ECONOMICS OF PRODUCING A VALUE ADDED SEAFOOD PRODUCT FROM SHRIMP WASTE IN QUEBEC

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ABSTRACT

This research examined the economics of reprocessing shrimp waste into edible breaded and battered seafood products. The proposed technology involves the extraction of broth from shrimp waste and using it to impart shrimp taste and flavour to surimi nuggets. A survey of foodservice institutions in Montreal revealed that 50% of these commercial establishments were willing to buy the product for use in their operations at a suggested wholesale/supplier's price of $4.40 per kg. Results of a Logit model indicated that price and restaurant ownership appeared to influence respondent's purchase intentions significantly. The odds-ratio in favour of a low-end, independent or family-owned restaurant adding the product to its menu was significantly greater than the odds-ratio in favour of a high-end restaurant or chain establishments buying the product for its operations. Asian restaurants were equally as likely to purchase the product as restaurants serving other menus. In general, respondents said that product taste, texture, appearance and aroma were satisfactory.

The proposed plant expansion required to include a surimi - shrimp processing line into an existing processing plant would cost $4.3 million to install in the Montreal area. Its installation would allow an interested firm to process 5000mt of surimi-shrimp nuggets from about 500mt of shrimp waste per year at $2.62 /kg. Results show that if the plant operates normally for a 10-year period, it would recover initial outlay and interest payments in 4.2 years. The net present value (NPV), at a 10% rate of discount, would be about $3.12 million and the internal rate of return (IRR) would be about 25%. If raw material prices and unit product price changes within a 10% range, the feasibility of the proposal will be acceptable in some but not under all sensitivity scenarios.

RÉSUMÉ

Cettte recherche analyse l'économie de le transformation des sous-produits de crevettes en un produit paté et pané qui soit commercialisable. La technologie proposée consiste à extraire un buillon de crevettes qui sera utilisé pour donner un goût et une saveur de crevette aux croquettes de surimi. Après une enquête menée auprès des restaurants de Montréal, il est apparu que 50% d'entre aux etaient favorables à l'achat des produits à un prix de gros de $4,40/ kg. A l'aide d'une estimation selon un modèle logit, il ressort que le prix et le type de propriétaire du restaurant sont les variables significatifs qui influencent l'achat du produit. Les chances d'insérer le produit au menu sont les plus élevées dans les resturants à bas prix et/ou à propriétaire familial unique dans les restaurant haut de gamme ou des chaînes de restaurants. De plus, les restaurants Asiatiques sont probablement aussi enclin à acheter le produit que les autres restaurants. Après avoir fait tester que le produit aux chefs cuisiniers des restaurant visités, il est apparu que le goût, la texture, l'apparance etl'arôme étaient satisfaisants.

L'installation de la technologie proposée pour inclure les croquette des crevettes-surimi dans la chaîne de production existante coûterait $4,3 Mio, ce qui permettrait à l'usine de produire 5000TM de croquette de crevette-surimi à partir de 500TM de residue de crevettes, à un coût de $2,62/ kg. L'analyse de L'investissement montre que sur une durée de vie de 10ans des installations, l'usine récupérerait le capital initial et les intérêts apres 4,2 annees. La VNA de cet investissement initial serait de $3,12 Mio et le TRI serait de 25%. Si les suppositions en ce qui concerrne le prix des intrants et le prix du produit venaient a changer de 10%, la faisibilite financière du projet seraient acceptable uniquement dans certains cas.

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PREFACE

As a requirement for the manuscript-based thesis format, the following text is reproduced for the information of the external examiner from the Guidelines for Thesis Preparation issued by the Faculty of Graduate Studies and Research:

"Candidates have the option of including, as part of the thesis, the text of one or more papers submitted or to be submitted for publication, or the clearly-duplicated text of one or more published papers. These texts must be bound as an integral part of the thesis.

If this option is chosen, connecting texts that provide logical bridges between the different papers are mandatory. The thesis must be written in such a way that it is more than a mere collection of manuscripts; in other words, results of a series of papers must be integrated. The thesis must still conform to all other requirements of the "Guidelines for Thesis Preparation." The thesis must include: A Table of Contents, an Abstract in English and French, an Introduction which clearly states the rationale and objectives of the study, a final Conclusion and Summary, and a through Bibliography or Reference list.

Additional material must be provided where appropriate (e.g. in appendices) and in sufficient detail to allow a clear and precise judgement to be made of the importance and originality of the research reported in the thesis. In the case of manuscripts co-authored by the candidate and others, the candidate is required to make an explicit statement in the thesis as to who contributed to such work and to what extent. Supervisors must attest to the accuracy of such statements at the doctoral oral defence. Since the task of the examiner is made more difficult in these cases, it is in the candidate's interest to make perfectly clear the responsibilities of all the authors of the co-authored papers".

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CHAPTER ONE

INTRODUCTION

1.1 Background and introduction

The fish and fish processing industry is an important component of the Canadian Food Industry. It forms an important part of the economies in the maritime regions along the eastern seacoast of Canada and in the northwestern territories. In Newfoundland and Nova Scotia, the region's leaders in the trade, fish and fish processing accounts for 20% and 16% of the Gross Provincial Product (GPP) (Industry, Science and Technology Canada, 1991) respectively and employs a sizeable number of the population in many small communities in the area. In Quebec, the seafood industry accounted for about 2% of industry sales in 1997 (MAPAQ 1998) but employs more than a quarter (26%) of the total industrial workforce. For some communities in Atlantic Canada and also for some aboriginal people, fish and fish processing provides the primary economic base and it is often the most important economic activity available to most people. Over the years from 1990 to 1996, the performance of the industry has been varied accumulating a modest compounded average annual growth rate (CAAGR) of 1.5 %. Manufacturing value added declined over the same six-year period from an initial $0.92 billion in 1990 to $0.80 billion in 1996. By way of contrast, industrial value added for the corresponding industry in the US increased by a CAAGR of approximately 7% in the same period (Industry Canada, 1998). Total industrial employment declined considerably by a CAAGR of –1.9% in the period compared to a much lesser decline of -1.3% in the analogous industry in the Unites States. The collapse of the major traditional fisheries in Atlantic Canada, due to over fishing during the earlier part of the decade has led to unprecedented

structural changes and re-organization within the industry. Fishing effort in the primary sector has focused on shellfish and crustaceans and on landing more under-utilized and lesser-known species. The secondary or processing sector has responded to growing shortage of traditional species by "squeezing every ounce out of its precious resource" Higgins (1997). Firms are coming up with more efficient ways of processing and more innovative ways of meeting consumer demand under these constraints in supply. One major issue facing the industry is the rising concern over sanitation and waste disposal. Environment Canada, the federal regulatory body on environmental issues has well stipulated guidelines regarding effluent disposal in the fish processing industry. By-product disposal problems are more pronounced for shellfish than for other kinds of fish. The demand for high protein fishmeal necessitates the near-exclusion of shellfish processing waste from fishmeal and fish oil production. The tons of shellfish processing waste generated is either composted or dumped at landfills or at sea. Composting however, is generally considered breakeven activity (King 1996) and returns no benefits to processors who must pay composting companies to dispose of their processing waste. In the province of Quebec for example, shrimp processing waste generated in the Gaspésie region is creating problems as a result of the closing of several municipal land fill sites due to overfilling. Terrestrial dumping of residue attracts animals, causes odors and creates migratory gases. Similarly, sea disposal is increasingly attracting attention as a source of environmental pollution. Fewer sea dumping permits are now being issued by Environment Canada and at an increasingly higher cost. In 1994, 126 permits were issued for fisheries waste disposal for the Atlantic region. In 1995 only 60 permits were delivered due in part to the increases in permit cost from $50 to $2,500.

As traditional avenues for handling by-product disposal become more and more inadequate, Environment Canada has been urging fish processors to find sustainable ways of recycling their waste (Environment Canada, 1994). The fishmeal and fish oil sectors, which are auxiliary operations in the industry, have been partly responsible for recycling some of the tons of processing waste arising from industrial activities. Though fish processing by-products are available almost for free the wide geographical distribution of processing plants and the bulky nature of the material has inhibited large scale waste recovery efforts. Potential recovery efforts must therefore concentrate on provincial and regional levels in close proximity to the sources of waste generation, since prohibitive transportation costs makes handling relatively expensive. However, with the decline in the seafood industry brought about by the collapse of principal fish stocks, the idea of reprocessing edible fish products from material generally discarded may prove to be important and particularly useful in enhancing processors' revenue and in creating jobs in the industry.

On the demand side, apparent per capita seafood consumption has been on the increase in Canada. Over the past decade, seafood consumption in Canada has risen from 8.76 kg per capita in 1988 to almost 10.91 kg in 1997. In all, seafood consumption has shown an overall increase of about 25% within a period of less than 10 years. Peak consumption was attained in 1997 when apparent per capita consumption reached almost 11kg. Much of the gains in seafood consumption have occurred while consumption of other competing protein sources, such as red meat, has been declining. Over the same period that seafood consumption made gains, consumption of pork, for example, declined by 10% from almost 21 kg to about 19 kg per capita and beef consumption declined by

almost 15%. Except for the period 1993 to 1995, when consumption made negligible average annual increases, beef consumption has shown a consistent downward trend since the mid 1970's. The rise in seafood consumption has also been observed in the US (Kinuccan et al 1993; Bockstael 1984), which imports about two-thirds of Canadian and Quebec seafood exports. The industry has received an upward boost in the last couple of years due in part to the changing social dynamics of the average North American household and also to advances in technology (Lambert 1990). Since the removal of tariffs on processed seafood between the US and Canada in 1993, Canadian seafood processing has had an unprecedented access to improved market opportunities. For instance it is estimated that the demand for edible seafood products in the US alone will require an additional 771,115 tons of fish and seafood by the year 2010 just to maintain current consumption levels (Industry Canada 1997). This anticipated growth in projected demand for processed seafood products would require the processing industry to grow at a similar pace in order to meet growing demand. However a combination of increasing costs of processing and dwindling stocks makes this expectation seem rather unlikely. Radical changes such as costs shifting by large grocery and wholesalers of seafood products have often forced manufacturers to assume the costs of their business. Current environmental regulation and access rights issues make any dramatic increases in landings or any possibility of over-exploitation remote. But with this apparent growth in seafood demand and the restrictions on Canadian fish stocks, it seems an examination of ways to increase processing efficiency is appropriate.

1.2 Statement of the Problem

The fisheries products processing industry provide employment and generate millions of dollars in revenue annually in Canada. The shellfish sector is increasingly gaining more prominence as the moratorium of Canadian ground fishery continues to take effect. Based on the 1990 total fish landing of 1.647 million tons, the value of the harvest used as inputs for processing activities was $1.51 billion. Shellfish processing accounted for over a third of this amount, though its contribution by weight to total landings was only about 15%. In 1996, the total catch of shellfish increased to 310,662 tons worth $1.016 billion and representing a 26% increase in totalshellfish landings over the 1990 levels. Most seafood processing establishments in the industry process for export. In all about 80% of all industrial shipment is exported mainly to the US, Japan and the EU. Traditionally, processing of fish has resulted in much by-product generation. In the case of some shellfish species, as much as 70% -75% of the landings used as input in processing ends up as waste. Some of the waste is recovered through auxiliary operations such as fishmeal production and composting. More than half the volume of all shrimp landed and processed in the industry is discarded at landfill sites or at sea.

In 1997, the department of Food Science and Agricultural Chemistryof McGill University conducted research on the potential use of shrimp processing by-products to formulate value-added products for the seafood market. The work was motivated by the fact that shrimp processing often results in substantial quantities of waste (up to about 75%), disposed of into the environment. With dwindling fish stocks, loss of jobs and ever-increasing concerns about environmental waste pollution, the possibility of reprocessing by-products appeared to offer a potential to recoup more value from this

resource to processors. With this in mind, a value-added seafood product made from surimi (mechanically de-boned and minced fish) and shrimp broth were formulated in several combinations of ingredients and the best selected for market evaluation and possible commercialization. The product attempts to imitate the sensory attributes of real shrimp but is quite different from seafood analogs, in that, it is not produced from real shrimps but from shrimp by-product extracts. The initial safety and sensory tests conducted by the scientists indicated acceptable product characteristics and a potential for large-scale industrial production. But the question: "would this newly developed technology to produce wholesome convenience seafood products from shrimp processing waste be economically viable at the industrial level?" remains to be answered. That is, is there a market for the product and would investment in the technology pay for itself and return rewards to the investor for the use of capital? These and other questions about the segment of the seafood market most likely to provide the best opportunity for possible product introduction, the proportion of this market segment that would be willing to buy and use the product and the determinants of purchase intentions must be answered.

1.3 Objectives of the study

In order to provide answers to the above questions, this study was undertaken to examine the economic potential for commercializing the new technology. The main objective was to examine the feasibility of producing commercially acceptable value added seafood from shrimp processing by-products. In particular, the study aimed at:

(i) Conducting a market survey of foodservice operations in Montreal to assess product acceptability and establish the potential for product commercialization,

(ii) Establishing through the survey, an average price that users of the product would be willing to pay per unit as reference point for potential producers,

(iii) Proposing a plant layout and computing a unit cost estimate based on variations in the level of output and operating assumptions, and

(iv) Conducting a financial analysis of adding a surimi-shrimp nugget processing line to an existing industrial seafood processing plant.

1.4 Organization of the Study

The study is structured after the recommendation for manuscript-based thesis format and is composed of five chapters including two manuscripts.

Chapter Two reviews background literature relevant to the problem. It reviews background information on the shrimp fishery and processing sub-sector of the Quebec seafood industry network as an example of the Canadian situation. Then follows a review of the evidence of rising seafood demand including the increase in demand of convenience or value added products and shellfish analogs. A brief review of the methodology used in the study concludes the chapter. Chapter Three presents the first of the two manuscripts covering the market research phase of the study, complete with conclusions, references and appendices. The second paper, building on the results of the first paper and presenting the results of production cost estimation and investment cost analysis constitute the subject of Chapter Four. A connecting section is inserted in between the two manuscripts to provide a logical progression and a natural link between the two chapters.

The final Chapter presents a summary and general conclusion drawn from the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section presents a review of the relevant literature. No previous publications were found dealing with the economics of producing value- added products from shrimp processing waste. However several studies dealing with various issues in the market for seafood and introduction of new products were identified. A review of the issues relating to shrimp processing and waste disposal is first presented before a review of studies dealing with fish processing waste recovery. Thereafter, a review of the evidence of rising seafood demand and the determinants of seafood demand are outlined, followed by a review of the research methodology vis-a-vis the market research technique and the concepts involved in cost estimation and capital investment analysis.

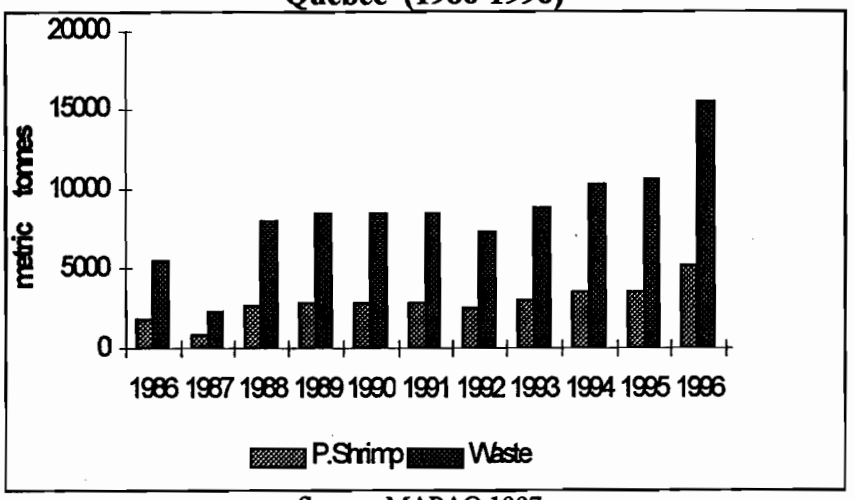
2.2.1 Shrimp Processing and Waste Disposal Issues

The collapse of the ground fishery in the early 1990s had a devastating effect on the fishery industry in Eastern Canada as thousands of workers, fishermen and plants were forced to find alternative employment (Higgins 1997). In Quebec, close to 120,000 people, mostly young people have migrated from the maritime region in search of better job opportunities elsewhere, over the past 15 years (Dupuis 1997). The region has an unemployment rate of 20% compared to a Quebec average of 12% and Dupuis (1997) reports that, between 1993 and 1995, 13 plants closed down in the fish-processing sector as a result of the structural changes taking place in the industry. Recovery is in progress,

due in part to improvement in shellfish catches and the introduction of new innovation. The increases in shellfish catches meant that, in Quebec for instance, shrimp landings (and consequently by- product generation) has increased by some 35% since 1993 (Dept of Fisheries and Oceans 1999). Seafood processing is the most important link in the Quebec seafood industry network. In 1995, 76% of all fish landings in Quebec was processed including nearly all the shrimp (96%). It accounted for over a quarter (26%) of total industrial employment and 31% of value added in 1992

Shrimp processing, however, has a unique waste generation problem. Yield is unusually low (25-30%). Processing is done by a semi-mechanized peeling operation, involving the removal of parts of the raw product in the form of head, shells, legs and gut. These, together with other broken and undersized pieces constitute more than half of all processed landings. An accurate measure of the shrimp waste generation is not readily available in the literature but it has been estimated that an average of about 4000 mt was generated annually between 1994 and 1996 (Simpson 1998). Other sources put the amount well beyond this estimate. Teftal (1997) reports a waste generation level of nearly11000 mt per annum for 11 processing plant located on the Gaspesie peninsula in Quebec. Of this amount, some proportion is reduced to fishmeal or recovered by processing into industrial ingredients (Alibhay 1990). The bulk of the material is dumped at landfill sites or disposed of at sea, at an annual cost ranging between $10000 and $20000. In 1996, shrimp processing plants in Quebec produced 5,163.70 mt of processed shrimp, and generated more than $ 54 million (MAPAQ, 1997), generating over 15,000 mt of waste in the process. Figure 1 illustrates the approximate quantity of shrimp waste generated through industrial processing activity in Quebec.

