MARKET DEPLOYMENT PLANNING: AN EXECUTIVE FACTOR BASED OPTIMIZATION MODEL

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Market Deployment Planning: An Executive Factor Based Optimization Model

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Abstract: This paper introduces a novel systematic approach for market deployment planning of new ventures. This methodology exploits databases to surrogate market factor data and utilizes an optimization model via an interactive decision framework to generate a sustainable roadmap for decision makers in early phases of business ventures. Application of this model to a case study of a proposed business venture aiming to tackle natural disaster supply relief markets in the USA is used to demonstrate the usefulness, efficiency and capability of the model.

Keywords: *Market Deployment Plan, Optimization Model, Natural Disasters*

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1 INTRODUCTION

In today's fast-paced global economy, entrepreneurs increasingly tend to design their business ventures holistically during the early stages of business creation. They exploit business modeling methodologies as they aim for rapidity and a position where they will be well-poised for large-scale deployment. This paper focuses on an important, yet novel, decision process embedded in the global business design process: market deployment planning. The outcome of this decision process is a set of roadmap scenarios, each stating which markets is targeted for deployment at each phase of the development of the business (usually over a three to ten- year planning horizon). Markets (or market segments) can refer to countries, regions, cities, industries, niches, etc. The market deployment roadmap becomes a key tool for further development and planning the activities, resources, networks, financial flows and expected value creation of the business to be launched. The market deployment planning process can then extend past the early phases of a business and become a key element of its overall strategic planning process.

During the business design phase, the market deployment planning process is characterized by: (1) its fast pace with tight lead times; (2) an absence of comprehensive hard numbers and figures relative to all potential markets, partners, resources and sites; (3) a strong need for conceptual and strategic alignment with the character of the business and the type of offers and value creation processes to be put in to place; and (4) a need to build a realistic roadmap, detailed per market-year over a significant planning horizon, even though this roadmap will be dynamically revisited as the business takes shape and gets through its development and growth phases. The above characteristics are still representative in these latter phases, with the advantage that numbers and experience accumulate to help better steer the process. Developing a market deployment planning process can help managers select better target markets in order to achieve their market expansion plans and profit objectives as well as to decrease the associated risks of market expansion. This paper provides an optimization model to help managers, especially business development and marketing executives to make better market deployment planning decisions within the context of the proposed process. The model can be applied in a global context where managers want to make decisions relative to their deployment in international markets, or in more localized contexts such as within a country or continent. Considering the importance of natural disasters, supply relief solutions have demanded more attention from industry participants, service providers, local governments and people who live in areas which may be affected by these catastrophes. The paper uses the case of a business venture in this supply relief market to provide context to the introduction of the process and model, and to demonstrate the usefulness, efficiency and capability of the model. The paper is structured as follows. Section 2 includes a brief literature review including market deployment approaches and international market selection studies. Section 3 provides an overview of the proposed market deployment planning process. Section 4 describes the generic formulation of the proposed optimization model. Section 5 presents the case study, data set preparation, optimization model parameterization and the final market deployment roadmap resulting for this case study. Finally, section 6 provides concluding remarks and areas for further research.

2 LITERATURE REVIEW

When creating a new business venture, entrepreneurs must decide in which market segments to invest. To answer this question, firms normally develop a market growth plan, called a market horizon plan. In the market horizon planning process, market selection, expansion and deployment have been research topics for a long time as they represent a highly visible strategic domain for businesses, especially for entrepreneurs. According to Douglas and Craig (1992), international market selection has an essential role in the success or failure of multinational firms. Location is critical based on the resource view (Priem and Butler, 2001), transaction costs view (Brouthers, Brouthers, and Werner, 2003), and knowledge transfer (Kostova, 1999). Moreover, location can sustain a firm's competitive advantages, and selecting countries with larger market potential and stability lead to greater subsidiary performance (Cavusgil and Zou, 1994). Furthermore, the combination of location advantage and a firm's advantage can make for greater advantages for firms over their competitors (Makino, Lau and Yeh, 2002). Before considering market deployment studies, an overview of systematic approaches in the market selection literature is needed. Even if these markets need to be selected for international companies or global firms, or even for expansion purposes, the methodology and techniques proposed have the same framework. Hence, studying the market selection process in each context (local market selection, international market selection, global market selection or market expansion) can highlight a developing market deployment plan. Fish and Ruby (2009) provide a review of the efforts related to the process of international market selection. The authors mention three stages of this process: 1) market screening, 2) market identification and 3) market selection (Kumar et al, 1994; Anderson and Strandskov, 1998). Market screening with a preliminary list of markets for further study, based on macro variables with secondary data, is an essential phase of the market selection process.

