++ water Feed + consumption rate <Consumption market effectofdemand - - <Chicks Hatched> distribution cost Unit Dist cost + operation cost investment cost gas + rate> + <Broiler chicken><GP Farming> Required Wastage/Litter onmarket - capacitygap admnicost+ Feed + Inventory transport cost <Mortality> + - Potential + + + wage cost + + + Wastage Dump Employments customer Customer rate Production rate <Fertilizers> + cost per head + Feed Waste - - - + staff + + + + + + investment for HR Waste for Fish Feed Waste for Fertilizer Waste for biogas productointime desiredProduction <Bio gas> Feed waste rate BG convrate Consumer Lookup taining cost+ FF conv rate + Fer conv rate + + Consumer Consumptoinrate numerofonjob + Populat oin + + eggs per gp training <Fish Feed><Dsitrbiution <GP chicks> cost per training house> Fish Feed Fert liizers Bio gas Per Capita + unit fish feed pr cie unit fert price unit gas price Consumption costoftrainnig + - FishFeedMV BiogasMV AvgLiveChicken Skilllost Fert liizerMV prcie LivebirdPrice PerCapitaCons Lookup Impacton Knowledg SkillLevel - gained/perceiv+ed lookup + AvgProcessed + RetailPrice - <Suppyl> production- lostrate ChickenPrice Processbird lookup MarketMargin Figure 2: A Qualitative model for Future work based on current modelVI.CONCLUDING REMARKS In this paper, researchers developed a simple and proposed an idea of a poultry simulation model incorporating mainstream, forward, and reverse supply chain . This model will help th e entrepreneurs to compute ge neral calculation of what numbers and quantities of chicken, chicks, wastage, by-products can be generated from a poultry process. Again, this is a very simple model to shown real dynamics in the practical arena. Later, a qu alitative model displays to understand how this simple model could be more realistic and complex. This model co nsists of wastes, production, distr ibutors, various process centre, and different outputs. In future, supply- de mand, finance, calamities, government intervention, capital flows, bank issues etc. added in qualitative model. Obviously, it would be gre at challenge to work on it and give input of more and mo re realistic issues based on system dynamics and supply chain manageme nt. The model will also indicate that wastage can contribute towards the establishment of many s mall-medium enterprises (SMEs) with the potentials of creating more by-products, employments and income. This study can help poultry entrepreneurs to evaluate their waste subject to individual farm capacity to assess the quantity of by-products. The model can also be further extended, modified, or tuned up in several directions of forward and reverse which has shown in figure 2 in the above. For example, in in the situation like heavy rainfall, calamity similar to cyclones, droughts, poultry disease (bird-flue), alternative mea t price, and practice, main operation and recycling matters hampers flood, natural some cultural influence etc. In these cir cumstances, the percentage of workflow shall be change as per situation. Future research could focus on testing the entire proces s model and variables to understand the total industry operatio ns an d its optimality. VI. REFERENCES 1.

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