Figure 1: Quantity of waste generated and the volume of shrimp processed in Quebec (1986-1996)



Source: MAPAQ 1997

There appears to be an emerging trend among food processing firms to find alternative to dealing with the waste disposal problems. Some are looking to contracting out waste and by-product handling to enhance efficiency. In a survey to study emerging trends in the food processing industry, Ferrante (1999) found out that outsourcing was among the top 10 priorities likely to emerge to improve firm competitiveness and efficiency. The survey revealed that within the next five years, outsourcing plant sanitation is expected to increase from its current level of 25.2 % to 41.3% of all food processing firms. This compares to expected outsourcing of such functions such as maintenance (from 20% to 28% in five years) and microbial testing (from 60% down to 39% in five years). Seafood processing establishments could be enhancing their efficiency and improving their competitiveness if reprocessing is proven a viable alternative. Some small firms, especially within the fish processing industry in Canada, have resorted to new innovation and diversification to maintain year round activity and

overcome to the period of prolonged inactivity during the winter when the fishing season is officially closed.

2.2.2 Fish Processing Waste Recovery

No and Meyers (1995), Simpson et al (1995) and Knorr (1991) have studied the scientific aspect of extracting industrial ingredients from shellfish waste and examined the various applications of certain organic extracts. Few studies are available on the economic aspects of waste conversion at the industrial level though the interest in fish waste recovery seems to be nearly a century old. Felding (1918) pioneered the research on ways of converting fish waste produced in Canada into animal protein supplement. Hitherto, fish processing waste had been partly used for fertilizer production and linseed and cotton seed cake meal were the major animal feed supplements. The author estimated the raw material availability and demonstrated that by constructing a model waste reduction plant, that fish processing by-products could be reprocessed into fishmeal at a profitable margin. Mcalpin (1994) studied the economic feasibility of producing surimi from catfish frames. Catfish trimmings (frames) are generated as by-product during catfish processing, and the author found that good quality surimi could be processed at an affordable cost if an additional processing line was added to an existing catfish processing plant in the Mississippi delta. The potential of chitin and chitosan production in Quebec has been investigated by Teftal (1999). Using the total allowable shrimp catch as a proxy, the author forecasts the availability of shrimp waste from processing activities in Quebec. After estimating the production cost of production at the pilot plant level, the author concludes that, chitin and chitosan could be produced profitably from available

crustacean waste (gross margin of about 90%) and would have important applications in the Quebec pharmaceutical industry.

2.2.3 Demand for Value Added Seafood

Lambert (1990) defines the term value added as the value added to a product from the time it enters the processing plant to the time it leaves the plant. Value added seafood products are ideal for today's busy consumer and have seen an increase in demand as consumers opt for more convenience and for more meals taken away from home. Sales of value added products in the UK, for example, increased from $87million in 1985 to over $140 million in 1988. In North America value added seafood items are a fast growing category in the seafood business. There's been increasing household ownership of microwave ovens and an increasing labour force participation rate by women over the past few decades (Lambert 1990). Occasional consumers of seafood have indicated that high price, boniness and difficulty in preparation are the most significant factors restricting wider consumption of seafood products. The rise in the consumption of value added breaded and battered convenience products have partly been attributed to the ease of preparation (heat and eat), mostly boneless and relatively cheaper than other forms of product. Surimi-based shellfish analogs or imitation seafood are fast becoming an important component of the value-added market. These products have been developed by the industry in response to rising consumer shellfish demand. Marvis (1991) reports that surimi analog consumption in the US alone has grown by about 50% over the period 1986 to 1990. Further, rising per capita disposable incomes and changing consumer expenditure patterns has resulted in the rising popularity of meals away from home.

Harnarine (1992) studied the characteristics of the demand for meals purchased from restaurant by Canadian consumers and concluded that a rising proportion of consumers' food budgets is spent on restaurant meals. The author found that in the Consumer Price Index basket of goods for 1957, 12% of the food budget was allocated to food purchased from restaurants. By 1986 this proportion had risen to 28% at the expense of meals prepared at home. Rising incomes, increase one-parent families and decrease in family sizes were partly responsible for this trend. The market outlook for seafood analogs and shellfish in general is expected to continue to grow as consumers' discretionary incomes increase and more and more households find it convenient consuming meals away from home.

The potential consumer acceptance of new seafood products has been studied. Engle and Kouka (1995) studied the effects of socio-demographic factors on consumers' willingness to accept canned bighead carp (a new experimental fish product) and their willingness to pay as much for canned bighead carp as for canned salmon and canned tuna. They found that, consumer income, region and gender significantly affected ratings on product attributes while taste variables significantly affected consumers' willingness to pay as much for canned bighead as for canned tuna. The authors concluded that canned bighead competes more favourably with canned tuna than with canned salmon. The market environment into which new seafood products are introduced have been assessed by Miller (1974). The author points out that, for seafood products, where the "action" mostly depends on the species but for frozen seafood products in general, greatest product movement is found in the restaurants and institutional trade. He concludes that marketing underutilized species of seafoods in the US are exceedingly bright since retail

and institutional buyers continue to maintain and open and cordial attitude towards new seafood products. Thomas (1985) has reviewed the difficulties involved in producing accurate estimates of the market performance of new products. By examining various methodologies used in forecasting demand for a new telecommunications service, he found that most of the methodologies used in demand estimation made no prediction of demand growth, used a dichotomous measure of purchase intentions to measure market potential and generally ignored non-response issues.

Most of these studies have focused on the preference and demand characteristics of consumers. However, other studies have examined buyer attitudes at other marketing levels. Hatch et al. (1990) and Halbrendt et.al (1995) have used surveys to elicit retailer preferences for seafood. Pomeroy et al (1990) used telephone surveys to assess fish and seafood use among full-service restaurants in the U.S. Gall and O'Dierno (1995) have discussed opportunities for value added products in the seafood market at the restaurant and retail levels. The determinants of consumers' preferences for seafood have been studied by Hanson et. al. (1995) and Kinnucan et al (1993). Capps (1982) has investigated the magnitude of demographic and socioeconomic variables on consumers' seafood expenditure and barriers to effective seafood marketing have been identified by Gempesaw et. al (1995) and Halbrendt et al (1995).

2.3.1 The market research approach

Market research involves the collection, processing and analysis of data usually to answer questions relating to product marketing. It usually involves a market survey of a target population to elicit responses pertinent to the problem of identifying and defining

marketing opportunities, forecasting product sales and investigating consumer choice decisions. The marketing research approach include the following:

- Defining the problem
- Identifying research objectives
- Designing the research (including definition of instrument)
- Collecting and analyzing data
- Writing the final report

Market research techniques have been used extensively to gather data and investigate those market questions to which traditional methods fall short. In this approach, statistical analytical procedures for example, are applied to primary data to answer questions about consumer preferences, new product demand, existing product market shares and to gather information on products for which strategic decision making is required (Wessells and Anderson 1992). Kinnuccan et al. (1993), Cheng and Capps (1988) and Dellenbarger et al. (1992) have used the marketing research technique to study the determinants of consumer preferences for seafood. Engle and Kouka (1995) have used it to study the potential consumer acceptance of a new seafood product and Pomeroy et al (1990) and Rauniyar et al (1995) have studied the different aspects of the restaurant markets using the methodology.

2.3.2 Cost estimation

Nelson et al (1991), define cost estimation as the identification and compilation of all the costs of the elements included in a project or of effort that is involved in a section of a proposed project. It is a very limiting practice fraught with many uncertainties because it is an approximation procedure and the estimate has a significant likelihood of

being different from the true figure. However, a good cost estimate can provide the basis for significant decision making and meaningful conclusions can very well be drawn for economic evaluation purposes.

Humphreys (1996) lists the different ways in which a cost estimate can be obtained. The method to be selected will depend on the purpose for which the estimate is being obtained. In general, fixed capital costs can be obtained by identifying all the fixed capital items included in the project and obtaining a free on board (F.O.B) or installed price quote from the equipment manufacturer or supplier. Identifying capital cost item by item is often a laborious way usually necessary only for a detailed assessment of capital investment projects. For an initial feasibility study, it suffices to use a scale up (down) factor to estimate cost of the major capital equipment provided reliable historical data of similar equipment is available (Nelson et al 1991).

The order-of-magnitude methodology is simply a proportional way of obtaining capital cost for plants or major equipment if the cost capacity factor is known. The concept of cost capacity factor (ccf) introduced by Williams (1960) assumes that the cost of plant equipment varies with capacity for most industries according to the six-tenth-factor rule. If the cost to capacity ratio of any piece of equipment is known, then the cost of smaller or larger capacity equipment of the same function can be estimated by relating the two ratios by a factor of 0.6. Thus by using appropriate historical plant construction or equipment cost data, an estimate of the cost of a larger (or smaller) but similar facility or equipment can be obtained using this approach. Cost-capacity factors vary with industry and the average of 0.6 is useful only when more reliable data cannot be obtained. Cost-capacity factor estimation has been used to scale up cost of major process

equipment in engineering (Remer and Chai 1990) and pharmaceutical industries. Zugarrramurdi (1991) applied cost capacity factor estimation to fish processing plants. Parin and Zugarramurdi (1994) have computed the cost capacity factor for the fish processing industry.

2.3.3 Capital budgeting

Since firms are constantly in the business of making new capital investments and expanding existing ones, several authors have discussed the application of capital budgeting techniques to investment analysis in the literature.

Casler et al (1984) gives a comprehensive review of the methods involved in capital investment analysis. The authors argue for the superiority of discounted cash flow methods (DCF) of investment analysis over the common and more widely used criteria such as payback period and return on original investment (ROI). Bierman and Schmidt (1984) review the methodologies involved in the capital budgeting decision. They discuss the merits of discounted cash flow procedures and touch on the relative merits and demerits of using each method. Discounted cash flow methods have found the widest use among economists in the assessment of the economic worth of investment projects. The ones that are most widely known and used are Net present value (NPV) and Internal rate of return (IRR) criteria. There is some debate in the financial and economic analysis literature as to, which of these two criteria provides the best measure of economic worth. Some authors, including Turvey (1963), Flemming and Feldstein (1964) and Bierman and Schmidt (1984) for example, have argued that, in certain cases, NPV is preferable or easier to use than IRR. Price and Nair (1984) and Brealy and Myers (1988) have documented the problems of internal rate of return as a performance criterion and cast

doubt on the usefulness of IRR as an investment selection criterion under some types of projects. However Casler et al (1984), though not disputing these limitations, point out that both methods are superior to other measures of investment worth and that both the NPV and IRR " will suggest the same decision under most circumstances". That the differences in NPV and IRR as investment criteria lead to no error in decision in investment selection for most projects, has been demonstrated (Ramsey1970). Thus Martin (1997) points out, neither the NPV nor IRR is superior to the other. They are complementary and have "essentially equivalent utility" in analysing capital investments. Indeed, the use of internal rate of return to analyse capital investment projects has been widely advocated (Busby 1985). Fisher and McGowan (1983), call it "the only correct measure of profit rate for purposes of economic analysis" and Gittinger (1982) and Hacking (1986), have discussed their usefulness in project feasibility studies. Thus it appears that using both the NPV and IRR criteria have merits and when used together, they provide a better view than either one alone.

In a survey of 189 large US firms to find out about the investment analysis techniques in use by these firms, Schall et al (1978), found that almost 86% of the respondents used more than one capital budgeting technique. The same proportion of firms used either IRR or NPV or both. Over two-thirds of all respondents used one or both of these measures together with another non-discounted technique. Seventeen percent used all four available methods (net present value, internal rate of return, accounting rate of return and payback period) for analysing potential investment options. It appears therefore that in practice, most firms attempt to minimize the uncertainty about capital investment choices by analysing proposals in as many different ways as possible.

In fact using other non-discounted measures of project worth to complement NPV and IRR seem to be common practice and may even be desirable in some cases (Casler et al 1984). The "use of so–called time adjusted measures of profitability constitute a sufficient but not a necessary condition for reaching optimal decisions" (Sarnat and Levy 1969). Beke et al (1996) have used the NPV and IRR criteria to investigate the financial feasibility of producing steam and electricity from forest biomass using a small-scale co-generation facility in Northern Ontario. The authors found that, at full capacity, the plant would generate an NPV of $7M and an IRR of 17% or $2M and 9% on an initial investment of $6M, depending on which source of the two types of biomass was used as fuel. Gunjal et al (1999) have assessed the feasibility of minimal processing of fish and pork in Quebec and concluded that processing of both products were feasible and the rates of return comparable to that of some food and beverage concerns on the Toronto Stock Exchange.

CHAPTER THREE

POTENTIAL MARKETABILITY OF BY-PRODUCT SHRIMP NUGGETS ON THE QUEBEC FOODSERVICE MARKET

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Abstract: *For a new, unbranded, low volume surimi- based convenience seafood product made from shrimp by-products, the foodservice and institutional market offer a greater possibility for objective product evaluation and an assessment of potential market for possible product introduction.*

This paper presents the results of a market survey and product attribute preference evaluation of a value added, breaded and battered product made from shrimp processing waste, on the commercial foodservice market in Montreal. The results indicate that half of all respondents were likely to buy the product for use in their operations, at an acceptable supplier/wholesale price of $4.40 per kg. Commercial restaurant food service managers were generally satisfied with product attributes, though mean ratings for appearance, taste and aroma indicated that improvement in these attributes was necessary to fully satisfy potential consumers. Price and restaurant ownership type were the only two variables, which significantly influenced respondents' purchase intentions.

Introduction

The foodservice industry in Canada is a multi-billion dollar industry. In 1998, nation-wide sales topped the $34 billion mark. Over the past decade, the industry has made improvements recovering from an earlier recession in the early 1990's. The dampening effect of the introduction of the Goods and Services Tax (GST) around the same period, have also largely been overcome by the industry to reach an average annual real sales growth rate of about 3%. Foodservice market share in total consumer food expenditure has made dramatic gains over the decade, to even surpass pre-1990 levels, reaching almost 40%, up from a record low level (36.8%) in 1991. Reduced bankruptcy levels (formerly the highest in Canada) and increasing operating pre-tax margins seem to

suggest at the very least, a healthy industry that is likely to keep it present growth patterns. Some of the reasons for the high performance of the foodservice industry in general, have been attributed to the overall positive performance of the Canadian economy. Other reasons are traceable to changes in consumers' tastes and preferences, demographic shifts and new trends in the North American food industry.

The changing family structure in Canadian society is by far the most significant driving force behind demand for foodservice meals. Average family size is estimated to be about 2.6 persons. The increase in two-bread winner families has also increased the demand for foodservice meals. The popularity of convenient, ready-to-eat items as well as the proliferation of fast-food or quick service establishment is an indication of the current structural changes taking place within the industry to meet the needs of the busy consumer. Operators have innovated by expanding in the areas of more drive-through outlets, and food stands, which take just a few minutes to serve a meal or food wrap. To save time and cost, some operators are gradually using prepared food products in their menu preparations. The trend seems to be to move towards using products that save time and labour in the kitchen. According to Campbell (1995) " the move to pre-portioned, pre-processed and frozen products" by restaurants has simplified the work of chefs enormously. Such high quality, value added products are also cost saving, generating little or no waste at all. Operators are also realizing that, getting manufacturers to prepare foods also provide a more consistent product for use in their menus items.