Gaston-Breton & Martín (2011) highlighted the gaps in the literature on international market selection including the lack of considering consumer values. Domain specific studies lead to the development of a two stage market selection and segmentation model by integrating market attractiveness and consumer values in order to help decision makers identify and screen the most suitable European macro-regions, countries and groups of consumers. Sakarya et al. (2007), in a survey on market selection for emerging markets, reviewed assessment approaches for market selection. These approaches contain long-term market potential assessments from Arnold and Quelch's (1998) market demand-driven model, Hofstede's (1980, 2001) cultural dimensions to measure cultural distance (Morosini et al., 1994), and Porter's (1990) competitive analysis of an industrial sector. Sakarya et al. (2007) added customer receptiveness to these factors and introduced long-term market potential, cultural distance, competitive strength of the related industry and customer receptiveness as four measures for evaluating emerging markets for subsequent detailed analysis. On the other hand, quantitative approaches according to Papadopoulos and Denis (1988) are well-established for market potential assessment. These approaches, including market share estimation, market grouping and market ranking based on demands and enterprise capacities, can provide managers with more elaborate results during their decision-making process. The key benefits of a quantitative method for market screening are decreasing subjectivity in the process and the possibility of assessing a large number of markets (Kumar et al., 1994). Fish and Ruby (2009) noted some studies which applied quantitative approaches for market screening, including Sethi (1971) and Liander et al. (1967). The authors explained that the common strategies in quantitative approaches are based on similarities of criteria according to Kumar et al., (1994). Market estimation aims to differentiate and evaluate foreign markets according to criteria that measures market potential at the appropriate level of analysis (e.g.,Cavusgil et al.,(2004)address market potential assessment at the country level). Market grouping aims to create cohesive clusters of markets to be bundled for market expansion purposes. Finally, market ranking aims to prioritize selected markets or market clusters for expansion planning purposes. The term "market deployment" has been used in multiple ways for market growth purposes. Slotegraaf et al. (2003) defined market deployment as the level of actions focused on managing organizational resources in the market place. In another definition, market deployment is a part of a wider strategic process integrating product, operation modes, market selection and market expansion (Luostarinen & Gabrielsson, 2006). Tor et al, (2008) believe that in market expansion models, the operational parameters, such as the level of demand, the offering/bidding structures, and the uncertainty, are the key variables of long-term expansion. The multi-year structure of market expansion is applied in models that consider a dynamic expansion framework using ordinal optimization (Min. et al, 2007). The most important methods used to solve the market expansion problem are based on: linear programming (Hartung and Fisher, 1965), fuzzy analysis (Wei and Wang, 2009; Ou and Chou, 2009; Kiani Abari, 2012; Golsefid et al. 2012; Wibowo and Deng, 2012), neural networks (Brouthers, 2009) and data envelopment analysis (Shabani et al., 2013), but none of them provides a long-term view. We propose an optimization model using a dynamic planning view, which will be presented in this section.

3 PROPOSED MARKET DEPLOYMENT PROCESS

In this part, we explain the conceptual model for the market deployment plan. This framework presents a systematic approach with the benefits of a quantitative approach. The visualization techniques in this time-phased planning framework provide managers, particularly entrepreneurs in new business ventures, with a dynamic market deployment plan. Firms normally have the strategic intent to deploy new markets. The strategic desire for market deployment provides an insight into the minds of firm managers who seek to expand their regular market(s) to untested potential market(s). This ambition for expanding markets comes from the firm's vision, which is implemented by daring managers. The next step in reaching this goal is identifying the potential markets. These markets are determined based on the managers' gut feelings, firms' previous experiences and general information regarding market expansion. After uncovering the potential set of markets, we should find the executive factors (the various factors which define each potential market) for market deployment. These influencing factors determine market demand more specifically. These factors come from statistical data such as population, GDP (gross domestic product), gender, age, income, culture, religions, education level, etc. If the mangers are not able to find real data for all the executive factors, they could use surrogate data. A surrogate statistical data-base is used in order to support executive factors, and these factors are believed to reflect levels of market deployment. After data gathering for each factor, we can assess the market attractiveness based on different indicators, market growth rate and trade barriers. Following this, we should set firm goals based on the time horizon, which provides us with a road map outlook for market expansion. In reality, we are unable to take full advantage of this knowledge or make predictions as perfect and effective as possible. Based on optimization advantages, we can plan or carry out an economic activity with maximum efficiency. Hence developing an optimization model to implement this roadmap is required during this step. This optimization model is executed based on special objectives and a set of constraints such as budget, resources, the level of risk-taking and etcetera. This optimized roadmap needs to be assessed and evaluated. Based on their expectations, managers decide to either accept or reject this optimized road map. If the model is adequate, it can be saved as a potential roadmap scenario. Otherwise, the process must be repeated. In latter case, changing key parameters in objectives, constraints or market factors may be needed in order to obtain a satisfactory scenario. Moreover managers may have some interests in exploring alternative scenarios based on their needs. This well-organized process can aid managers in order to develop a market deployment roadmap. This process is shown in figure.1.

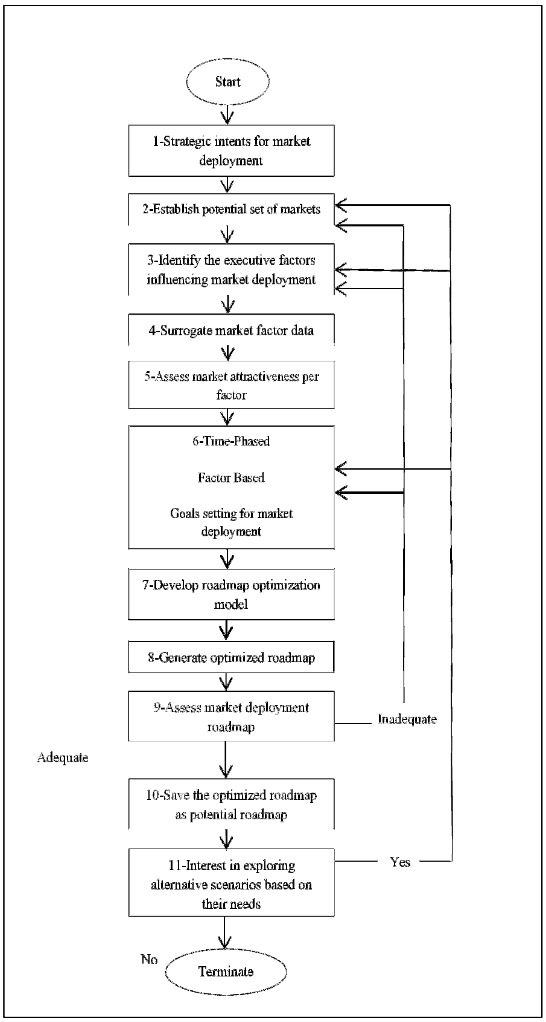

Figure 1: Market deployment planning process

The proposed methodology exploits the wide access to numerous databases providing statistics, facts and metrics for potential markets. It builds on these to specify and populate a set of strategic criteria reflecting the key characteristics of the markets for the business. Based on goals relative to market deployment and to performance relative to each criterion, the methodology optimizes market deployment. As explained above, the optimized roadmap needs to be assessed and evaluated by experts to be accepted or rejected.

4 PROPOSED MARKET DEPLOYMENT PLANNING OPTIMIZATION MODEL

In order to develop an optimization model supporting market deployment planning, we use an integer goal programming formulation. The key decisions are to whether or not launch deployment in a market in a period (e.g. quarter, year, business phase). The model exploits on one side the executive factors for goal setting and on the other side the financial information accessible on expected revenues and costs associated with specific deployment decisions. The mathematical notation and formulation are as follows:

Sets:

$\boldsymbol{F}$: Set of factors for which time-phased goals are specified

$\boldsymbol{F}^{bg}$: Set of factors with time-phased boundary goals

$\boldsymbol{F}^{tg}$: Set of factors with time-phased target goals

$\boldsymbol{T}$: Set of time periods in the planning horizon

$\boldsymbol{M}$: Set of all potential markets

$\boldsymbol{M_f}$: Set of markets to which factor f applies

Indices:

f: A factor

m: A market

t: A time period (e.g. a year or a business phase)

Variables:

$B_{ft}^{l^-}$: Negative deviation from target market window for each potential market's demand category to set deployed market for each potential market's demand category at time t

$B_{ft}^{u^+}$: Positive deviation from target market window for each potential market's demand category to set deployed market for each potential market's demand category at time t

D_{mt}: Deciding to deploy market m at time t

D_{ft}^{+}: Positive deviation from the total goal in proportion to total deployed markets in each specific market's population category at time t

D_{ft}^{-}: Negative deviation from the total goal in proportion to total deployed markets in each specific market's population category at time t

Parameters:

b_{ft}^{l} : Lower bound of each factor at time t

b_{ft}^{u} : Upper bound of each factor at time t

$b_{ft}^{u^+}$: Estimated cost for positive deviation from target deploying market at time t

$b_{ft}^{l^-}$: Estimated cost for negative deviation from target deploying market at time t

b_t : Upper bound of budget at time t

$c_{m\tau t}$: Expected present value of the generated cost by market m at time t over the planning horizon
d_{ft}^{-}: Estimated cost for negative deviation from the total target deploying market at time t
d_{ft}^{+}: Estimated cost for positive deviation from the total target deploying market at time t
g_{ft}: Total goal based on each market's population category at time t
p_{mt}: Expected present value to be generated by deploying market m at time t

$$Max\ Z = \sum_{\forall m \epsilon \boldsymbol{M}, \forall t \epsilon \boldsymbol{T}} p_{mt} D_{mt} - \sum_{f \in \boldsymbol{F}^{tg}, t \epsilon \boldsymbol{T}} (d_{ft}^{-} D_{ft}^{-} + d_{ft}^{+} D_{ft}^{+}) - \sum_{f \in F^{bg}, t \epsilon \boldsymbol{T}} (b_{ft}^{l^-} B_{ft}^{l^-} + b_{ft}^{u^+} B_{ft}^{u^+}) \quad (1)$$

Constraints:

$$\sum_{\forall\ t \epsilon \boldsymbol{T}} D_{mt}\ \leq 1; \forall\ m\ \epsilon\ \boldsymbol{M} \quad (2)$$

$$(\sum_{m \in M_f} D_{mt}) - D_{ft}^{+} + D_{ft}^{-} = g_{ft}\ ; \forall f \in \boldsymbol{F}^{tg}\ ; \forall\ t\ \epsilon\ \boldsymbol{T} \quad (3)$$

$$b_{ft}^{l} - B_{ft}^{l^-} \leq \sum_{m \in \boldsymbol{M}_f} D_{mt}\ \leq b_{ft}^{u} + B_{ft}^{u^+}; \forall f \in \boldsymbol{F}^{bg}\ ; \forall t \in \boldsymbol{T} \quad (4)$$

$$\sum_{m \in \boldsymbol{M}} \sum_{\tau \leq t} c_{m\tau t} D_{m\tau} \leq b_t\ ; \forall\ t\ \epsilon\ \boldsymbol{T} \quad (5)$$

$$\{B_{ft}^{l^-}, B_{ft}^{u^+}, D_{ft}^{-}, D_{ft}^{+}\} \in \boldsymbol{Z}^{+}; \forall\ f\ \epsilon\ \boldsymbol{F}, \forall\ t\ \epsilon\ \boldsymbol{T} \quad (6)$$

$$D_{mt} \in \{0,1\}\ ; \forall\ m\ \epsilon\ \boldsymbol{M}\ , \forall\ t\ \epsilon\ \boldsymbol{T} \quad (7)$$

The objective function (1) maximizes the expected present value from time-phased market deployment minus time-phased goal deviation costs over the planning horizon. Constraint set (2) ensures that the deployment of each market is launched at most once over the planning horizon. Constraint set (3) determines the positive or negative deviation from the target goal in term of number of deployed markets in time t within the factor-f market subset. Constraint (4) determines the deviation from the lower and upper boundary goals relative to the number of deployed markets in time t within the factor-f market subset. Note that constraint sets (3) and (4) may be expressed to allow more complex goal setting, for example with parameters weighing each decision variables, allowing numerous modeling variations as pertinent. Constraint set (5) express time-phased budget limitations bounding the expenses induced by market deployment decisions. Constraint set (6) enforces non-negativity of the goal deviation variables while (7) enforces the binary nature of market deployment decision variables. This model is a generic model for market deployment planning. Setting its markets, planning horizon, factor sets and parameters allows tailoring it to specific cases as is demonstrated hereafter for our case study.

5 CASE STUDY: methodology and results

Building a time phased set of market targets for deployment is a complex took due to having to deal with limitations of budget, the multiplicity of cities, the time-market combinatory and the pure size of the potential market set. Hence, a goal integer programming model is developed as a tool in order to achieve the market deployment road map in the GRS case study. The model selects cities in order to reach the objective function which is to maximize the expected present value from time-phased market deployment minus time-phased goal deviation costs over the planning horizon. A decision tool was developed with MATLAB. The details of data set preparation and optimization model parameter calculation are explained in the next sections. At the end, based on the stochastic nature of disaster probability, the uncertainty in estimated costs, the variability in GDP and population which affects the profit directly, framework also considered these three parameters as the scenario builder variables and we have this opportunity to perform the scenario (potential roadmap) analysis for this case study.