Increasing ethnic diversity has contributed to trends in foodservice demand. As more and more immigrants settle into Canadian society, ethnic foods have become commonplace and demand for many specialty items have developed. The rising

consumption of fish and seafood have been attributed in part to a growing Asian population. More than half of all immigrants coming to Canada between 1991 and 1996 were Asians. With this demographic shift has come the development and marketing of some formerly exotic items. Surimi, a typically Japanese-style mince fish, is the principal ingredient on which the booming shellfish analog market is based. Such products as crab legs, and tempura made with surimi technology (Lee 1986) has been received well by North American consumers in general (Kawana 1986). Other forms of value added seafood, especially, breaded and battered products still remain popular foodservice items, though, their high calorific value is considered by some to be a setback to wider patronage by today's health conscious consumer (Regenstein 1986)

Per capita seafood consumption rose from 8.76 kg in 1988 to almost 10.91 kg in 1997. In all, seafood consumption has shown an overall increase of about 25% within a period less than 10 years. Peak consumption was attained in 1997 when apparent per capita consumption reached almost 11kg. Much of the gains in seafood consumption have occurred while consumption of other competing protein sources, such as red meat, has been declining. Over the same period that seafood consumption made gains, consumption of pork, for example, declined by 10% from almost 21 kg to about 19 kg per capita and beef consumption declined by close to 15%. Except for the period 1993 –1995, when it made negligible average annual increases, beef consumption has shown a consistent downward trend since the mid 1970's. The change in the Consumer Price Index (CPI) for beef and pork over the period, show that the fall in consumption of these products have occurred though their prices have increased at a much slower rate than has the price of seafood. Within this period, the CPI of beef and pork increased by 8% and

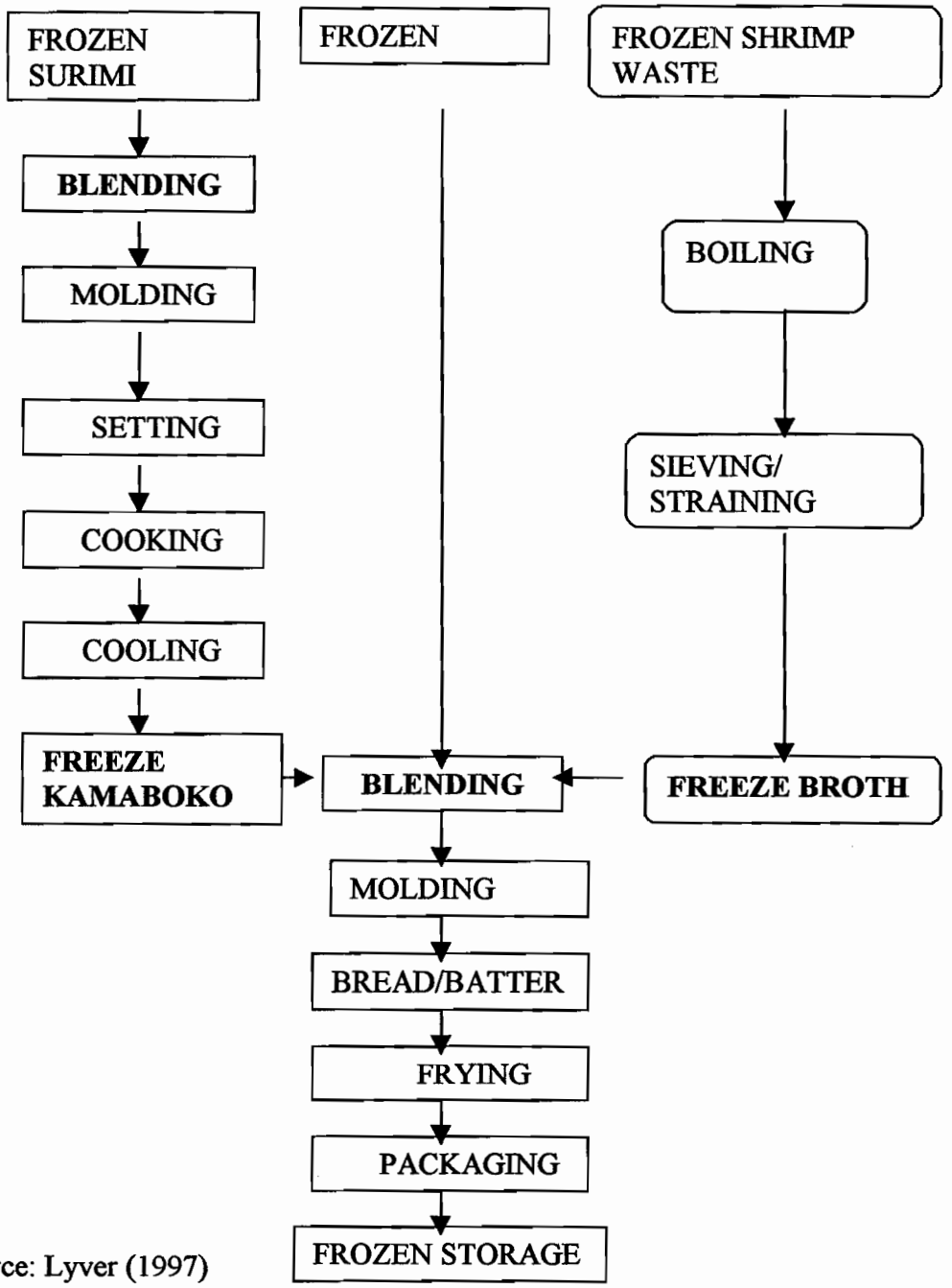
14% respectively. Seafood price inflation, however, rose by 18%. Thus, the decline in red meats consumption has occurred, in spite of lower relative price increases whereas the gain in per capita seafood consumption, on the other hand, has occurred against a trend of relatively higher prices. There is reason to indicate that, much of this boost in apparent per capita consumption has occurred in foodservice. In general about 75% of all fish and seafood sales occur in meals consumed away from home. Foodservice operators find fish easier to prepare and very versatile to use in menu development. According to nationwide survey of independent operators, fish and seafood was the third most popular product in use by foodservice establishments. Salads and Pasta were the only items more widely used than fish and seafood. Then again, most consumers would rather buy fish at a foodservice outlet because fish is not as convenient to prepare at home as other protein alternatives and its odour lingers for longer. Further, the range of fish available at a foodservice establishment is wider than is available in grocery retail. Consumers' increasing desire for healthier lifestyles, rising per capita disposable incomes and the increasing popularity of eating are likely to sustain the positive increases in per capita seafood in Canada and across the North American continent (Pomeroy et. al. 1990)

The development of a new value-added, heat-and-eat surimi and shrimp product made from shrimp processing by-products, and related safety issues have been investigated and discussed by Lyver (Lyver 1997; Lyver and Smith 1998). This paper tests the marketability of the product within the foodservice market. Specifically, it presents descriptive analysis of results of a survey of foodservice outlets which evaluated the product and analyzes implications for marketing this value added product on Quebec's foodservice market.

New Food Product Technology and Marketing

A process flow diagram for making value added seafood from shrimp by-products is presented in figure 2. The technology was developed by Food Scientists at the Macdonald Campus, McGill University, Montreal, Quebec. Frozen surimi blocks are received in a holding area and portions of it are sliced, weighed and blended together with specific ingredients in the bowl cutter to commence the process of Kamaboko preparation. Kamaboko is an intermediate product used as a gelling agent in product formulation. The soft gelatinous material that result is molded, heat-set in warm water and cooked for 15min at a temperature of 90°C. After cooling, the gel is kept frozen for later use. A fresh batch of surimi is again blended with appropriate mixture of ingredients and shrimp broth (fig 2) and measured quantities of kamaboko to give a jelly like substance. This is then molded, extruded, battered and breaded before deep-frying for 2 min to set the crumbs. The product is packaged and frozen for distribution. The details of the product formulation and subsequent safety studies conducted by the scientist are discussed elsewhere by Lyver 1997, Lyver and Smith 1998).

Figure 2: Process flow diagram for processing value added nuggets from surimi and shrimp waste



Source: Lyver (1997)

Issues concerning the development and introduction of new products to seafood markets have been well discussed. Commercial product acceptability in terms of sensory attributes, product presentation, pricing and safety issues pose real challenges to the

success of any new product introduced to the seafood market. The heterogeneous nature of the seafood market makes it particularly difficult to predict potential acceptance of any new product based on generalization about market behaviour. However, new products are the "lifeblood" of the seafood industry and therefore the introduction of a potential product demands a careful assessment of the chances of success within the segment of the market in which the product will compete. Thousands of new seafood products are introduced each year but only half survive the first year and the overall success rate is pegged at about 20% (Tamsevicius 1997). The reasons for new product failure are many and varied and include poor marketing, poor product design and bad timing. But no matter the reason, a proper assessment of market potential and product acceptability and related issues, is necessary to reduce the chances of failure and the resulting wasting of scarce resources (Geurts and Reinmuth 1980). In Quebec and in Canada, grocery retail seafood marketing is dominated by two major processing companies, which together account for greater than 90% of the total processed fish products in supermarkets. Other private label brands, currently on the market, that have won any significant market share, have traditionally been introduced to the retail trade via the foodservice and institutional markets. The reason for this is because foodservice markets are especially adapted to the small processor who is often characterized by low volume, no brand products with little or no sales promotion or advertising support (Morehead 1974). Further, if it comes to product positioning on the seafood market, the "action" seems to be in the foodservice and institutional trade.

Descriptive analyses have been used extensively in the marketing research literature to evaluate preferences and respondents' opinions on various research

questions. Descriptive statistics have been used to analyze restaurant managers' use of catfish in their operations (Pomeroy et al 1990) and to study consumer perception of aquaculture products (Gempesaw et al 1995). Qualitative choice models have been used extensively in the seafood market literature to study U.S at home consumption of seafood (Cheng and Capps 1988) and Olowolayemo et al (1983) to study U.S grocery markets for catfish. Pomeroy et al (1990) have used a logit model to estimate the odds-ratio in favour of restaurants adding catfish to their menus and to study consumers' choices for fish and shellfish products (Gempesaw et al. 1995). Engle and Kouka used it to measure the effects of demographic variables on binary choice variables related to preference comparisons and willingness to pay much for canned bighead carp as for canned salmon and canned tuna.

Overview of the Quebec Foodservice Market

The Canadian foodservice market (including Quebec) consists of the commercial and non-commercial sectors. These sectors are different and are generally viewed as such by the industry. Commercial sector establishments are those operations that are based on direct consumer demand for the services they render. These establishments focus on meeting consumers food needs for profit and their services are open to the general public. Examples include restaurants, social and contract caterers, pubs, taverns and nightclubs. Non-commercial foodservice operations derive demand indirectly through consumers' patronage of some other principal product or service. These are usually auxiliary operation which, is not the major business orientation of the organization of which it forms a part. Consequently, non-commercial foodservice caters to the needs of members

of a particular group of people. Non-commercial outlets are usually operated for the welfare or convenience of those served rather than primarily for profit. Examples in this category include institutional foodservice operations such as schools, hospitals and correctional facilities; accommodation, machine vending, leisure and department stores. Commercial establishments account for about 78% of all Canadian foodservice and hospitality sales. Restaurants account for over two-thirds of all commercial foodservice sales. In 1999, commercial foodservice sales in Canada was expected to reach $28 billion. Restaurant sales was expected to account for about $24 billion of the estimated amount, growing by some 4.9% over 1998 levels.

The diversity observed in the restaurant business and the pace of change within this market makes a simple system of classification difficult or even impossible (Powers 1979). However, based on service, restaurants differ in whether they quick/counter service, table service, self-service or any blend of these. Quick service (fast food) establishments, cafeterias and limited menu; and sometimes buffet outlets usually combine some amount of counter and self-service to provide clients with quick, cheap and convenient meals usually popular with eating out occasions. Ethnic, specialty (foodservice operations organized around a particular food item e.g. seafood), diners (operations serving breakfast, lunch and supper); as well as other family, theme and fine dinning (haute cuisine or white table-cloth) restaurants concentrate on providing quality table service and a dinning out experience. Food served by the first category may be varied containing many convenience items set up on a more or less inflexible menu. Restaurant ambience is informal and even if seating is provided, it is of limited capacity and food is mostly consumed at some point other than within the outlet. Take-out and

home delivery is a common feature of this category. Full-service operations on the other hand, usually have broad relatively expensive menu items where food is mostly consumed within establishment. Seating capacity is usually medium to large, and enough to accommodate a sizeable clientele. Take-out /delivery is done only occasionally. Food is usually prepared from "scratch" and trained staff usually prepares food served by waiters and waitresses. Dining ambience is semi-formal to very formal. Attendance at some restaurants in this category may even require prior reservations. This type of establishment is usually suitable for celebration and/or dining out occasions.

Due to the introduction of the GST and the recession of the early 1990's, foodservice operating margins have been low. Nevertheless, as the industry gradually recovers from those early difficult years, operators are embracing new menu ideas and new products in a bid to improve service differentiation and to get an edge over the competition. Restaurateurs are experimenting with lesser-known products and menu items (and dropping others) or looking to new products aimed at attracting a wider clientele and also to help reduce the monotonicity of eating at the same place (Foodservice and Hospitality 1999).

Problem and Survey Objectives

The transformation of fish processing by-products into forms edible for human consumption raises a number of concerns. Granted that the product as formulated is safe and suitable for the commercial market, the reaction of the market to product characteristics and the chances of product success must be fully assessed. Though the product is formulated from lean ingredients, the process of value addition (breading, battering, and frying) involve increasing the unit fat content. With today's health

conscious consumer, this process may probably not be very acceptable. Specifically, the research focuses on the following issues about the potential marketability of the product on the Quebec foodservice market.

Market potential: The study examines questions about the proportion and composition of the Quebec restaurant market that is willing to purchase and use the product in their operations. The question is how much of the foodservice market would purchase breaded, battered and pre-cooked seafood in their serving the needs of the consumer. Then the question whether quick service/ self service (counter) foodservice operations are more likely to be interested in the product than full service/fine dining establishments needs to be examined.

Menu theme: The increase in seafood consumption among Canadians is partly been attributed to the on-going demand for other sources of low-fat protein and the taste and preferences of a growing population of people of Asian origin. This needs to be assessed by testing the influence of ethnicity (menu theme) on preferences for the product. Again, the principal ingredient in the product, surimi, originated from Japan and has been known to be traditionally more acceptable to the tastes and preferences of consumers of Asian origin (Smith, 1995) than to people from elsewhere.

Assuming establishments that described themselves as Asian served primarily consumers from this ethnic background, the question of whether foodservice operations belonging to this group had a higher preference for the product needs to be answered.

Product price: High prices are an important restriction on increased seafood purchases (Hanson et al 1995, Data Development Corporation 1988). This has led some to suggest that the gains made by the imitation seafood products industry, the so-called surimi

revolution (Kawana 1986), has come about principally because of consumers' desire for the positive attributes of seafood at a lower price. Therefore, questions about the acceptable price range must be examined. Quick service and allied foodservice operations using less skilled workers to reduce service costs. These savings are then passed on to the consumer in the form of lower food prices. Suggested acceptable wholesale price per unit of product is therefore expected to be different for the two types of restaurant operations.

Attribute preference evaluation: Respondents' preferences regarding product attributes is the objective of the preference evaluation. Respondents' evaluation of product attributes affects their preferences and ultimately, purchase decisions (Engle and Kouka 1995). The study would examine the suitability of the product for commercialization and whether respondents' ranking of product attributes is related to certain demographic and relevant operational variables. In particular, questions regarding the acceptability of product taste and texture to the North American consumer must be answered since the test product was formulated with the average North American seafood consumer in mind as well.

Choice determinants: The extent to which certain respondent characteristics influenced the decision to buy must be quantified. The likelihood of a typical restaurant adding the product to its menu must be assessed. It is hypothesized that respondent's demographic characteristics as well as experience in selling seafood or breaded products among others, is likely to influence the likelihood of purchasing the product for use in meeting consumers seafood needs.

Methodology and Model Specification

To address the questions discussed in the preceding section, a combination of descriptive and inferential analytical tools would be used. Frequency tables would be used to describe the proportion of the foodservice respondents indicating a willingness to buy the product for use in their operations. Frequency tables would also be used to describe respondents' opinions on acceptable price range and in the preference evaluation tests. To adjust for the deviation between stated purchase intentions and actual purchase behaviour, a modified form of the purchase intention scale would be used give the proportion of respondents likely to purchase the product. The approach assumes that respondents' uncertain state of mind about purchase intentions is probabilistic not deterministic. The author developed a standard scale (and probability distribution) by asking respondents in a new product survey to identify with certain descriptive words indicating the likelihood that they would indeed buy the product some time in future. Then using a follow up survey, he determines the proportion of respondents in each response category that actually purchased the product. From this he develops corresponding probabilities for the likelihood of purchase given each descriptive response Juster (1966).

Chi-square test of independence in a contingency table would be used to test for statistically significant association between pairs of variables. The test would be applied to cross tabulations of choice against type of foodservice operation. The strength of any such relationship is indicated by the Cramer's V statistic. Pearson' s correlation coefficient would be used to test the degree of association between respondent's ratings of pairs of product attributes. T-tests would test hypotheses about the mean score for the

important product attributes between potential buyers and non- buyers and to compare results of the preference evaluation by restaurant category.