5.1. Business context

The mission poised for the GRS global business venture by its entrepreneurial team is to advance the readiness and response of worldwide client cities by empowering fast and consistent supply accessibility of effective tools and supplies before, during and after a natural disaster. For this purpose, the entrepreneurs are developing the multiple facets of GRS's business model and planning the roadmap towards a full implementation of their vision. Key to this roadmap is the elaboration of a market deployment plan from launching to maturity. The entrepreneurs intend to be serving cities covering most of the disaster-prone countries within a 15-year horizon. Preparing the USA portion of the market deployment plan is the subject of this case study. Given the strategic intent for GRS, the planning process of Figure 1 requires defining the set of potential geo markets. The team has first strategically decided to focus on metropolitan cities with a minimal population of 75,000 inhabitants. So the potential set includes 366 U.S metropolitan cities. City size has been selected as an executive market selection factor, as measured by its population, recorded from US census date (Metropolitan cities for 2009). City size relates both to the potential contract revenues and to the complexity of serving the city. The other selected executive factor is disaster risk for the city (see Skidmore and Toya, 2002). In the U.S.A., there are three types of natural disasters: earthquakes, tornadoes and hurricanes. Measures and goals for this factor have been set relative to each of these three types of disasters. Risk is dealt with here through hazard probability on one side and city vulnerability on the other side.

5.2. City-disaster risk factor data set

Estimating the city-disaster risk factor requires relying on a series of databases, involving approximate surrogate indicators. The process for generating the city-disaster risk factor data set and assessing the city-disaster couples is described in this section.

5.2.1 Selected cities formally defining risk in the context of natural disasters

Natural disasters can cause damage to human and social-economic development. Therefore the risk associated to these catastrophes is defined as the probability of occurrence coupled to the amount of damages caused by it during the following several years (Zhang et al., 2005). Similarly Borden et al. (2007) define risk as a measure that the probability of a hazard event will occur and adversely affect a population. Mortality and economic losses are two key elements in that regard (Dilley et al., 2005). Skidmore and Hideki (2007) report that significant variables affecting the number of deaths are the population, the land area and the disaster type. As the hazard and vulnerability are two essential parameters in the natural disaster risk function, we used them to calculate the risk in this study. In fact, the risk can be evaluated based on the interaction between hazard and vulnerability, as defined by equation set (8).

$$\boldsymbol{r_{dm}} = \boldsymbol{h_{dm}} \times \boldsymbol{v_m} \qquad \forall\, \boldsymbol{d} \in \boldsymbol{D}, \forall\, \boldsymbol{m} \in \boldsymbol{M} \tag{8}$$

In this equation set, D is the set of disaster types, $\boldsymbol{r_{dm}}$ is the risk of disaster for market m, $\boldsymbol{h_{dm}}$ is the disaster hazard for market m and $\boldsymbol{v_m}$ is the vulnerability of market m.

5.2.3. Hazard

"A Hazard represents an extreme natural event that adversely affects human life, property or activity and to the extent of causing a disaster with a certain degree of probability and severity"(Zhang et al., 2005, p.2). Borden et al. (2007) defined the hazard for natural disasters as the potential threat from an environmental process, such as a hurricane, tornado, or earthquake. In fact, the disaster hazard can be evaluated based on the interaction between disaster types and its sub type's number of occurrence and intensity, Eq (9).The disaster sub-types and the method for the hazard calculation of these three types of natural disasters are presented in section 5.3.

$$h_{dm} = \sum_{\forall l \in L_d} i_{dl}\, f_{dlm} \qquad \forall\, d \in \boldsymbol{D}, \forall\, m \in \boldsymbol{M} \tag{9}$$

In equation set (9)L_d is the set of levels for disaster type d i_{dl} is disaster type's intensity and f_{dlm} is the frequency for each sub disaster type.

5.2.4. Vulnerability

"Vulnerability denotes the degree of resistance of the asset and population against hazard. It decides the loss degree caused by hazard"(Zhang et al., 2005, p.3). Borden et al., (2007) consider "vulnerability" as the susceptibility to harm from the risk posed by hazard events at a particular location and the potential for social disruption. The authors studied the vulnerability of 132 urban areas in the U.S using three indexes of vulnerability: social, built environment, and hazard impact. We used this study in order to compute the vulnerability of cities to natural disasters. We utilized social and built environment vulnerability indices of this study and calculated the result for our dataset through interpolation. Vulnerability is calculated as the sum of two vulnerability indexes: social and built environment, Eq (10).

$$v_m = v_m^s + v_m^b \qquad \forall\, m \in \boldsymbol{M} \tag{10}$$

In this equation set V_m is vulnerability to disaster, v_m^s is social vulnerability for market m and v_m^b is built environment vulnerability for market m.

5.3. Natural disasters risk calculation

In this study we focused on three types of disasters: earthquakes, tornados and hurricanes. For earthquakes we used Seismic-Hazard Maps for the Conterminous United States, 2008. These summarize the available quantitative information about seismic ground motion hazard for the conterminous United States from geological and geophysical sources (Petersen et al., 2011). For tornados, we used Severe Weather Database Files(http://www.spc.noaa.gov/).The data base provides files for tornado, hail, and damaging wind data as compiled in Storm Data. We used the data from 1980 to 2010. These tables include the tornado name, the date and the time of incidence, the starting latitude, starting longitude, ending latitude and ending longitude and the wind speed, hail size or the intensity of tornado based on the Fujita Tornado Scale. We applied an algorithm in order to calculate occurrences by disaster types and subtypes. We searched the data base to find match cases for latitude and longitude of cities in our reference dataset, while considering a radius effect of each incident proportional to its intensity. Hence for each city, we considered several types of incidents over 30 years and used Eq. (9) to estimate the tornado hazard and we finally normalized the hazard. We applied the same approach for hurricane hazard. We used Database Files from the U.S National hurricane center and Saffir-Simpson Hurricane Wind Scale in this case. In order to calculate the hazard of disaster incident, we considered the frequency of each disasters sub type and its intensity, identifying those that lead to major damage. For tornado and hurricane cases, we took into account the frequency of disaster equal to or greater than F4 on the Fujita Tornado Scale and S3 on the Saffir-Simpson Hurricane Wind Scale in a 30 year history of disaster (1980-2010). The disasters with these intensities lead from moderate to major damage. Based on these scales the well-built framed homes may incur major damage and well-constructed houses leveled. For earthquakes, we considered the frequency of earthquakes greater than 6 on the Richter scale (we used a data base to extract this data). Maps of Natural disaster history in USA are shown in figure 2.