To throw some further light on the determinants of restaurant managers' choice decision, a binary logit choice model (Amemiya, 1981; Maddala, 1983) would be used to examine the likelihood of respondents adding the product to their menus given certain characteristics. The logit model is based on the cumulative logistic function and it is useful in analysing choice problems in which the object is to predict a ratio of probabilities in favour of one choice against another.

Specifically, the root equation of the logit model from which the regression is developed, is represented as:

$$P_i = \frac{e^{X_i\beta}}{1 + e^{X_i\beta}} \tag{1}$$

where,

P_i = the probability of observing either value of the choice variable of the i^{th} respondent, given X_i.

X_i = column vector of independent variables influencing the response variable of the i^{th} respondent.

β = column vector of coefficients.

The model is linearised in the following steps:

$$1 - P = 1 - \frac{e^{X_i\beta}}{1 + e^{X_i\beta}}$$

$$= \frac{1}{1 + e^{X_i\beta}} \tag{2}$$

Therefore,

$$\frac{P_i}{1 - P_i} = e^{X_i\beta}$$

Or an estimable linear form,

$$Log\left(\frac{P_i}{1 - P_i}\right) = X_i\beta \qquad (3)$$

The ratio P_i /(1- P) represents the odds-ratio in favour of observing the occurrence of one event and not the other. In this case, P_i is the probability of the i^{th} respondent buying the product and 1-P_i is the probability of that establishment not buying the product. Given restaurant characteristics including menu type, seating capacity, ownership type and experience in seafood sale, the model estimates the odds ratio in favour of predicting the probability that the given restaurant will in fact purchase the product for its customers.

The matrix of explanatory variables, (X) used in the estimation was a combination of continuous and dummy indicator variables. In general, the latent variable, Y_i, which is correlated to the set of explanatory variables represented by X_i in equation (3), can be represented as follows for each respondent, i:

$$Y_i = \beta_0 + \beta_1 Menu_i + \beta_2 SC_i + \beta_3 Type_i + \beta_4 Owner_i + \beta_5 Breadfsh_i + \beta_6 Price_i + \beta_7 Experience_i + \beta_8 Sellcrab_i + \varepsilon_i \qquad (4)$$

The definition of the explanatory variables in equation 4 is given below.

Y_i = 1, if respondent will buy the product, zero otherwise,

Menu = 1 if restaurant serves predominantly Asian meals, zero otherwise,

SC = Seating capacity of restaurant, (continuous variable)

Type = 1 if restaurant is a fast-food establishment, zero otherwise,

Owner = 1 if restaurant is family/independently owned, zero otherwise,

Breadfsh = 1 if restaurant sells breaded fish, zero otherwise,

Price = suggested wholesale price (continuous variable)

Experience = number of years the restaurant has been in business (continuous variable)

Sellcrab = 1 if the establishment sells imitation crab, zero otherwise,

Respondent's demographic characteristics (menu theme, seating capacity, and restaurant ownership) are expected to influence the choice decision because these are respondent-specific. Operations serving mainly Asian menus may have a higher preference for the product than say non-oriental establishments. Seating capacity measures physical size of operation. Larger restaurants with a large annual turnover (and a high overhead cost) have an established client base and are less likely to be interested in value added processed products. Similarly long established restaurant operations with well established menu reputation are expected to be less willing to try the product. Independents restaurateurs have more freedom to experiment with new menu ideas than have chain establishments or franchises. Similarly, establishments that are already using similar (breaded fish and surimi-crab analog) products may have less difficulty adjusting their menus to include the product. Therefore, the decision to buy the product may be influenced by whether or not an establishment has similar items on its menu. Finally, price is expected to influence choice decision in the sense that respondents suggesting high sale price for the product may be less likely to be interested in the product. The logit model (equation 1) is highly non-linear in both variables and parameters. The natural logarithm of the logit $(P_i/1-P_i)$ does not exist when Y_i, the latent choice variable is binary.

Therefore the maximum likelihood technique, as used in the logit command in SPSS was used to calculate estimates for the model parameters. The estimated value of P_i (probability that a given establishment will actually buy the product) is calculated by using the estimates from equation (4) and plugging them back in equation (1).

Survey Procedure

An initial questionnaire designed to identify potential ambiguities in wording and question structure for the industrial level survey was extensively pre-tested with restaurant foodservice on two university campuses and revised accordingly. The final questionnaire (Appendix 1A) sought among other things, to elicit responses to the questions posed in earlier sections. To find out whether a market for the product exists, the questionnaire asked respondents to indicate their willingness to buy the shrimp nuggets for use in their restaurant operations. Restaurant managers were asked about their purchase intention if their suppliers made the product available. Respondents, who indicated a willingness to buy the nuggets, were assigned a score of 1 and those that did not intend to buy were given a value of zero. The binary choice variable of purchase intention was the response variable in the model which related purchase intentions to respondents' characteristics in order to isolate significant factors that influence the choice variable.

Possible product pricing information was obtained by providing a scale of suggested prices ranging from the wholesale price of the more expensive seafood items to the more low end, cheaper imitation seafood analog products. The questionnaire then asked respondents to select how much they were willing to pay per unit of the product. To assess the commercial acceptability of the product, respondents were asked to use

their knowledge of the market to evaluate the suitability of the product for commercial distribution and note their comments in the questionnaire. Restaurant managers were asked to rank product attributes on a scale of 1 to 5, where 1 was the most positive and 5 was the most negative and then to provide suggestions on how to improve product quality, if further improvement was necessary in their judgement. Finally, the survey asked respondents to indicated their demographic information relating to ownership and menu type, seating capacity, number of years of business, meals served and number of employees among others.

Sampling Procedure and Data Collection

The survey consisted of a simple random sample of restaurant managers. The sample was selected from a list of all restaurants contained in the telephone directory. Since restaurants were only listed in alphabetical order, it was not possible to isolate seafood restaurants. Moreover, almost all restaurants sold some form of seafood or value added product. Therefore, the random sample was taken from the population of all restaurants on the island of Montreal. The target population was defined (bearing in mind the existence of alternative definitions) as "all restaurants on the island of Montreal". The directory listings contained about 80% of all known restaurants in Montreal. All listed restaurants were assigned a number from 1through 3875 and a set of random numbers within this range was generated in Stata (a statistical software package). The random sample consisted of restaurants, numbered 1 to 3875 which, appeared in the random number set generated with the software program. The 120 establishments retained by the random selection process were contacted to take part in the survey.

A personal letter explaining the importance of the study, was mailed to all prospective respondents asking them to participate in the evaluation and market survey and urging those not interested to call or send a fax or e-mail to say so. Two weeks after the initial mailing, only five establishments had indicated their unwillingness to participate. Five other restaurants were either closed down or had moved without a forwarding address. Of the remainder, 97 restaurants were visited over a two-month period and the researcher personally interviewed 50 managers, a response rate of approximately 52%. Now since, testing and trying out a new product give potential users a better grasp of product attributes and narrows the deviation between purchase intentions and actual purchase possibility, respondents were provided with real samples of the product to evaluate so as to better answer the choice question

At the interviews, frozen samples of the surimi-shrimp nuggets were distributed to the respondents to cook, taste, smell and assess its commercial suitability and to complete the questionnaire in the presence of the researcher. In most cases, several recalls were necessary in order to get the survey completed. Forty-two respondents, out of the 50 that were interviewed actually evaluated the product as described.

Survey and Estimation Results

Demographic Characteristics of Respondents

Forty percent (40%) of respondents classified themselves as quick/counter service operations. The rest (except for 5 respondents who gave invalid responses) offered full-service. Thirthy-eight percent (38%) of the full service operations considered themselves casual/ family dining establishments whereas the remaining 12% said they were fine

dining operations. Ethnic menu themes dominated the sample (52%), followed by specialty menus (24%), limited menu operations (16%) and deli bars (8%). Within the ethnic menu restaurant category, establishments classifying themselves as Chinese, Vietnamese, Japanese or Thai formed 14% of all respondents, followed by French cuisine (12%), Italian (10%), Greek (6%), Lebanese (4%), Mexican/ Spanish (4%) and Indian (1%). An overwhelming proportion of survey respondents (82%) was not affiliated with any other restaurant but a franchiser operated a small fraction (18%). Average dinner price ranged from less than $3 to over $25. However, most establishments (56%) served meals for less than $10 and the majority (31.1%) served less than 50 meals per day. Fifty-one percent employed 5 or less full-time workers and most (38.8%) had been in business from 2 to 10 years. A significant number of respondents (26%) though, were quite new to the Quebec foodservice market with less than a year's experience in their present business. Geographically, the random sample consisted of establishments located in the western parts of the island (6%) and 14%, operated from the eastern area of the city. Eighteen percent (18%) of respondents were located within the mainly business Downtown core and the greater majority (62%), served the residential communities in and around the city centre (areas immediately outside of the downtown core).

Potential Market

The survey asked respondents to indicate the likelihood that they will buy the product, if it was made available through their suppliers. However, since respondents may not be alterably committed to their stated intention (Kalwani and Silk 1982), a simple dichotomous yes-no answer may not accurately measure respondents' assessment of the product. Thus a four-point scale, with assigned probabilities reflecting the degree

of certainty in each response category was used. The average of the expectation of the different frequencies of the different responses gave a better estimate of sample purchase intentions than a simple dichotomous yes-no response would otherwise indicate. Table 3.1 presents the response scale and associated frequencies for survey respondents indicating a willingness to buy the product for use in their operations.

Table 3.1: Frequency distribution of survey respondents willing to buy surimi/shrimp nuggets in survey of restaurant managers in Montreal.

Response	Frequency	Percent	Prob. of Purchase[a]	Expected value[c]
Certain	0	0	0.99	0
Good possibility	17	39.5	0.60	10.2
Fair possibility	14	32.5	0.40	5.6
No chance	12	28.0	0.01	0.1
Total	43[b]	100		21.6
Exp. Proportion [d]				0.5[c]

a. Associated probabilities for likely positive purchase action as estimated by Juster[1] (1966).
b. Does not add up to 50 due to non-response on this question.
c. Expected value = frequency * probability of purchase
d. Expected proportion = 21.64/43

About 40% of all respondents said there was a good possibility that will actually buy the product. Thirty-two percent said there was a fair chance they would include the product in their menus and 28% indicated that there was no possibility they will buy the product at this time. Seven respondents avoided the question. Of those who said they were "certain", 1 out of every 100 respondents may actually not buy the product when faced with actual purchase decision. Therefore, probability of likely purchase for this group is 0.99. Similarly, only 0.6, 0.4 and 0.01 respectively of respondents who said there is a "good", "fair" or "no" possibility will indeed end up buying the product. Based on the probability distribution of likely purchase, about half the sample of respondents

[1] Juster (1966) assumes respondents' uncertain state of mind about purchase intentions is probabilistic and not deterministic. He asked respondents in a survey to identify with certain descriptive words and in a follow up, he estimated the proportion of respondents exhibiting positive purchase behaviour.

interviewed would be expected to take a positive purchase action in future. By implication, 50% of all registered establishments in Montreal are likely to buy the shrimp nuggets for use in their operations. This represents quite a sizeable number since there are over 5000 commercial restaurants establishments in Montreal and over 16000 in the province of Quebec alone.

Table 3.2 presents the results of the Chi-square test in a cross tabulation of purchase intentions and type of restaurant. About 22% of respondents willing to buy the product classified themselves as quick service outlets, 17% were full service. The same proportion of quick service establishments would not buy the product whereas the proportion is much higher (37.5%) for full service operations.

Table 3.2: Cross tabulation and chi-square test results of purchase intentions versus restaurant type.

			Restaurant type		Total
			Quick Service	Full Service	
Buy/Not Buy	Yes	Count	9	7	16
		% of Total	22.5%	17.5%	40.0%
	No	Count	9	15	24
		% of Total	22.5%	37.5%	60.0%
Total		Count	18	22	40[a]
		% of Total	45.0%	55.0%	100.0%

	Value	df	Asymp. Significance
Pearson Chi-Square	1.364	1	.243
Continuity Correction	.711	1	.399
Likelihood Ratio	1.366	1	.242
Fisher's Exact Test			.335
Linear-by-Linear Association	1.330	1	.249
N of Valid Cases	40		

a. Invalid and missing data not included
Computed only for a 2x2 table
0 cells (.0%) have expected count less than 5. The minimum expected count is 7.20.

The chi-square test of independence is not significant, indicating that, the hypothesis that purchase intentions and type of restaurant are independent cannot be rejected at the 95% confidence interval level. Thus, it appears that a restaurant's decision

to buy the product for use in its operations is statistically not dependent on whether it is a quick/counter service or full service operation.

Menu Theme

Fifty-two percent (52%) of all respondents said their main menu theme was ethnic. Of all total responses, restaurants serving Chinese, Japanese or Vietnamese meals were 14%. The distribution of the other major ethnic menu restaurants among survey respondents was French cuisine (12%), Italian (10%) and Greek (6%). Results of a chi-square test of association between respondents purchase intention and whether or not they served predominantly Asian menus are summarized in Table 3.3.

Table 3.3: Cross tabulation and chi-square test results of respondent's purchase intention by menu theme

			Menu theme		Total
			Asian	Non-Asian	
Buy/Not Buy	Yes	Count	4	13	17
		% of Total	9.3%	30.2%	39.5%
	No	Count	2	24	26
		% of Total	4.7%	55.8%	60.5%
Total		Count	6	37	43
		% of Total	14.0%	86.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.147	1	.143
Continuity Correction	1.031	1	.310
N of Valid Cases	43		

Computed only for a 2x2 table
2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.37.

Table 3.3 shows that, about 9% of those respondents willing to buy the product is Asian, 30.2% belong to operations serving non-Asian ethnic or other menus. On the contrary, only 4.7% of those having no intentions to purchase the product are Asian. The remainder of valid responses for this category (55.8%) classified themselves as serving main menus

other than Asian. Results of chi-square tests show a statistically non-significant relationship (at the 95% C.I. level) between purchase intention and main menu theme (P>0.05). Purchase intention appears to be independent of whether or not restaurants served mainly ethnic Asian menus. However, the result of the test is interpreted with caution, since the validity of the Chi-square test cannot be guaranteed when one cell has a value less than 5.

Product Price

Table 3.4 presents a summary of the distribution of suggested wholesale price per kg for the product as indicated by respondents in the two categories (potential buyers and non-buyers).

Table 3.4: Frequency distribution of suggested price per kg by purchase intention as indicated by respondents' in a survey of restaurant managers in Montreal

Purchase intent.	Price($)	Frequency	Percent	Cum. Percent	Mean	Mode
Yes	2.20	1	5.6	5.6	4.53	4.40
	3.30	4	22.2	27.8		
	4.40	7	38.9	66.7		
	5.50	4	22.2	88.9		
	6.60	2	11.1	100.0		
	Total	18	100.0			
No	2.20	1	4.2	4.2	6.16	4.40
	3.30	2	8.3	12.5		
	4.40	7	29.2	41.7		
	5.50	4	16.7	58.3		
	6.60	5	20.8	79.2		
	7.70	3	12.5	91.7		
	>7.70	2	8.3	95.8		
	Total	24[a]	100.0	100.0		

a. Eight non-buyers did not respond to the price question

The distribution of potential product price appears to follow similar patterns over the range of possible values for both potential buyers and non-buyers. Of those that are willing to buy the product, about 40% said they would buy the product if it was made

available at $4.40 per kg or less. About 28% would buy the product for use if the price were below this average. About an equal proportion (33%) of potential buyers indicated an acceptable price range above $4.40 per kg. The mode for the price frequency distribution among both potential buyers and non-buyers is the same ($4.40 /kg). However, the suggested mean price per kg for potential non-buyers is sufficiently higher than for potential product buyers, suggesting more consistency among potential buyers in selecting an acceptable price point. Thus, the $4.40 per kg is the supplier/ wholesaler's price most likely to be acceptable to respondents. Processor's price would be markedly lower than $4.40 per kg after accounting for wholesaler/supplier's mark-up.

The mean price suggested by quick service outlets was just a little lower ($2.26) than that indicated by full-service operation ($2.35). The difference appears not to be significant and therefore the hypothesis that, quick service respondent are likely to indicate a significantly lower price per kg of product cannot be supported from the results of the price analysis.

Product Attributes Preference Evaluation

The results from the product evaluation by respondents hovered around the midpoint of the scale used to rank the attributes of commercial importance (Table 5). On the given 5-point scale (1= very satisfactory, 2 = satisfactory, 3 = neither satisfactory nor unsatisfactory, 4 = Unsatisfactory, 5 = Very Unsatisfactory), product appearance obtained the poorest mean satisfactory score (2.6). The scores for taste (2.53), aroma (2.51) and texture (2.15) followed in that order. It appears that among the four attributes, respondents found product texture the most satisfactory or that respondents were the least satisfied with product appearance. The results also seem to suggest that restaurant managers were as much satisfied with product taste as they were with its aroma.

To test whether these indications are really the case, t-test of means were further conducted on each attribute. The midpoint of the ordinal scale (assigned a score of three) represents a rating of indifference about product attributes and can be interpreted as an unsatisfactory rating for all practical purposes. Therefore, to find out if the observed scores truly represented a satisfactory rating (score less than three), t-tests about the sample means were conducted to see if they were statistically different from a population with mean score equal to 3. The computed t-ratios (column 5 in table 3.5) show that the mean scores for taste, texture, appearance and aroma are all significantly different from the population with mean score equal to 3. In general, therefore, respondents rated product attributes as satisfactory.

Table 3.5 Respondent ranking of shrimp nuggets on taste, texture, appearance and aroma

Attribute	n	Mean	sd	t[a]
Appearance	40	2.62	0.9524	-2.176*
Aroma	39	2.51	1.1209	2.714*
Taste	34	2.53	1.2610	-2.490*
Texture	41	2.15	0.7603	-7.189*

a. H_0 : mean = 3. * = statistically significnt at 5% level

To test whether the level of satisfaction is the same for all attributes, the paired t-tests of the differences between mean score for pairs of attributes are tested to see if they are statistically different from zero. The test results are summarized in table 3.6

Table 3.6 Comparison of mean ratings of the sensory attributes of shrimp nuggets in a survey of restaurant foodservice in Montreal, Quebec

Variable pair	n	Correlation	Paired- t
Taste - Aroma	33	0.598*	-0.643
Appearance - Aroma	39	0.205	0.368
Taste - Appearance	34	-0.002	0.109
Texture - Appearance	40	0.009	2.464**
Texture - Aroma	39	0.292	1.803*
Taste - Texture	34	0.681*	2.596**

* = 2-tailed significance at 10%, ** = 2-tailed significance at 5%

Pearson correlation coefficient estimates test the presence of bivariate association between pairs of variables. The result indicates statistically significant correlation between respondents' perception of taste and aroma and between taste and texture. That is the test scores of taste and aroma, and texture and taste appear to be correlated. The t-statistic, however, indicate that only the paired difference between taste and texture and between appearance and texture scores to be significantly different from zero at the 5% level of significance. The difference between mean scores for texture and aroma is statistically significant at the 10% level. On average, therefore, respondents appear to be more satisfied with product texture than with the other three sensory attributes. The differences between the mean scores of pairs of these attributes are not statistically different from zero (Table 3.6). Overall, the results of the commercial evaluation indicate that the commercial foodservice market in Montreal did not rate the appearance of the shrimp nuggets as well as taste and aroma as "very satisfactory" or highly acceptable. An improvement would probably be required to attract a wider market segment and increase the commercial potential of the product. Product texture, however, was rated satisfactory.

Comparison of means scores among respondents with different demographic characteristics or between means scores for taste and texture for buyers and non-buyers did not show any significant differences in ratings. Thus, it appears respondents objectively evaluated the product suitability for commercialization without prejudice to demographics or purchase intentions.

Determinants of Respondents' Purchase intentions

The empirical results of the logit model and the corresponding level of significance of the estimated parameters are presented in Table 3.7

Table 3.7 Parameter estimates of the logit model to determine the probability that Montreal restaurants would buy shrimp nuggets made from shrimp by-products

Variable	β	Std. Error	Level of Significance
Menu	1.6612	1.1788	.1588
BREADFSH	4507	.4184	.2814
Type	-.2287	.5839	.6953
Owner	2.1197	1.1151	.0573 *
Sellcrab	-.1208	.1516	.4258
Experience	-.0477	.0380	.2099
Price	-1.4792	.6300	.0189 **
SC	.0038	.0034	.2603
Constant	1.1737	1.7210	.4952

N= 50, Goodness of fit = 39.436, R^2 (Cox & Snell) = 0.336, Chi-sq. = 20.504 (8 df), p = 0.0086 , correct predictions = 80%

* = significant at 10% level

** = significant at 5% level

Restaurant ownership type and price of product have a significant effect on respondents' purchase intentions. Specifically, the probability of an independent or family restaurant buying the shrimp nuggets was significantly higher than for a provincial or national restaurant chain establishments. Managers of chain restaurant operations indicated having little control over the content of their menu. A central buyer or warehouse determines the content of the restaurant menu and restaurant managers simply have to fit their menu within the available product selection.

In general, the higher the suggested price, the lower the chances that a given restaurant will buy the product. Restaurant managers who selected prices at the higher end of the suggested range, probably belonged to the medium to higher class category that usually prepare their own meals from fresh ingredients and who were the least likely to use processed food.

The results indicate that years in business, restaurant size and whether or not an establishment already has imitation crab on its menu does not significantly influence the

odds-ratio in favour of predicting a given restaurants' willingness to buy the product. Menu, Type, and Experience in selling breaded fish products were not important determinants of the odds-ratio in favour of predicting restaurants that would buy the surimi-shrimp nuggets in the given sample of restaurants in the Montreal area. The estimated parameters are statistically not significant. Whether the establishment was a fast-food or full-service restaurant, whether it served mainly Asian dishes or not, and whether it had some or no experience in selling breaded fish products, did not significantly influence purchase intentions. Previous experience in selling breaded products does not affect the probability of a manager's intention to buy the product. Thus the hypothesis that, the product would find the greatest movements among establishments that identified their menu as mainly Asian cannot be supported from the results of the analysis. The potential scope of the market for the product cuts across all independent and family-owned restaurants and menu type does not offer any particular advantages in terms of product positioning on the restaurant market.

Summary and Conclusion

In order to deal with the twin problem of dwindling fish stocks and low processing efficiency of the Canadian (including Quebec) seafood industry, the potential of a value added, breaded and battered surimi-based product was tested for marketability and potential commercial acceptance. The product is made from shrimp broth extracted from shrimp processing by-products. A survey of restaurant foodservice operations in Montreal was conducted. The results showed that 50% of foodservice establishments would be willing to purchase the product for use in their operations. Of those respondents

who said they will buy the product, most indicated they were would be willing to pay a supplier/ wholesaler's price of $4.40 /kg of product. For respondents, the higher the unit-wholesale price over this threshold, the lower the odds ratio in favour of buying the product and the lower the market potential. Independent or family-owned restaurants were more likely to buy the product compared to chains or franchises. In the former case, the content of the menu is under the control of the unit managers. Restaurant chain managers and higher-end establishments that usually make a reputation from the culinary expertise of their chefs however, do not have that much control over the content of their menus and were the least likely to buy the product. The two most commonly cited reasons for this apparent lack of interest expressed by the high-end and chains were "Product doesn't fit menu theme" and "don't sell processed food".

Using their expertise and knowledge of consumer preferences, respondents evaluated the important product attributes as generally satisfactory. On the given 5-point scale where 1 was the least positive and 5 the most positive, product appearance was the least satisfactory, obtaining the poorest mean score (2.6). The scores for taste (2.53), aroma (2.51) and texture (2.15) followed in that order. Of these sensory attributes (taste, texture, appearance and aroma) respondents were more satisfied with texture than with any of the others. The average rating for taste, appearance and aroma were not significantly different from the other. The paired t-test on the differences between mean scores of pairs of attribute was significant only between texture and other attributes. The results showed that respondents gave a satisfactory rating to the texture of the product but indicated a significant lower score for the taste, aroma and appearance of the nuggets.

This study reveals that, contrary to conventional wisdom, a product made from waste material has potential for commercialization. As stated earlier, a sizeable proportion of the restaurant foodservice market in Montreal would be willing to buy nuggets made from shrimp processing by-product extracts. A significant proportion of the remainder was willing to try out a free sample in their operation before deciding (see appendix 1b). With further reformulation incorporating some of the suggestions of respondents such as "removing MSG" and making product into " burgers" instead of nuggets, the outlook for the potential market may be expected to improve. However, there are gains to be made if the current product is reformulated to improve taste, aroma and appearance to acceptable commercial standards. The decision to commit resources to large-scale conversion of shrimp processing by-products, however, must be made in conjunction with a thorough assessment of costs of production from a processors point of view and an indication of the relative profitability of any necessary capital investments over a definite planning horizon. Net product price is expected to be much lower than the $4.40 /kg obtained from the survey. Foodservice operators usually acquire their products from suppliers who act as middle-men between processors and operators. If it is assumed that, from processor to user, there is a 25 – 30% mark-up to cover suppliers' margin and processors distribution/ marketing costs, the true price of the finished product to the processor would be approximately $3.10 / kg. Based on this, potential financial feasibility can be assessed. However, from a potential product marketability point of view, there appears to be a modest potential on the Quebec restaurant foodservice markets, which is likely to improve with product improvement. The marketing challenge would be to overcome the negative image likely to result from the fact that certain ingredients in the

product are extracted from shrimp processing "waste" and also to convince consumers of possible health and safety concerns.

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Appendix 1A

Questionnaire

CONCEPT DESCRIPTION

The Surimi-shrimp nugget is the result of innovative work conducted by the Food Science Department at McGill University. The product was developed in response to the growing need for more value-added convenience seafood products among North American consumers that are becoming increasingly health conscious. Many consumers of seafood especially consumers of shellfish are gradually shifting to "imitation seafood" as these have all the benefits of "real seafood" but are less expensive. This product has the potential to satisfy consumers as well as provide a profitable alternative for the foodservice industry.

The main ingredients are:

Surimi (alaskan pollock)
Kamaboko
Shrimp broth
Calpro
MSG
Shrimp flavour
Batter mix
Bread crumbs
Vegetable oil
Spice mix
Wheat flour

To prepare the nuggets just deep fry at 300oC for 2-4 minutes until nuggets attain a golden brown colour. Serve hot either as main dish or seafood entrée.

SECTION A

1. Do you have fish or seafood as a main dish/entrée on your menu?
   ( ) Yes ( ) No

2. If yes, in a normal year what percentage of your total sales comes from fish or seafood?
   ( ) less than 50% ( ) about 50% ( ) greater than 50%

3. Do you serve **breaded** fish or seafood products on your menu?
   ( ) Yes ( ) No

4. If yes, please list the three **most important breaded** products on your menu in terms of sales.
   (i) .....
   (ii) .....
   (iii) .....

5. Which of the following **surimi** products (or imitation seafood) do you serve in this restaurant?

( ) imitation crab ( ) imitation lobster ( ) imitation salmon
( ) imitation shrimp
( ) none ( ) other (specify) .....

6. For each of the **surimi** products selected in Question (5) above, please indicate the average quantities in pounds purchased per week.

(i) Crab .....lbs (iv) Lobster..... lbs
(ii) Shrimp..... lbs (v) Salmon.....lbs
(iii) Other .....lbs ( ) None

SECTION B

(Please give us your opinion on the sample product.)

7. If your local supplier were to make the product available, which of the following package sizes would you prefer?

( ) 5lbs ( ) 10 lbs ( ) 15 lbs ( ) 20 lbs ( ) other (specify).....

8. Which size of nugget would you prefer?

( ) less than 0.5oz ( ) 0.5 oz ( ) 1 oz ( ) 1.5 oz
( ) 2 oz ( ) 2.5 oz ( ) other (specify) .....

Wholesale prices of processed seafood range from $0.99 per pound for some fish products to about $10.99 per pound for shellfish products.

9. If you were asked to suggest the wholesale price per pound for the surimi-shrimp nuggets, would you say.....?

( ) $ 1.00 /lb
( ) $1.50 /lb
( ) $2.00 /lb
( ) $2.50 /lb
( ) $3.00 /lb
( ) $ 3.50 /lb
( ) $ 4.00/lb
( ) other (specify) ..... /lb

10. At the price suggested above, would you buy the product?

( ) Yes ( ) No ( ) don't know

(Please evaluate the product before you answer Questions 11,12 & 13)

11. On a scale of 1-5, where 1 represents very satisfactory and 5 represents very unsatisfactory, rank the product on the following attributes.

Very Satisfactory ◄——————————► Very Unsatisfactory

Taste	1	2	3	4	5
Texture	1	2	3	4	5
Appearance	1	2	3	4	5
Aroma	1	2	3	4	5

12. Please give **two** suggestions on how the product could be improved to meet market standards.

.....
.....
.....
.....

13. If the quality of the product is improved by considering the suggestions given above, what are the chances that you will buy the product?

( ) certain
( ) good possibility
( ) fair possibility
( ) no chance, almost no chance

14. If **free** trial samples of the improved product were available from your supplier, would you consider using them in this restaurant?

( ) yes ( ) no ( )maybe ( ) no comment

15. Please look at the following reasons that might influence your decision **not to buy** the product if it were on the market.(Tick all that apply)

( ) don't offer seafood
( ) No established clientele for product
( ) patrons wont like the product
( ) don't own a deep fat fryer
( ) suggested wholesale price too low
( ) suggested wholesale price too high
( ) taste not good enough
( ) offer only fresh fish products
( ) product has too much fat
( ) doesn't fit within menu
( ) other.....

SECTION C

16. In which of the following categories does this restaurant fall? (please select **not more** than two responses)

( ) steak ( ) chicken ( ) Chinese ( ) Greek ( ) Italian
( ) Mexican ( ) hamburger ( ) pizza ( ) seafood ( ) other Asian
( ) Indian ( ) French ( ) hotdog ( ) Japanese ( ) Deli
( ) other (specify) .....

17. Please select the type of ownership for this restaurant.
( ) national chain ( ) provincial chain ( ) family-owned/independent
( ) other (specify) .....

18. What is the seating capacity of this restaurant? .....

19. On average, how many meals do you serve in a day? .....

20. How long has this restaurant been in business? .....

21. Would you say this restaurant is a ..... restaurant ?
( ) fast-food ( ) formal dinning ( ) casual dinning ( ) family
( ) other(specify) .....

22. What is the average dinner entrée price? .....
( ) over $25 ( ) $20 - $25 ( ) $15 - $20 ( ) $10 - $15 ( ) less than $10

23. How many full-time workers does this restaurant employ? .....

Thank you for taking part in the survey.

Appendix 1B

Comparison of selected responses between groups of survey respondents

Table 1B-1 Comparison of mean suggested supplier price level/kg of product as indicated by type of restaurant

		N		Mean	Median	Mode
Restaurant type		Valid	Missing			
Quick Service	price/lb ($)	17	3	2.2618	2.0000	2.00
Full Service	price/lb ($)	21	5	2.3571	2.5000	2.00
Total		38	8			

Table 1B-2 Comparison of mean ratings for product attributes as indicated by potential buyers and non-buyers.

	Buy/Not buy	N	Mean	Std. Deviation	Std. Error Mean
Appearance rating	1.00	16	2.4375	1.0308	.2577
	2.00	24	2.7500	.8969	.1831
Aroma rating	1.00	16	2.4375	.9639	.2410
	2.00	23	2.5652	1.2368	.2579
texture rating	1.00	16	2.2500	.9309	.2327
	2.00	25	2.0800	.6403	.1281
Taste rating	1.00	14	2.6429	1.0082	.2695
	2.00	20	2.4500	1.4318	.3202

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig.
Appearance	(Equal var.).	416	.523	-1.017	38	.316
	(Unequal var.)			-.989	29.123	.331
Aroma rating	Equa	.852	.362	-.346	37	.731
	Unequal var			-.362	36.442	.720
texture rating	Equal var	3.013	.090	.694	39	.492
	Unequal var			.640	24.079	.528
Taste rating	Equal var	2.239	.144	.433	32	.668
	Unequal var			.461	31.991	.648

CONNECTING SECTION

FROM MARKET TO PROCESSOR

The result from the market survey in the last section answered three basic questions relating to:

- whether there was a potential for marketing surimi-shrimp nuggets made from shrimp processing by-product in Quebec,
- the price at which potential users would be willing to purchase the product,
- what the determinants of product purchase intentions were and
- the ways in which the important product attributes were or weren't acceptable among respondents.

From the results of the analysis, there appears to be a potential for marketing the product among restaurant foodservice establishments in Montreal at net processors' price of about $3.10 per kg. Important product attributes were generally acceptable to restaurateurs in Montreal and independent and low-end foodservice outlets were the most likely to express a willingness to buy the product for use in their operations.

The existence of a potential market alone however, does not imply successful commercialization of the new technology. Determining whether there was a market for the product and the likely market niche was indeed the first step in the process of assessing the feasibility of the potential for commercialization. Having established the existence of potential demand and the most likely price point, an assessment of the costs of production is important to more generally conclude on the question of whether or not it makes economic sense to attempt to commercialize the technology. Specifically, plant

requirements and production assumptions must be examined and the unit production cost determined. If the product cost more to produce than consumers are willing to pay per unit, then there must be some other justification why processors or investors may want to experiment with a product that would not initially recover outlay. However, if, as expected, average product cost is less than the net processors' price, then the margin of total revenue over total cost (annual gross profits or cash inflow) over a definitive period must be compared to the cost of the required investment. If expected benefits from investment in the new technology outweighs initial costs over this period, then investment in this new technology would appear feasible. Otherwise, investors and processor's are better off putting their money in alternative investments.