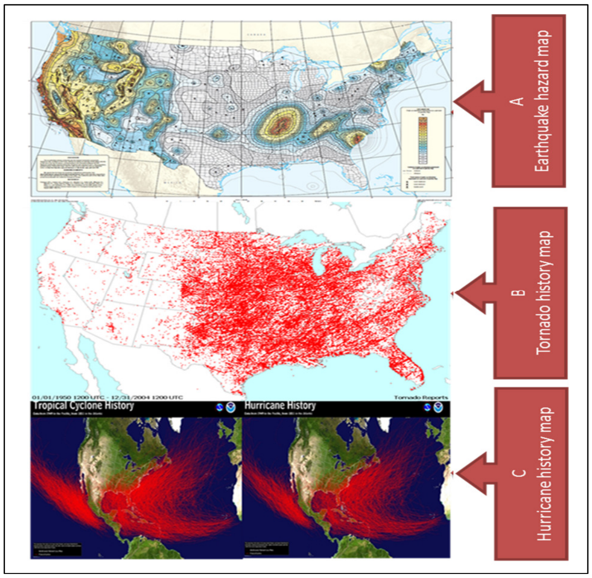

Figure 2: Maps of Natural disaster history in the USA[1] (A: Earthquake hazard map, B: Tornado history Map, C: Hurricane history map)

5.4.Present value estimation for time-phased market deployment decisions

After calculating the risk of each disaster type for each city (according to latitude and longitude of city), with the assumption of independency of disasters, in order to calculate the total expected present value from deployed market m at time t (p_{mt}), we use the following Eq (11):

$$p_{mt} = \sum_{\tau \geq t} \left(\frac{r_{m\tau t} - c_{m\tau t}}{(1+r)^{\tau}}\right); \quad \forall\, t \in \boldsymbol{T}, \forall\, m \in \boldsymbol{M} \qquad (11)$$

Where:

r: Interest rate
$r_{m\tau t}$: Expected revenue at time τ from market m deployed at time t
$c_{m\tau t}$: Expected total cost at time τ from market m deployed at time t

In order to calculate the revenue at time τ from market m deployed at time t ($r_{m\tau t}$), we used the following calculation. As we defined three categories of cities, in each category we used the following formula Eq (12):

$$r_{m\tau t} = \left(r^{l} + \frac{(p_{m\tau t} - p_m^{l})}{(p_m^{h} - p_m^{l})}\,(r^{h} - r^{l}) \right) f_{m\tau t}^{r} \;\; ;$$

$$\forall\, \tau \geq t \in \boldsymbol{T}, \forall\, t \in \boldsymbol{T}, \forall\, m \in \boldsymbol{M} \qquad (12)$$

Where:

$f_{m\tau t}^{r}$: Natural disaster risk factor influencing the potential of market m at time τ that deployed at time t (3 risk levels: High, medium and low with factors 0.5, 0.35 and 0.15)

$p_{m\tau t}$: Population of market m at time τ that deployed at time t

p_m^{l} : Lowest population of a market in the category in which market m belongs

p_m^{h} : Highest population of a market in the category in which market m belongs

r^{l} (Minimum contract value in target category): Average of GDP per Capita in target category (small, medium and large) × $\text{population}_{\text{low}}$ in target category (small, medium and large) × r^{b}

r^{h} (Maximum contract value in target category): Average of GDP per Capita in target category (small, medium and large) × $\text{population}_{\text{high}}$ in target category (small, medium and large) × r^{b}

r^{b} : Expected contract value per unit of city GDP (0.01 was used in this paper for illustrative purposes).

It should be noted that as we used city population and GDP in order to estimate the value of the contract, we multiplied the value by 0.01 to have a reasonable contract value.

In order to calculate the cost at time τ from market m deployed at time t ($c_{m\tau t}$), we use the following Eq(13):

$$c_{m\tau t} = c_{mt}^{I} + c_{m\tau t}^{OT} + \sum_{\forall d \in D} c_{dm\tau t}\, pr_{dm\tau t};$$

$$\forall\, \tau \geq t \in \boldsymbol{T}, \forall t \in \boldsymbol{T}, \forall m \in \boldsymbol{M} \qquad (13)$$

Where:

c_{mt}^{I} : Expected present value initial deployment cost from market m if deployment is initiated at time t
$c_{m\tau t}^{OT}$: Expected present value operation cost at time τ from market m deployed at time t
$c_{dm\tau t}$: Estimated costs in case of disaster d (for three types of disasters) at time τ from market m deployed at time t

[1] http://earthquake.usgs.gov/ ,http://www.spc.noaa.gov/ and http://www.nhc.noaa.gov/

$pr_{dm\tau t}$: Probability disaster d incident at time τ in market m deployed at time t

$pr_{dm\tau t} \in (0,1)\ ; \forall\ m \in \boldsymbol{M}\ , \forall\ \tau \geq t \in \boldsymbol{T}, \forall\ t \in \boldsymbol{T}$ (13-1)

Finally constraint (13-1) ensures that the value of probability of each type of disaster should be between zero and 1.