In the subsequent sections, cost estimation techniques are applied to a proposed expansion in a seafood processing plant to include a shrimp nugget processing line. Based on the earlier market survey and previous laboratory work, investment and operating expenditure is calculated and used to determine average product cost assuming a commercial industrial plant capacity. Standard investment analytical methodology are then applied to the computed annual cash flows to determine overall investment profitability under different output and price sensitivity scenarios.

CHAPTER FOUR

FINANCIAL FEASIBILITY OF PRODUCING VALUE ADDED SEAFOOD FROM SHRIMP WASTE IN QUEBEC

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Abstract *Shrimp waste disposal represents a financial and environmental cost to processors and society. Attempt to extract certain industrial ingredients from shrimp waste are yet to make any significant commercial impact. This paper uses discounted cash flow methods (NPV, IRR) and the payback period criteria for project selection, to assess the returns to investment in a technology that transforms shrimp processing waste into value added surimi-shrimp nuggets.*

The planned extension was estimated to cost $4.3M in capital investments and can process an estimated 5000mt of shrimp nuggets per year at $2.62 /kg. If the plant operates at full capacity (5400hours per year) for 10 years, it will recover initial outlay and interest payments in 2.3years with a net present value of $6.9M and an internal rate of return of 43%. The expected values of net present value, internal rate of return and the payback period for the project, given varying output levels, were $3.27M, 26% and 3.9 years respectively

Introduction

The seafood industry is a very important sector of the Quebec economy, injecting close to a billion dollars, in expenditures, incomes and tax revenues into the economy annually. In addition it provides over 11000 jobs for people mainly in Quebec's maritime region. It is estimated that, on the Gaspesie peninsula, the region in Quebec that provides close to half the value of the entire province's fish landings, 1 out of every 6 jobs is related to the seafood industry network (Dupuis 1997). Over the past decade, total fish landings have consistently declined in volume though the value has been on the rise. Over the past decade, total landings consistently declined from 82000mt to 52000mt in 1998. Value of landings, on the other hand, trended upward from $83million to $103million over the same

period. This seemingly contradictory observation reflects an important change, taking place in the dynamics of the seafood industry in Quebec. The entire industry has shifted its focus on shellfishes (and mollusc), mainly crabs, lobsters and shrimps, which due to its higher value explains the rising value of landings observed in the past decade. The moratorium imposed on Canadian groundfishery almost a decade ago is partly responsible for the decline in volume of landings and the relatively lesser importance of groundfish to the industry. The rising values of landings, however, have done little to compensate for the negative socio-economic effects of the collapse in Canadian groundfishery.

Small processing firms along the East Coast of Quebec (and along the Canadian maritime region) suffer from seasonal inactivity. In the winter, when harvesting is officially closed, many of these firms cease processing while still carrying plant overhead costs. Some have successfully innovated value added processing to ensure year round activity (Higgins 1997). In the Gaspesie region of Quebec, for example, seasonal processing activity implies higher rates of unemployment and lower annual returns on capital. By identifying new technology or innovative ways to more efficiently utilize fish harvests, these firms might increase potential returns and create more reliable year round employment for plant workers.

New technology to manufacture value added surimi-shrimp nuggets from shrimp processing waste has been developed by food scientists at McGill University (Lyver 1997) and its market acceptability tested (Amankwah et al 2000). The quantities of waste generated and the need to recycle have been documented (Teftal 1999). However, technical feasibility and market acceptability alone, does not drive the investment required in new product introduction. Skinner (1972) observes that at any point, there exists

several "redundant technologies" which do not go farther than the research laboratory. Firms, as profit maximizers, tend to choose the best among competing alternatives. Thus, shrimp processors and owners of capital can be expected to embrace new technology, only if there is incentive for them to do so. To assist them in this decision making process, plant owners and product managers must have a clear projection of the costs involved and the benefits expected from the investment as compared tothe alternative uses of capital.

Capital budgeting techniques have been used extensively in the economic and financial literature to tackle problems of investment analysis. Since firms are constantly in the business of making new capital investments and expanding existing ones, several authors have discussed the application of capital budgeting techniques to investment analysis in the literature. Discounted cash flow methods have found the widest use among economists in the assessment of the economic worth of investment projects. The ones that are most widely known and used are Net present value (NPV) and Internal rate of return (IRR). Casler et al (1984), and Bierman and Schmidt (1984) have discussed the NPV and IRR in capital investment projects and Schall et al (1978) have surveyed the use of capital budgeting techniques by US firms. Beke et al (1996) have used NPV and IRR to assess the financial acceptability of producing steam and electricity from forest biomass while Gunjal et al (1999) used it to study the feasibility of minimal processing of fish and pork in Quebec. The problems relating to the use of these discounted cashflow methods have been highlighted and addressed by Martin (1997).

Cost estimation is the identification and compilation of all the costs of the elements included in a proposed project (Nelson et al 1991). There are several ways of obtaining cost estimates of capital projects. Most involve the use of data from company records and

from manufacturers and equipment and services suppliers. For any given size plant, the cost capacity factor proposed by Williams (1960) can be used to estimate costs of major pieces of equipment where market price information is not readily available. Cost-capacity factor estimation has been used to scale up cost of major process equipment in engineering (Remer and Chai 1990) and pharmaceutical industries. Zugarrramurdi (1991) applied cost capacity factor estimation to fish processing plants and Parin and Zagarramurdi (1994) have computed the cost capacity factor for the fisheries products industry. Teftal (1999) has used cost-capacity factor to estimate the production cost of producing chitin and chitosan from shrimp waste at the pilot plant level.

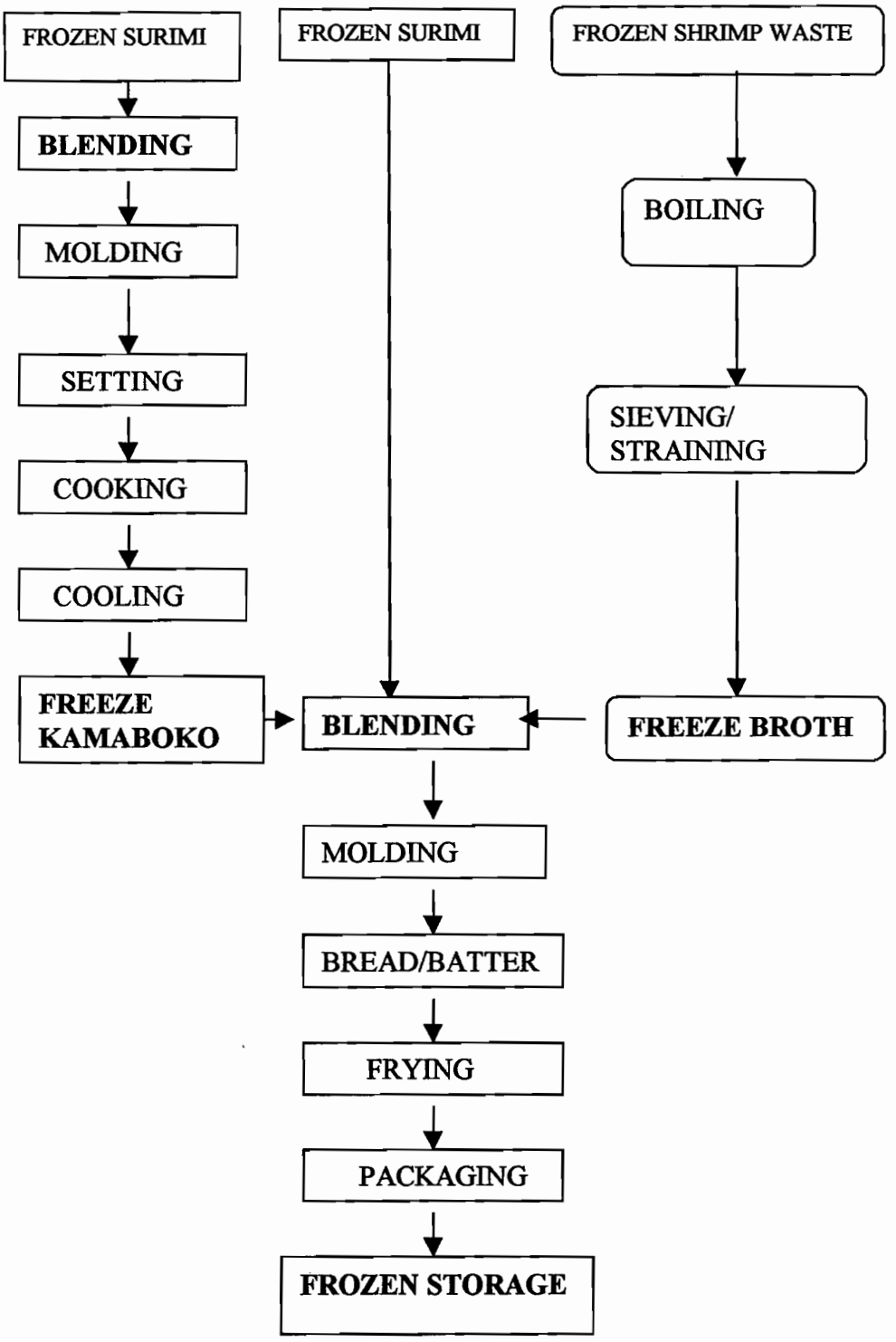
This paper analyzes the costs and benefits expected from an investment in a new technology to produce edible seafood from shrimp processing by-products. Specifically, it presents investment and production cost estimates and a financial assessment of the economic viability of the proposed investment by using a combination of capital budgeting techniques to examine three possible cash flow and profitability outcomes. The expected values of the criteria used in the investment analysis are calculated to express the underlying project uncertainty.

New Food Product Technology

A process flow diagram for making value added seafood from shrimp by-products is presented in figure 2. The technology was developed by Food Scientists at the Macdonald Campus, McGill University, Montreal,Quebec, (Lyver 1997).

Frozen surimi blocks are received in a holding area and portions of it are sliced, weighed and blended together with specific ingredients in the bowl cutter to commence the process of Kamaboko preparation.

Figure 2 **Process flow diagram for processing value added seafood from surimi and shrimp waste.**



Source: Lyver (1997)

Kamaboko is an intermediate product used as a gelling agent in product formulation. The soft gelatinous material that result is molded, heat-set in warm water and cooked for 15min at a temperature of 90°C. After cooling, the gel is kept frozen for later use.

A fresh batch of surimi is again blended with appropriate mixture of ingredients and shrimp broth (Figure 2) and measured quantities of kamaboko to give a jelly like substance. This is then molded, extruded, battered and breaded before deep-frying for 2 min to set the crumbs. The product is packaged and frozen for distribution. The details of the product formulation and subsequent safety studies conducted by the scientist are discussed elsewhere by Lyver 1997, Lyver and Smith 1998, and Lyver et al 1999).

Plant Requirements and Layout

The proposed investment consists of adding a surimi shrimp processing line to an existing shrimp processing plant. The purpose of the proposal is to provide interested processing firms the option of expanding their operations and generating more employment and revenue while reducing waste pollution at the same time. The following assumptions were made about plant requirements and operation in order to simplify computations:

- The extension is made to shrimp processing plant in Montreal. All production costs not directly affected by the proposal are assumed to remain unchanged.
- The proposed machinery and equipment requirement of the additional line is similar to the generic pattern in used by value added seafood processing plants.
- Construction of the line and accessories is completed in year zero and production commences the following year over a 10-year planning horizon.

The plant would obtain shrimp by-products mostly waste from its operation and from other nearby operations (for a fee). The other major ingredients are available from local suppliers. The finished product is expected to be distributed along with other products of the firm in addition to the development of new marketing channels to increase product distribution. In the early stages of the product, expensive investments in packaging and advertising may not be absolutely necessary in the sale of the product to foodservice and institutional outlets. Furthermore, investment in new (food product) technology is the least likely to appear attractive if the required initial outlay appear prohibitive, given that the failure rate of new products in general is unusually high. Therefore, to ensure the greatest chance of success in the early stages of product introduction, the product would be distributed in 4-5kg units packaged in cartons suitable for distribution in the foodservice and institutional markets.

Plant setup, capacity and operational requirements were determined from secondary sources and from conducting interviews with food processing industry professionals as explained in the next sections.

Investment Cost Model

To compute the total investment in equipment required for the proposed plant, the concept of cost capacity factor was applied to actual historical cost data from an existing plant producing value-added products. Cost and capacity data for the major processing equipment was obtained from the company records of a seafood-producing firm in Metropolitan Montreal.

Using the technique of cost-capacity factor estimation (Williams 1960), the total investment (Cx,Ck) for two plants or equipment with different capacities of production(Ex,Ek) but producing the same product is given by the formula:

$$C_x = C_k \left[\frac{E_x}{E_k} \right]^{ccf} \qquad (1)$$

where,

C_x = unknown cost of equipment

C_k = known cost of similar equipment

E_x = capacity of new equipment

E_k = capacity of similar equipment

ccf = cost capacity factor.

A list of the required plant equipment was taken from the equipment list in the proposed plant layout (see Figure 3 in Appendix A). For a particular industry, the precise exponent in equation (1) can be determined by plotting graphs of historical cost-capacity data. Parin and Zugarramurdi (1994) estimated the ccf for fish processing plants to be 0.846, which implies that there are gains to be made by increasing plant size.

Using this relation and the estimated cost capacity factor of 0.846 for fish processing plants (from the literature), the total equipment cost for the proposed plant was estimated after adjusting for inflation in the equipment cost data using equipment cost indices. Data for the industrial equipment price indices were obtained from the Construction Price Indices data published by Statistics Canada (Statistics Canada 2000). Cost of 1400m^2 of industrial space in Metro-Montreal was obtained from Royal LePage

Real Estate Developers. This area represented only factory space and warehouse facilities, plant services such as administrative buildings and parking space are assumed to be unaffected. Cost of construction of the required industrial buildings was estimated using per unit construction cost computed by Gunjal et al (1999) for a similar project in this area. The unit cost of constructing a modern fish processing facility complete with piping and utilities installation computed in the earlier study was inflated to its present day nominal equivalent by using the Non-residential Building Construction Price indices published by Statistics Canada (Statistics Canada 1998). The required space was then estimate from actual company records to obtain total cost for buildings.

Working capital and manufacturing cost estimation followed a review of existing company data and from industrial guidelines published in the literature as reviewed by Black (1991). Variable costs including costs of all ingredients, packaging material and utilities were assessed at the market price per unit and quantity required, given the plant output capacity and data from the laboratory product development. Overhead like lighting, heating, and fixed overhead including plant insurance, real estate taxes and depreciation were obtained from company records. In computing the expected sales revenue, product price was obtained from an earlier market survey of potential users of the product (Amankwah 2000).

Returns to Investment

To analyse the returns to investment, a combination of investment analysis criteria was used. Payback period, Net present value and Internal rate of return were applied to the estimated annual after-tax cash flow for the investment over a 10-year planning horizon.

Payback Period

The payback period is defined as the length of time required to recoup the initial capital investment from the revenues expected to accrue from the investment proposal.

That is:

$$PBK = \frac{C}{R} \tag{2}$$

where

PBK = payback period of the investment proposal

C = amount of capital required for the investment

R = the additional average after-tax income before depreciation, expected from the investment.

The payback period is frequently used to provide additional insight into the desirability of a particular investment. It is a complimentary criterion used very commonly in practice to augment other discounted cash flow (DCF) methods (Schall et al 1978), especially in projects that have unusually high levels of uncertainty or that have a high chance of becoming obsolete (Casler et al 1984). The acceptable payback period is subjective and depends on the type of project, but for most industrial concerns, maximum PBK range from 2-5years (Bierman and Schmidt, 1984).

Net Present Value

Net present value (NPV) is defined as

$$NPV = \sum_{t=0}^{n} A_t (1+r)^{-t} \tag{3}$$

where,

A_t = net cash flow (revenue minus expenditure) in period t

A_0 = the initial capital expenditure, and it is negative.

A_n = net cash inflow at the end of the planning period and includes terminal values.

r = discount rate or minimum acceptable rate of return. In this study r is equal to 10.41%.

n = expected economic life of the investment.

First, the no default rate (risk free rate), is approximated by the rate of return on 5-10 year government of Canada marketable bonds. The average yield of 7.43% on these government bonds was computed over the period 1990 to 1999. Then it was converted to real returns by subtracting average annual rate of inflation, 2.02% computed over the same period. In order to calculate the minimum acceptable rate of return, Gunjal et al (1999) have used premium of 2% for investment in a minimal processing (low risk) fish and pork plant in the study area. Given the high level of expected risk in marketing this product and the fact that, about half of all new products introduced in the market fail, a 5% risk premium was thought to be sufficiently high enough to compensate for the high probability of product failure. And therefore, a risk premium of 5% was added to the required real rate of return to obtain the real discount rate of 10.41% (7.43% - 2.02% + 5%).

A positive net present value indicates that an investment proposal will yield a stream of returns greater than the initial outlay required to produce it. A negative net present value, on the contrary, implies that the cost of investment required for the project exceeds the maximum amount the investor could possibly recover. Thus, the rule says to accept all projects with a positive net present value and reject project in which the net present value is negative.

Internal Rate of Return

Following from equation (3) above, The internal rate of return, δ, or that rate of discount that equates the present value of the expected net revenue stream of the project to its initial outlay, is given as:

$$NPV = \sum_{t=0}^{n} A_t(1+\delta)^{-t} = 0 \qquad (4)$$

where,

δ = internal rate of return and all other symbols have the same meaning as in equation (3).

The internal rate of return "represents the highest rate of interest an investor could afford to pay, without losing money, if the all the funds for the investment were borrowed and the loan was repaid by application of the cash proceeds from the investment as they were earned" (Bierman and Schmidt 1984). In using this criterion, the decision rule says to accept all projects with an IRR greater than the minimum acceptable rate of return. The IRR was obtained by solving equation (4) iteratively, using the "IRR" financial function of Microsoft Excel spreadsheet application.

Risk and Uncertainty

New product introduction is fraught with a high risk of failure and many uncertainties in the recovery of investment and in reaching profit projections. One method by which one can account for the inherent risks in a project proposal is to adjust the so-called "hurdle rate" so that more riskier projects tend to be discounted more heavily than those perceived to be of lesser risk. Thus given the default-free interest rate adjusted for inflation, a risk premium, corresponding to the degree of risk thought to be inherent in the investment, is added such that the NPV of riskier investments are adjusted accordingly. The problem, though, is the selection of the risk premium to adequately reflect the degree of risk perceived to be inherent in the proposal. The decision remains entirely subjective and rather arbitrary. There is no easily used formula for guiding the researcher other than informed judgement and managerial intuition (Casler 1984). Therefore, a 5% increase in the default-free real rate of return was chosen as the premium to represent project risks.

To address possible uncertainties about the future cash flow streams, due in part to production uncertainties, a range of possible cash inflow scenarios (optimistic, most likely and pessimistic production outcomes) were analysed. The expected result were subjected to sensitivity analysis to test the robustness of the predicted outcomes to shocks in product and raw material prices and interest rate.

Results and Discussion

The results of the production cost estimation are summarized under the following sections.

Proposed Plant and Layout

The proposed line will produce 5000t of shrimp nuggets from 361t of shrimp waste per annum, and will operate for 24 hours for 225 days per year. The plant has capacity to produce other breaded value added products. The plant extension will occupy a space of 1400m^2. Office and managerial facilities are assumed to be already present. The space proposed will cover actual production space, warehousing and additional workers facilities. The layout of the plant line is presented in Figure 3 (Appendix 2A). The components of the proposed line, representing the industrial equivalent of the equipment used in the laboratory are listed in the appendix 2C. It was anticipated that, except in cases where there are automated packaging equipment already installed, it would be best to commence production with manual packers and change to full automation once the market for the product becomes established.

Investment Cost

The results of estimating the required fixed capital investment cost are presented in Table 4.1. Industrial land in Metropolitan Montreal was estimated to cost \$27/ m^2. For the additional space required, cost of land was calculated to be about \$38000. Machinery and equipment cost together add up to a total of \$2,505,000, purchase and installation. Extra building space, including all additional or new wiring, piping and heating installation was estimated at \$1,442,000, based on a unit (fish processing plant) construction cost of

$1029.84/m2. Building rental and purchase options were considered as alternatives, but were either impractical or relatively more expensive over the long term.

Table 4.1 Estimated capital investment cost for surimi/shrimp nuggets processing line in an existing seafood processing plant in Montreal

Investment Item	Cost ($'000)	Percent
Land	38	1
Buildings	1,442	36
Machinery and Equipment	2,500	63
Total *	3,980	100

* Excludes working capital

Total fixed capital investment cost was estimated to be approximately $4 M. Working capital requirement to cover items such as raw material purchases, wages, supplies, was computed at 10% of depreciable investment cost (Nelson et al 1991) bringing the total investment needs for the proposal to about $4.3M.

Cost of Processing

Table 4.2 summarizes the cost estimates for the 5000t capacity processing line. The proposed expansion will require a total of $13.1M to operate annually. For each dollar spent on processing, material cost (raw material ingredients and packaging) alone account for $0.91. Labour, repair and maintenance costs, fixed plant overhead and others, (except for production utilities), account for $0.02 each, per dollar spent. The remaining cent is spent on electricity and heating. It will cost the firm $2.62 to process each kilogramme of surimi/shrimp nuggets at the plant level. Six cents out of the cost/kg is fixed and would increase for each unit, if the plant operates at less than the 5000t maximum capacity. The remainder, ($2.56) will not be affected by level of output.

Table 4.2 Annual total and per unit processing costs of a surimi/shrimp nugget processing line in an existing plant in Montreal, Quebec

Item	$ ('000)/year	$/kg	%
Materials			
Ingredients[1]	9186		
Packaging	2756		
	11942	2.40	91.0
Labour			
Direct	167		
Supervision	29		
Payroll	93		
	289	0.05	2.0
Utilities			
Electricity[2]	52		
Heating	62		
	114	0.02	1.0
Repairs and Maintenance	**233**	0.05	2.0
Other fixed costs			
Depreciation[3]	259		
Taxes[4]	30		
Insurance	8		
General[5]	8		
	305		
		0.06	2.0
Other[6]	**229**	0.04	2.0
Grand Total	**13112**	**2.62**	**100**

1. Includes raw material and intermediate products
2. 80% of electricity is for direct production.
3. 6% straight-line depreciation method used.
4. Real estate taxes include charges for water use
5. Increase in general plant overhead due to the expansion
6. Comprises supplies, quality control and sanitation.

Columns 3 and 4 in Table 4.3 depict what happens to the cost of processing as level of output is reduced. When the plant is operated at two-thirds capacity (running double instead of a tripple shift), total annual cost of production is reduced to about $8.8M and to $4.6M for a single shift operation. However, since fixed cost of production remains unaffected by changes in level of output (variable cost), cost/kg increases by some

$0.03 ($2.65) and $0.12 ($2.74) respectively. These changes represent a 1.1% and 4.5% increase over operating cost at full capacity.

Table 4.3 Effect of level of output on unit cost of production for a surimi/shrimp nugget processing line in an existing plant in Montreal, Quebec

Item	Annual cost per level of output ($)		
	100% capacity	66% capacity	33% capacity
Materials	9186000	7961000	3980000
Labour	289000	193000	96000
Utilities	114000	75600	37800
Repairs & Maintenance	233000	156000	78000
Overhead	305000	305000	305000
Others	229000	152000	76000
Total	13112000	8843000	4573000
Cost/kg	**2.62**	**2.65**	**2.74**

Profitability analysis

The results of profitability analysis based on three possible output assumptions (hours of operation) and cash inflow assumptions are presented in Tables 4.4 to 4.7

The optimistic assumption supposes that the plant is operated at maximum capacity (5000mt or 5400 hours/annum) over the entire life of the investment. On the contrary, a pessimistic view assumes that, plant output never really reaches maximum (due probably, to the product's inability to penetrate the value-added seafood market) but borders on a level barely sufficient to cover processing costs. The most likely outcome assumes a blend of these two extremes would actually occur in practice. Plant production is maintained at about two-thirds capacity (3300mt or 3600 hours/annum) for the duration of the investment. In general, we assume that, production starts in year 1 and all product

produced each year, is sold. Further, it is assumed that the plant is operated in such a way that, average level of output corresponds to one of the three possible production assumptions. The mean effect would therefore represent a plant which operates over its life span at varying capacities depending on market conditions for its product and other production constraints. The calculation of the annual cash revenues and subsequent profitability analyses are based on calculating expected values using a measure of the likelihood of occurrence of each production assumption. The net annual cash flow streams expected under each production assumption are presented in Table 4.4.

Table 4.4 Projected net annual earnings for surimi/shrimp nugget processing line operating at a maximum output of 5000mt, 3300mt and 1700mt in an existing seafood processing plant in Montreal, Quebec

Output	Optimistic[a] (full capacity)	Likely[b] (Half capacity)	Pessimistic[c] (1/3 capacity)
Net annual sales[d]	14,765,000	9,843,000	4,922,700
Processing expenses	12,806,000	8,537,000	4,269,000
Fixed overhead[e]	46,000	46,000	46,000
Net ann. cash flow	1,913,000	1,260,000	633,000

a. Optimistic = operation for 5400hours/annum or production at maximum plant capacity (year 1-10)
b. Likely = plant operated for 3600 hours or plant producing 3300mt of product per annum.
c. Pessimistic = plant operated for 1800 hours or plant producing 1700mt of product per year.
d. Net sales = sales receipts less distribution charges. Net processor's price = $3.10 (Amankwah 2000)
e. Fixed overhead excludes annual interest and depreciation charges

Estimated net annual cash flow was $1.91 M full capacity operation assumption. This amount is reduced to about $1.30 M for a 3600 hours annual operating time, and $0.60 M for the 1700mt annual output operation. For each of the processing output assumptions listed in Table 4.4, the net annual cash flow is an equal amount for planning period. Cash inflow for year 10, however, will include the terminal value of all depreciable project assets (assumed to be 15% of initial market value). All three output possibilities have a net positive annual cash flow.

Estimates of the desirability of the project under the different output assumptions and expected values, based on the likelihood of occurrence of each possibility are presented in Table 4.5.

Table 4.5 Profitability estimates of a surimi/shrimp nugget processing line in an existing seafood processing plant under three different production assumptions and expected values

Potential Output	Likelihood [4]	Payback period PBK(years)	Net present value($'million	Internal rate of return
5000mt (Optimistic)[1]	0.2	2.3	6.9	43%
3300mt (most likely)[2]	0.5	3.3	3.6	28%
1700mt (Pessimistic)[3]	0.3	6.7	-0.2	9%
Expected value		4.2	3.1	25%

1. Probability distribution is based on discussions with seafood processing industry professionals.
2. NPV computed at 10% discount rate

The most optimistic production outcome assumes maximum production and constant cash flow for the planning period. The PBK period is 2.3 years, NPV is $6.9 M and the computed IRR is 43%. Conversely, the pessimistic assumption, based on minimal profitable annual production, recovers investment capital in 6.7 years. However, over the period of the investment, the discounted cash flow stream gives an NPV of -$152,000 and a lower than required rate of return (9%). The PBK, NPV and IRR for the scenario based on the most likely production assumption are 5years, $3.6M and 28% respectively. However, since each plant output assumption has a certain likelihood of occurring, probabilities are assigned to each scenario and the expected values of PBK, NPV and IRR are computed. The probability distribution reflects the relative likelihood of operation at or

below maximum capacity and it was arrived at in consultation with seafood industry professionals.

The expected value of the payback period for the proposal is 4.2 years. The expected NPV is $3.12 M and the expected value of the IRR is 25.3%. The results show that, given a cost of capital of 10%, the likelihood of each of the plant line operating at or below maximum capacity, an investor could afford to pay $3.12 M over the required plant investment and not be economically worse off. The shrimp nugget-processing line, if added to an existing plant, has the capacity to repay all borrowed funds from project proceeds if the cost of capital were 26% and it would recover initial investment outlay in less than five years. Based on this result, therefore, an investment in the proposed technology appears desirable.

Sensitivity analysis

The robustness of the results above was tested by analysing how unexpected shocks in prices and interest rate will affect project desirability. Shocks were applied to projected production costs, sales receipts and the discount rate. For a 10% change in product and raw material prices and one percentage point change in the discount rate, the changes in estimated project profitability are summarized in Tables 4.6

Table 4.6 Sensitivity analysis of profitability estimates of a surimi/shrimp Nugget processing line in an existing seafood processing plant in Montreal, Quebec

Potential shock	Expected values		
	PBK (years)	NPV[b] ($'000)	IRR (%)
Base run[a]	4.2	3,120	25
Product price increase by 10%	2.2	9,000	51
Product price decrease by 10%	23.0	-5,075	-5
Raw material price increase by 10%	11.2	-1,020	2
Raw material price decrease by 10%	2.58	7,230	44

a. Results at current market prices of raw materials and net product price of $3.10/kg
b. NPV computed at 10% discount rate

Table 4.6 show that the profitability results obtained for the investment proposal will show a mixed response to unexpected shocks to prices. A 10% increase in projected product price has a similar effect on profitability as a 10% decrease in the price of raw materials just as the effect of a 10% decrease in product price reduced project profitability in the same direction as a 10% increase in price of raw material and ingredients. However, the magnitude of the reduction in NPV resulting from a 10% change in net product price is much more pronounced than the change in NPV due to a 10% change in raw material prices. A 10% increase in product price increases project NPV to $9.0 M compared to an NPV of $7.23 M for a 10% decrease in raw material prices. Internal rate of return in the former case increased to 51% with a new PBK of 2.2 years while IRR in the latter case was calculated to be about 44% with a corresponding PBK period of 5.2 years

Conversely, the base run results appear very sensitive to negative product price shocks and raw material prices increase. A 10% decrease in net product price or a 10 % increase in raw material prices have the potential to render the proposal unacceptable under the assumptions of the study. In both cases, NPV is negative implying that the

potential investor will be financially worse off with a potential loss of over -$1.0M or -$5. 0M depending on whether product price decreases or raw material prices increase by 10%. The expected IRR is less than the minimum acceptable rate of return (10%) and the PBK are longer 10 years.

Sensitivity analysis on the rate of discount shows that the feasibility of the proposal is unaffected by a percentage point change in interest rates. The base run NPV ($3.12M) changes by a slight margin the real discount rate is 9% or 11%. Thus, though a 10% increase in product price, a 10% decrease in prices of raw material or a percentage point change in the real discount rate will lead to no change in the financial acceptability of the shrimp nugget project. A 10% reduction in the price per kg of final product or a 10% increase in raw material prices, however, could make the proposed investment undesirable under the study assumptions.

Summary and Conclusion

Each year, a sizeable proportion of the shrimp catch in Canada is discarded as processing waste. In the province of Quebec, it is estimated that, about 90% of all shrimp landings are processed; of this amount 70% –75% end up as some form of waste in already overloaded municipal landfill sites and in various aquatic bodies. The scarcity of landfill sites and the attendant pollution problems resulting from aquatic disposal of this ever- increasing source of pollution, prompted food research scientists to investigate the possible utilization of this "resource" into edible food to satisfy the increasing demand for more affordable seafood products. The technology for the transformation process has been proven technically feasible and the resulting product, certified as safe within stipulated

guidelines. A description of the product and its manufacturing process, as well as reports of the thorough scientific tests that were conducted to assess product safety are discussed elsewhere in other scientific journals (Lyver 1997, Lyver et al 1999).

This paper examined the production cost structure and the returns to investment for a proposed plant extension to incorporate a surimi/shrimp nugget processing line. The planned extension was estimated to cost $4.3M in capital investments; and will process an estimated 5000mt of shrimp nuggets per year at $2.62 /kg. If the plant operates at full capacity (5400 hours per year) for 10 years, it will recover initial outlay and interest payments in 2.3years with a net present value of $6.9M and an internal rate of return of 43%. If, however, market circumstances force plant operation to be reduced to 3600 hours (producing 3300mt of final product) or 1800hours (producing 1700mt) per annum, then the PBK, NPV, IRR correspond to 3.3 years, $3.6M and 28% in the former case, and 6.7 years, -$0.2 M and 9% in the latter. The expected values of net present value, internal rate of return and the payback period for the project, given these assumptions, were $3.27M, 26% and 3.9 years respectively. Assuming a cost of capital of 10%, therefore, the proposed expansion appears desirable. If the assumptions about raw material prices and unit product price were to change within a 10 percentage point range, the acceptability of the project will not be affected except for a 10% decrease in the price of final product or a similar increase in the prices of raw material. A one-percentage point change in the cost of capital did not significantly alter project acceptability.

It may be concluded therefore, that an investment in the construction and operation of a facility to process shrimp waste into value added seafood represents an attractive financial investment and is likely to repay all investment capital and interest and

return rewards to investment under the assumptions of this study. The results as obtained are applicable to plant expansion located within the selected area. It is assumed that, the proposal relates to expanding operations of an existing seafood processing plant. Where a separate plant is to be used or a location is selected other close to an existing seafood plant, consideration must be given to excessive transportation cost and possible spoilage problems. Therefore if establishments located at relatively long distances away from the source of raw material must take these considerations into account.