For estimation of acquisition costs in each city(c^{I}_{mt}), we considered the relevant costs including rents or buying of local offices, exploitation equipment, total payrolls (employees at local offices) and software and maintenance costs. Operation costs($c^{OT}_{m\tau t}$) including the employees are estimated based on a percentage of fixed costs and proportional to the population of each city. For estimation of costs of disaster occurrence($c_{dm\tau t}$), we assumed that the costs will be a percentage of GDP of each city (3% of GDP).Generally, the probability of an incident can be approximated by the relative frequency or proportion of times that the event occurs; hence the estimated probability of each disaster ($pr_{dm\tau t}$)will be the following Eq (14):

$$pr_{dm\tau t} = \sum_{\forall l \in L_d} (f_{dlm\tau t} \Big/ \sum_{\forall d \in D, \forall l \in L_d, \forall m \in M} f_{dlm\tau t})\ \ ; \forall\ t \in T \qquad (14)$$

In this equation $pr_{dm\tau t}$ is the probability of disaster d at time τ for deployed market m at time t and f_{dlm} is the frequency of disaster d with level l for market m and $\sum f_{dlm}$ is the total number of occurrences d with l level for all markets over 30 years. As we have three types of disasters including earthquake, tornado and hurricane, d will be 1, 2, 3, respectively.

5.4. Goal oriented optimization model parameters

The objective function of the model is about selecting city-time couples for time-phased market deployment over the planning horizon so as to obtain the maximal total expected present value. To help the decision makers we established classified cities category table based on population in three categories: SC (75000 ≤ small cities ≤ 100000), MC (100001 ≤ medium cities ≤ 500000) and LC (500001 ≤ large cities). In addition, in order to facilitate the market deployment planning, DMs have to set goals about the number of cities in each combination of disaster risk and city size categories. These goals define target aspiration levels for the number of selected cities and their associated disaster risks. This interactive mechanism for entering the target cities aid DMs in developing much more expediently their market deployment strategy considering their experience and the market context. We categorized disaster risk in three parts: low risk (lr); medium risk (mr) and high risk (hr) and the natural disaster risk of cities are calculated based on the sum of risks of three types of disasters : Earthquake (E), Tornado (T) and Hurricane (H). Considering three categories of cities (small, medium and large) and three types of disasters, we have 21 factors which are shown in Table 1.Let us assume now that the firm is investigating the possibility of establishing its own service facilities in 216 cities among of the 366 U.S metropolitan cities and as illustrated in Table 2, the decision maker entered the relevant data for a five year market deployment plan for this business venture.

5.5. Results

After substituting the data provided in Table 2 into the model and solving it using Matlab, the results in Table 3 are exploited. It provides the selected cities, population and total risk of disaster for each city over a 5-year horizon plan. The hazard of each disaster and vulnerability are defined as a number between 1 and 3 (1 for low and 3 for high value). Hence, based on Eq (8), the risk value is a number between 3 and 27. For example, Miami with high hazard in Hurricane and low hazard in the other disasters (3+1+1) and high vulnerability (3) has the risk value equal to 15. For the cities in the database, the minimum amount for risk is 3 and maximum is 18. For simplification, we used index (1-3) (low (3 to 7), medium (8 to 12), and high (14-18)). Therefore, Miami is a city with high risk of natural disasters and indexed with 3 in table 3. In this table, 122 small cities, 73 medium cities and 21 large cities have been selected.

The target parameters for market deployment planning have to be based on decision maker's experiences in market strategy. For insuring a gradual expansion, the number of markets over the horizon plan has been selected to reduce the associated risk of selecting too many hot spots too early (the cities with high level of natural disaster risk and population). This logic could be explained by the result of organization learning theory. In the first year, the cities with high population and risk have not been selected and the profit can be sustained with choosing the cities in small and medium categories. In the second year, two high-risk cities (one from "small category "and another from "medium category") are planned for deployment. The first experience of deploying into a city with high population has been planned in a city within the low risk category. The number of large and medium cities in high-risk category is increased gradually by the end of the plan while numbers of low risk small cities are also selected to keep the plan sound and profitable.

Provided the revenue and cost parameters used in this paper, the total expected present value through five years horizon plan are shown in table 4. It should be noted that the total expected present value of each year was calculated based on the cumulative values of the markets which have been selected for that year. The value amount of each selected market is the present value of the expected returns of that market for the rest of horizon which was discounted (8%) at time t. The high amount of the present value of the expected returns in fifth year is due to selecting 8 large cities, with six of them having population higher than 4.5 million inhabitants.For visualization purposes, the result of the five-year planning horizon based on data entered by the GRS decision maker is also shown on a US map in figure.3.The optimization model and process described in this paper can play a significant practical value role for management in planning market deployment. Indeed the relatively high complexity and large scale inherent in such problems motivated us to develop a model that could help managers in dealing with the multifaceted nature of the market deployment process.

F_f	Risk	Low						Medium						High						Target number of selected cities in each year
		minimum			maximum			minimum			maximum			minimum			maximum			
Small	Type	E	H	T	E	H	T	T	H	T	T	H	T	T	H	T	T	H	T	
	Factor	1			2			3			4			5			6			7
Medium	Type	E	H	T	E	H	T	T	H	T	T	H	T	T	H	T	T	H	T	
	Factor	8			9			10			11			12			13			14
Large	Type	E	H	T	E	H	T	T	H	T	T	H	T	T	H	T	T	H	T	
	Factor	15			16			17			18			19			20			21