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CHAPTER FIVE

SUMMARY AND CONCLUSIONS

5.1 SUMMARY

Though shrimp landings have been on the rise in Quebec and in Canada over the past decade, much of this premium seafood is wasted during processing. Shrimp processing involve the removal of about 70-75% of the raw product in order to obtain the finished product. The tons of waste thus generated has been the subject of many scientific investigations since the requirements of fish meal production excludes nearly all shellfish processing waste from this method of waste recovery. The other alternatives to fishmeal production - composting and extraction of industrial ingredients from shrimp waste are yet to make significant commercial impact. The seafood processing industry, meanwhile, suffer from seasonal inactivity and the difficulty of getting adequate supplies outside the traditional harvesting season. Further, several jobs have been lost as the industry continues to undergo structural changes and reorganization after the collapse of the Canadian groundfishery. On the positive side, however, there appears to be an expanding potential on the demand side of the market as more and more consumerscontinue to add seafood products to their diets to reflect increasing awareness of the dangers of other alternative sources of protein especially red meat.

In this study, the economics of producing value added seafood products from shrimp processing by-products was examined. The potential marketability of the product and its suitability for commercialization was first tested in a survey. After a thorough evaluation, using their expertise and knowledge of consumer taste and preferences,

foodservice professionals saidthat the important product attributes were generally satisfactory. On a given 5-point scale where 1 was the least positive and 5 the most positive, product appearance obtained the highest mean score (2.6). The scores for taste (2.53), aroma (2.51) and texture (2.15) followed in that order. Of the four attributes, taste, texture, appearance and aroma, respondents were more satisfied with the texture of the product than with any of the others. The average rating for taste, appearance and aroma were not significantly different from each other. Results of the paired t-test on the differences between mean scores of pairs of attribute was significant only between texture and the other attributes implying a satisfactory rating for product texture but a significantly lower satisfactory rating for the other attributes. For all respondents, the higher the unit-wholesale price above some general threshold, the lower the odds ratio in favour of buying the product and the lower the market potential. Independent or family-owned restaurants were more likely to buy the product than national or provincial chain establishments. The content of the menu at the former restaurants is under the control of the unit managers. Restaurant chain managers and higher-end establishments that usually make a reputation from the culinary expertise of their chefs, were the least likely to buy the nuggets. "Product doesn't fit menu theme" and "don't sell processed food" were the two most commonly cited reasons for this lack of interest expressed bysome of the high-endestablishments and chain outlets. The results of the market survey, however, indicated that 50% of foodservice institutions were willing to purchase the product for use in their operations at a suggested wholesale (supplier) price of $4.40 per kg.

The shrimp processor could also expand operations to supply shrimp nuggets to the market. The proposed plant expansion required to include a surimi shrimp processing

line would cost $4.3M to install. Its installation would allow a firm to process 5000mt of surimi-shrimp nuggets from about 500mt of shrimp waste per year at $2.62 /kg. From the results based on a net processor's price of $3.10 (Amankwah 2000), it is expected also that if the plant operates normally for a 10- year period, it will recover initial investment and interest payments in 4.2 years. The net present value, given a cost of capital of 10% is $3.12 M with an internal rate of return of 25%. If the assumptions about raw material prices and unit product price changes within a 10 percentage point range, the acceptability of the project will not be affected except for a 10% decrease in the price of final product or a similar increase in raw material prices. Also, a one-percentage point change in the cost of capital did not significantly alter project feasibility.

5.2 CONCLUSION

The study has revealed that, contrary to conventional wisdom, recovery of value from processing by-products holds a modest potential for commercialization and industrial production. There appears to be a sizeable proportion of the foodservice and institutional market willing to buy the product for use in their operations. A significant proportion of the remainder was willing to try out a free sample before deciding (see appendix B). With further reformulationand incorporating some of the suggestions of respondents such as "removing MSG" and making product into " burgers" instead of nuggets, the potential market outlook may be expected to improve. Results of the production cost estimation and investment analysis also indicate that expanding a commercial shrimp processing plant to include reprocessing of by-products into value added breaded and battered seafood is economically feasible. Processors can produce below the expected market price for the

product adjusted for marketing costs and supplier mark-up and the net annual pre-tax income that accrue to investment can repay initial outlay and interest charges over a 10-year planning period. However, foodservice and subsequently retail markets acceptance of the product would be the main challenge for this and any product made from seafood (food grade) waste material. Since "consumers like to know what they are eating", marketing and promotional tools would have to be developed to improve product image and to promote the use by foodservice outlets in order to pave way for a possible retail market entry.

With the decline in Canadian wild fisheries and the subsequent institution of several moratoria and stock management policies, the proposal to construct and operate a facility to process shrimp processing waste into value added seafood represents an attractive financial investment. The proposal is likely to repay all invested capital and return rewards to investment if the product becomes acceptable in the local and overseas markets.

5.3 IMPLICATIONS OF THE STUDY

The finding of this research indicate that shrimp processors could expand their operations to include an additional line to process by-products into value added seafood. The technology appears to be technically and financially feasible under the assumptions of this study. If the product penetrates the domestic foodservice seafood market well enough, production could be expanded to service high-volume grocery retail and processed seafood export markets. If the technology is adopted, processors would be extracting more value from dwindling stocks and reducing environmental waste pollution while creating much-needed employment in the process.

5.4 LIMITATIONS OF STUDY

There were two major data limitations that were encountered in the course of the study and its correction in any further studies would improve the results obtained here.

The first relates to respondents for the market survey. The foodservice and institutional markets include restaurants, institutional feeding programs like hospitals, plants and school lunches. Though some of the institutional establishments mentioned were in the sampling frame, that the data collection was done over the summer months meant that most school lunch operations were closed and therefore could not participate in the study. It is recommended that any further market surveys be done so as to include school lunch programs.

Secondly since there were no existing plants engaged in reprocessing shrimp waste into edible seafood, plant requirements and cost estimates were based on scale and cost data obtained from a similar processing firm in the study area. Since plant operating cost structure is firm-specific, it is recommended that any further studies attempt to sample processing firms in Quebec in order to get a more general cost estimate.

Thirdly, it was assumed that tough competition for shelf space and the high volumes of product required by grocery chain outlets would more than likely, prevent the product from entering or surviving the retail market. However, if retail launch is anticipated or desired by potential processors, then a shopping centre survey of consumers may be appropriate.

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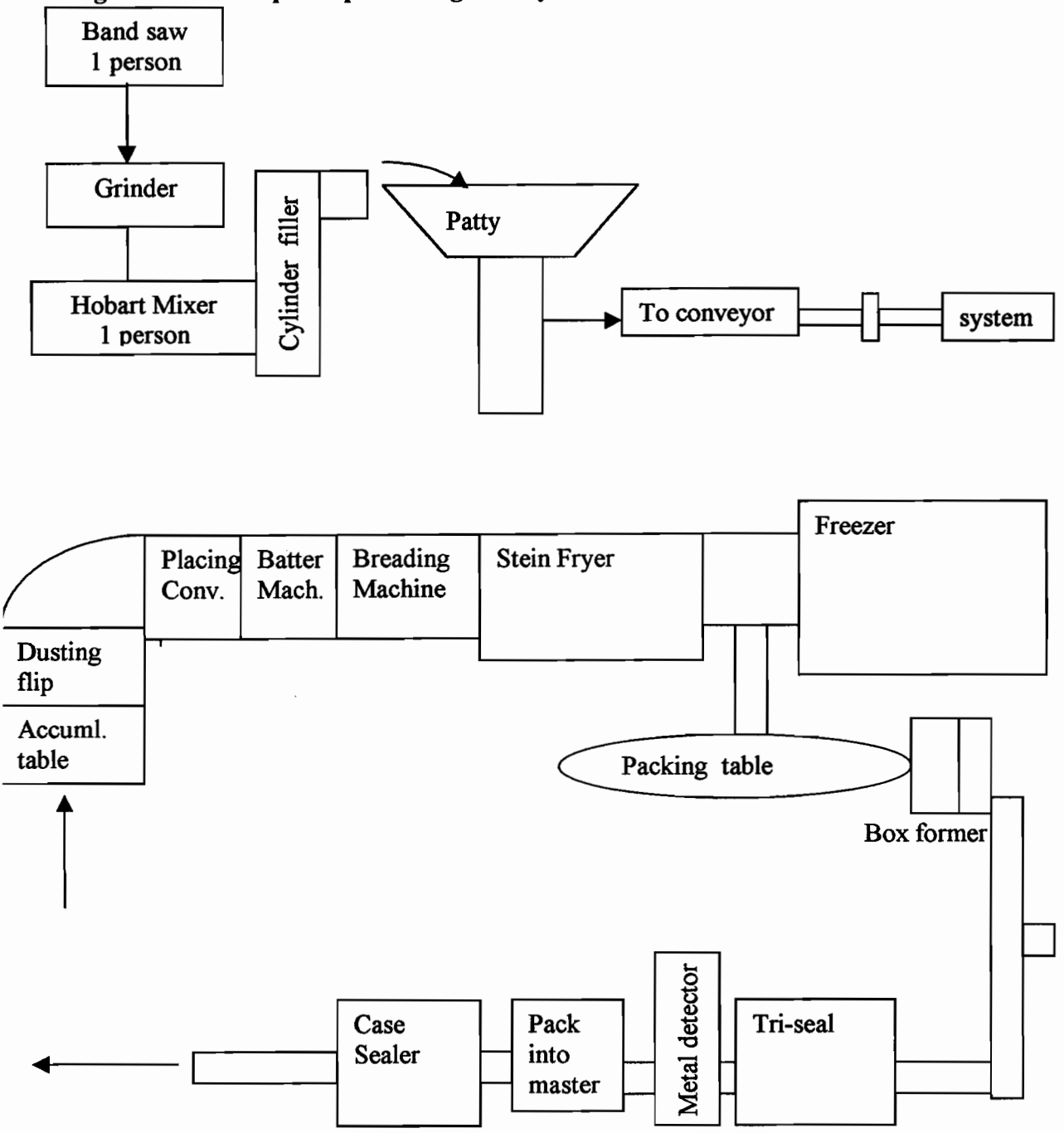
Appendix 2A

Figure 3: Proposed processing line layout



Appendix 2B

Summary statistics of responses demographic information elicited form a survey of foodservice Institutions in Montreal

Table 2B-1 Respondent categories by type of business

Type	Frequency	Valid Percent	Cumulative Percent
Fastfood	20	41.7	41.7
Formal	7	14.6	56.3
Casual/Family	19	39.6	95.8
Others	2	4.2	100.0
Total	48	100.0	

Table 2B-2. Average dinner entrée price.

	Frequency	Percent	Cumulative Percent
>$25	2	4.0	4.0
$ 20-25	2	4.0	8.0
$15 - 20	10	20.0	28.0
$10 - 15	8	16.0	44.0
<$10	10	20.0	64.0
<$5	18	36.0	100.0
Total	50	100.0	

Table 2B-3 Ownership distribution of survey respondents

	Frequency	Percent	Cumulative Percent
National chain	4	8.0	8.0
Provincial chain	5	10.0	18.0
Family/ Independent	41	82.0	100.0
Total	50	100.0	

Table 2B-4. Size of business as indicated by seating capacity of respondent restaurants.

Size	Frequency	Percent	Cumulative Percent
<50	15	30.0	30.0
50-100	21	42.0	72.0
101-150	7	14.0	86.0
151-200	4	8.0	94.0
>200	3	6.0	100.0
Total	50	100.0	

Appendix 2C

List of capital equipment items required for surimi/shrimp nugget processing line.

Equipment
Installed cost
Freezer
Fryer
Breading machine
Battering machine
Duster flip
Mixer/Grinder
Patty former
Cylinder filler
Conveyor
Box former
Band Saw
Boiling Kettle
Case Sealer
Check weigher
Large table

Appendix 2D

Table 2D-1: Estimation of annual operating cost for a 5000mt capacity surimi/shrimp processing line in an existing plant in Montreal,Quebec.

Capital Investment				Product(s)	Shrimp nuggets
	Total	4,320,495		Process	Value addition
	Less Working Capt.	335495		MEPI	133
	Less Salvage Value	630050		Annual operat. days	225
Fixed or	Depreciable Investm.	3,354,950		Annual Production Cap.	5,045,455
		Tripple shift	**Plant capacity**		
Materials		**Ann. Qty**		**Unit Cost**	**$/year**
Shrimp Broth (100% yield) kg		360576.9231		none	0
Surimi (kg)		1030219.78		$3.42	3,523,351.65
Kamaboko (kg)		1236263.736		$3.00	3,708,791.21
Breader (kg)		103021.978		1.352	139,285.71
Batter		412087.9121		0.5192	213,956.04
Duster		103021.978		0.3757	38,705.36
Wheat Flour		82417.58242		$1.60	131,868.13
Shrimp flavour		20604.3956		$52.73	1,086,469.78
calpro		10302.1978		$10.20	105,082.42
Spice Mix		45329.67033		$4.65	210,782.97
Vegetable oil		20604.3956		$1.33	27,403.85
Packaging material				$0.66	2,755,709.13
Total Weight		3424450.549	**Subtotal**		**11941406.25**
			Gross material cost		
By Product (Credit/Debit)					
Shrimp Waste (solid filtrate)					0
			Total credit/debit		0
			Net material costs		11941406.25
Other variable cost	unit			$/unit	$/year
Electricity	Kwh				51700
Heating					61700
Labour				$8.00	166700
Supervision	10-25% of labour **				29172
Payroll Charges	30-45% of lab. + Superv.				93000
Maintenance	2-10% of Invest. **				233400
Operating supplies	0.5-1.0% ' " " "				120000
Waste disposal@$30/ton					10817
Lab charges					65000
Royalties	1-5% of sales				0
Contingencies	1-5% of direct costs **				33000
			Total		**$864,489**
Fixed cost					
Depreciation	5-10% of Tot. Invest.				$259,230
Real Estate Taxes	1-2% " " " "				$30,000
Insurance	0.5 - 1.0% of Tot. Invest.				$8,000
General plant overhead	50-70% of lab.+sup.and Maint.				$8,000
			Total fixed cost		**$305,230**
			Total variable cost		**$1,169,719**
			Total production cost		**$13,111,125**
			Total cost FOB plant		$13,111,125
			Unit Production Cost		**$2.62**

Table 2D-2: Estimation of net annual cash flow for shrimp waste processing line in an existing seafood plant in Montreal, Quebec

	Annual cashflow Tripple shift (5400 hrs)
Total Investment	$4,320,495
Plant Capacity	5000000
Product Price $/kg	3.06
Annual sales	15300000
Finish Goods transfer freight	535500
Net annual sales	14764500
Direct Production Costs	12,805,896
Gross Operating Profit	**1,958,604**
Indirect costs	
Other Fixed overhead	46,000
Total indirect costs	46,000
Annual cashflow	**1,912,604**

Table 2D-3: Effect of level of output on net annual cash flow of surimi/shrimp processing line in an existing seafood processing plant in Montreal, Quebec.

	Annual cashflow		
	Tripple shift (5400 hr	Double shift (3600 hr	Single shift (1800 hrs)
Total Investment	4320495	4320495	4320495
Plant Capacity	5000000	3333348	1666674
Product Price $/kg	3.06	3.06	3.06
Annual sales	15300000	10200044.88	5100022.44
Finish Goods transfer freight	535500	357001.5708	153000.6732
Net annual sales	14764500	9843043.309	4947021.767
Direct Production Costs	12,805,896	8537298.765	$4,268,000
Gross Operating Profit	**1,958,604**	**1,305,745**	**679,022**
Indirect costs			
Other Fixed overhead	46,000	46,000	46,000
Total indirect costs	46,000	46,000	46,000
Annual cashflow	**1,912,604**	**1,259,745**	**633,022**

Table 2D-4: Estimation net annual cash flow for three plant output assumptions under different sensitivity scenarios

Net annual cashflow at different product prices

	10% increase			10% decrease		
	Single Shift (180	Double shift (3200 hrs)	Triple shift (5400 hr	Single Shift (1	Double shift (3200 hrs)	Triple shift (5400 hr
Total Investment	432,495	432,495	432,495	432,495	432,495	432,049
Plant Capacity	166,674	333,348	500,000	166,674	333,348	500,000
Product Price $/kg	3.4	3.4	3.4	2.72	2.72	2.7
Annual sales	566,691.6	1,133,383.2	1,700,000	453,353.28	906,706.56	1,360,000
Finish Goods transfer freight	17,000.748	34,001.496	51,000	13,600.5984	27,201.1968	40,800
Net annual sales	549,690.852	1,099,381.7	1,649,000	439,752.682	879,505.363	1,319,200
Direct Production Costs	$4,268,650	8,537,299.195	12,805,895	$4,268,650	8,537,299.195	12,805,89
Gross Operating Profit/loss	**1,228,041**	**2,456,083**	**3,684,105**	**128,703**	**257,406**	**386,10**
Indirect costs	46,000	46,000	46,000	46,000	46,000	46,00
Net annual cashflo	1,182,041	2,410,083	3,638,105	82,703	211,406	340,10