Table 1: Executive factors

		Low risk lower bound (b^l_{ft})	Low risk upper bound (b^u_{ft})	Medium risk lower bound (b^l_{ft})	Medium risk upper bound (b^u_{ft})	High risk lower bound (b^l_{ft})	High risk upper bound (b^u_{ft})	Target number in each year (g_{ft})
Year 1	*Small cities*	3	7	2	6	0	0	10
	Medium cities	2	6	0	6	0	0	6
	Large cities	0	0	0	0	0	0	0
Year 2	*Small cities*	4	18	4	11	0	2	22
	Medium cities	0	2	2	5	0	4	6
	Large cities	0	2	0	2	0	2	2
Year 3	*Small cities*	6	10	5	20	1	2	27
	Medium cities	3	12	4	10	0	1	16
	Large cities	1	2	1	2	1	2	4
Year 4	*Small cities*	5	15	5	20	2	3	30
	Medium cities	3	3	4	12	2	3	17
	Large cities	3	7	2	6	1	2	7
Year 5	*Small cities*	7	12	5	20	3	3	33
	Medium cities	7	20	5	20	2	4	28
	Large cities	2	5	2	4	1	4	8

Table 2: Data entered by decision maker for a 5 year plan

Figure 3: Selected markets on a US map

	Year 1			Year 2			Year 3			Year 4			Year 5		
	City Name	Population	Risk	City Name	Population	Risk	City Name	Population	Risk	City Name	Population	Risk	City Name	Population	Risk
1	'Ithaca, NY'	101779	2	Jonesboro, AR'	120139	3	Anniston, AL'	114081	3	'Decatur, AL'	151399	3	'Greenville, NC'	179715	3
2	'Cape Girardeau, MO'	93712	2	Odessa, TX'	134625	2	'Dothan, AL'	142693	2	'Florence, AL'	144238	3	'Fort Walton Beach, FL'	178473	3
3	Columbus, IN'	76063	2	'Mansfield, OH'	124490	2	'Morristown, TN'	137612	2	'Oshkosh, WI'	163370	2	Jacksonville, NC'	173064	3
4	'San Angelo, TX'	110119	1	Manhattan, KS'	123086	2	'Auburn, AL'	135883	2	'Janesville, WI'	160155	2	'Johnson City, TN'	197381	2
5	Missoula, MT'	108623	1	'Victoria, TX'	115396	2	'Battle Creek, MI'	135616	2	'Jackson, MI'	159828	2	'Lafayette, IN'	196329	2
6	Corvallis, OR'	82605	1	Goldsboro, NC'	113811	2	'Sebastian, FL'	135167	2	'Dover, DE'	157741	2	'Athens, GA'	192222	2
7	'Great Falls, MT'	82178	1	Decatur, IL'	108204	2	'Napa, CA'	134650	2	'Burlington, NC'	150358	2	'St. Cloud, MN'	189148	2
8	'Danville, IL'	80067	1	Coeur d"Alene, ID'	139390	1	'Lebanon, PA'	130506	2	'Hanford, CA'	148764	2	'Gainesville, GA'	187743	2
9	'Sandusky, OH'	76963	1	St. George, UT'	137473	1	'Pittsfield, MA'	129288	2	'Madera, CA'	148632	2	'Bloomington, IN'	185598	2
10	'Casper, WY'	74508	1	La Crosse, WI'	132923	1	'Glens Falls, NY'	128774	2	'Rocky Mount, NC'	146596	2	'Anderson, SC'	184901	2
11	'Laredo, TX'	241438	1	Wausau, WI'	131612	1	'Altoona, PA'	126122	2	'State College, PA'	146212	2	'Kingston, NY'	181440	2
12	'Macon, GA'	231576	1	Flagstaff, AZ'	129849	1	'Weirton, WV'	120929	2	'Wheeling, WV'	144637	2	'Redding, CA'	181099	2
13	'Topeka, KS'	230824	1	'Idaho Falls, ID'	126131	1	'Bowling Green, KY'	120595	2	'Johnstown, PA'	143998	2	'Terre Haute, IN'	169825	2
14	'Las Cruces, NM'	206419	1	'Rapid City, SD'	124766	1	'Morgantown, WV'	120327	2	'Hattiesburg, MS'	143093	2	'Bloomington, IL'	167699	2
15	'Medford, OR'	201286	1	Harrisonburg, VA'	120271	1	'Lawrence, KS'	116383	2	'Springfield, OH'	139671	2	'Yuba City, CA'	165539	2
16	'Racine, WI'	200601	1	'Salisbury, MD'	120181	1	'Muncie, IN'	115192	2	'Texarkana, AR'	137486	2	'Albany, GA'	165440	2
17				'Williamsport, PA'	116840	1	'Owensboro, KY'	113636	2	'Dalton, GA'	134319	2	'Panama City, FL'	164767	2
18				'Sheboygan, WI'	114560	1	'Billings, MT'	154553	1	'Anderson, IN'	131417	2	'Parkersburg, WV'	160905	2
19				'Michigan City, IN'	111063	1	'Jefferson City, MO'	147438	1	'Logan, UT'	127945	2	'Abilene, TX'	160070	2
20				'Wenatchee, WA'	109937	1	'Wichita Falls, TX'	147421	1	St. Joseph, MO'	126644	2	'Vineland, NJ'	157745	2
21				Bay City, MI'	107434	1	'Grand Junction, CO'	146093	1	'Columbia, MO'	166234	1	'Punta Gorda, FL'	156952	2
22				'Danville, VA'	105814	1	'Sioux City, IA'	144360	1	'Waterloo, IA'	164913	1	'Pascagoula, MS'	155603	2
23				Longview, TX'	206874	3	'Valdosta, GA'	135804	1	'Eau Claire, WI'	160018	1	Monroe, MI'	152721	2
24				Burlington, VT'	208055	2	'Warner Robins, GA'	135715	1	'Blacksburg, VA'	159587	1	'Yuma, AZ'	196972	1
25				'Houma, LA'	202973	2	'Midland, TX'	132316	1	'Bend, OR'	158629	1	'Charlottesville, VA'	196766	1
26				'Elkhart, IN'	200502	2	'Farmington, NM'	124131	1	'Pueblo, CO'	157224	1	'Lake Havasu City, AZ'	194825	1
27				'Fargo, ND'	200102	2	'Winchester, VA'	123989	1	'Alexandria, LA'	154101	1	'Lake Charles, LA'	194138	1
28				Bellingham, WA'	200434	1	Tyler, TX'	204665	3	'Iowa City, IA'	152263	1	'Rochester, MN'	185618	1
29				'Rochester, NY'	1035566	1	'Champaign, IL'	226132	2	'Bangor, ME'	149419	1	'Joplin, MO'	174300	1
30				'Honolulu, Hawaii'	907574	1	'Chico, CA'	220577	2	'Santa Fe, NM'	147532	1	'Monroe, LA'	174086	1
31							College Station, TX'	212268	2	Huntsville, AL'	406316	3	'Muskegon, MI'	173951	1
32							Springfield, IL'	208182	2	'Ocala, FL'	328547	3	'El Centro, CA'	166874	1
33							'Florence, SC'	200653	2	'Tuscaloosa, AL'	210839	3	'Niles, MI'	160472	1
34							'Green Bay, WI'	304783	1	'Reading, PA'	407125	2	'Pensacola, FL'	455102	3
35							'Roanoke, VA'	300399	1	'Peoria, IL'	375865	2	'Santa Barbara, CA'	407057	3
36							'Duluth, MN'	276368	1	'Montgomery, Ala.'	366401	2	'Beaumont, TX'	378477	3
37							'San Luis Obispo, CA'	266971	1	'Kalamazoo, MI'	326634	2	'Corpus Christi, TX'	416095	3
38							'Cedar Rapids, IA'	256324	1	'Naples, FL'	318537	2	'Deltona, FL'	495890	2
39							'Lynchburg, VA'	247447	1	'Charleston, WV'	304214	2	'Winston, NC'	484921	2
40							'Kennewick, WA'	245649	1	'Utica, NY'	293280	2	'Santa Rosa, CA'	472102	2
41							'Appleton, WI'	221894	1	'Lubbock, TX'	276659	2	'Fayetteville, AR'	464623	2
42							'Barnstable Town, MA'	221151	1	'Myrtle Beach, SC'	263868	2	'Lansing, MI'	453603	2
43							'Prescott, AZ'	215686	1	'Amarillo, TX'	246474	2	Springfield, Mo.'	430900	2
44							Tulsa, Okla.'	929015	3	'Waco, TX'	233378	2	'Visalia, CA'	429668	2
45							Richmond, Va.'	1238187	2	'South Bend, IN'	317538	1	'York, PA'	428937	2
46							New Orleans, La.'	1189981	2	'Kingsport, TN'	305629	1	'Flint, MI'	424043	2
47							'Salt Lake City, Utah'	1130293	1	'Boulder, CO'	303482	1	'Fort Wayne, IN'	414315	2
48										Memphis, Tenn.'	1304926	3	'Asheville, NC'	412672	2
49										'Birmingham, Ala.'	1131070	3	'Mobile, Ala.'	411721	2
50										Jacksonville, Fla.'	1328144	2	Salinas, CA'	410370	2
51										Louisville, Ky.'	1258577	2	Vallejo, CA'	407234	2
52										'Las Vegas, Nev.'	1902834	1	'Port St. Lucie, FL'	406296	2
53										'San Jose, Calif.'	1839700	1	Killeen, TX'	379231	2
54										'Hartford, CT'	1195998	1	Davenport, IA'	379066	2
55													Lexington, KY'	470849	1
56													Spokane, Wash.'	468684	1
57													Reno, Nev.'	419261	1
58													Canton, OH'	408005	1
59													Manchester, N.H.'	405906	1
60													Anchorage, Alaska'	374553	1
61													Trenton, NJ'	366222	1
62													'Houston, Tex.'	5867489	3
63													Oklahoma City, Okla.'	1227278	3
64													'Dallas, Tex.'	6447615	3
65													Miami, Fla.'	5547051	3
66													'Philadelphia, Pa.'	5968252	2
67													Washington, D.C.'	5476241	2
68													'Boston, Mass.'	4588680	1
69													Sacramento, Calif.'	2127355	1

Table 3 : market deployment for GRS in a 5 year plan

For testing this model, we explored one hypothetical example that investigates the selection of 216 cities among 366 candidate cities in U.S as a part of GRS potential market. The main purpose of the quantitative example was to show that the information produced by the model can be a significant useful resource during the market deployment decision process plan and support the firm's managers in developing prized decision.

Year 1	Year 2	Year 3	Year 4	Year 5	Total expected present value
0,65	1,29	2,21	3,31	7.3	14.76

Table 4: Total profit through five years horizon (M$)

6 CONCLUSION

A firm's market strategy can be supported by optimization and visualization techniques simultaneously in order to give managers a clear picture of their strategies for development, evaluation of the different scenarios and risk aversion in the early stages of business planning. This paper presented an optimization model for business ventures to plan the market penetration pattern considering their target objectives. The paper fills an important gap in the literature as there are very few studies in the field of target market selection with decision support tools that consider time as an important factor for market deployment, and none of them applied a multi-executive factor-based approach exploiting the vast databases available across the world. This model is applied for a service provider in natural disasters, an illustrative case Global relief supply (GRS) that intends to improve the readiness and reaction of worldwide client cities in natural disaster cases, in order to show the capability of the model. The application of the proposed model by GRS entrepreneurial team to obtain 5, 10 and 15 year roadmap, provides the opportunity to anticipate the expected value of a market deployment plan where multiple executive factors are included in decision making process and data availability is sparse. Although most firms develop their international business gradually, some of them include international business activities in the early stages of their foundations. These firms are identified as Born Global (Gabrielsson et al., 2008). For these firms, developing an appropriate decision support tool in order to generate a sound market strategy is essential. Therefore, for future research, the methodology proposed in this study can be enriched in order to offer a market deployment plan for born global firms notably dealing with international regions. Moreover, there is a rich research avenue in investigating how to better incorporate the information related to the supply chain and logistic networks into the market deployment planning optimization approach. Finally, there is strong potential for research on the joint application of this optimization approach with geo-market clustering in order to develop time-phased market deployment plans guiding business and ventures through their growth, helping to master the huge the number of potential markets having to be selected and time-phased for deployment purposes.

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